Assessment of an Integrated Engineering General Education/Senior Project Course

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Abstract

San José State University (SJSU), as part of the California State University (CSU) system, required that all undergraduate degrees, including engineering, be reduced to no more than 120 units. The mandate necessitated change to the overall structure of the College of Engineering's upper division general education (GE) requirements. The result of the restructuring has yielded a new two-course sequence intended to establish a relationship between the student's classroom experiences and engineering in the community, both in the US and globally. Faculty in the engineering senior project classes then created GE activities linked to their specific majors. In addition to the university GE learning objectives, these courses meet ABET requirements. This integrated GE course sequence has been used for five years at SJSU. This paper describes the structure of the senior level GE course sequence and the evolution of this course over the past five years. Presently, most senior students take ENGR 195A/B concurrently with their two-semester senior project classes. Results indicate that approximately 95% of the students either met or exceeded the criterion for each GE student learning objective in the course. The overall assessment results indicate that this innovative structure has worked.

Introduction

Five years ago, the CSU Board of Trustees, to increase the four-year graduation rate and address budget issues, set a new policy: all undergraduate degrees, with a few exceptions, had to reduce to 120 semester units (credit hours). Since the late 1990s, the CSU had encouraged campuses to reduce the number of units required for bachelor's degrees to 120 units. By 2008, over 80% of the CSU degrees had been reduced. The CSU Board of Trustees decided to take a more proactive approach to this issue and mandated that all degree programs must be reduced to 120 units. The CSU allowed campuses to petition to retain majors with over 120 units; however, SJSU administration elected to require all degree programs be limited to 120 units and did not submit any petitions for excess units.

The timeline was brief and required that the CoE move quickly so that proposals for how to proceed could run through the appropriate channels for review and approval via campus curriculum committees by the April 2013 deadline. Many programs looked towards "double-counting" curriculum courses, which meant revising major courses to meet the GE requirements as well as the major requirements existing in the course.

This paper reports on one restructuring effort. SJSU students are required to take core GE courses in their first two years (English, speech, math, etc.). In their last two years, the university requires that students take upper-division GE (UDGE) courses (called "SJSU Studies"). For more than 10 years, the CoE has used a double-counted class, ENGR 100W: Engineering Reports, to meet both the upper division writing requirements for GE (alternatively known as Area Z) as well as one of the areas in SJSU Studies (Area R: Earth & Environment). Five years ago, the CoE decided to integrated the remaining two SJSU Studies areas (Area S: Self, Society & Equality in the U.S. and Area V: Culture, Civilization & Global Understanding) into the senior project classes. The revisions to the GE requirements were previously presented at ASEE (Backer & Sullivan-Green, 2016). Before the reduction to 120 units, SJSU engineering degrees consisted of 130 to 134 units. The reduction plan to 120 units included both double counting between GE and major courses and reducing required technical units for all degrees to 96 units.

The SJSU guidelines state, "the SJSU General Education Program incorporates the development of skills, the acquisition of knowledge, and the integration of knowledge through the study of facts, issues, and ideas. Regardless of major, all who earn undergraduate degrees should share common educational experiences, as they become university scholars. In combination with major, minor, and elective courses, the General Education curriculum should help students attain those attributes found in an educated person" (2014). It was our goal to meet some of these UDGE requirements in an engineering context. To do this, the UDGE program for engineering majors was designed to include part of the math and science core, stand-alone UDGE courses, and integrated engineering/UDGE courses.

Review of the Literature: Incorporating GE into STEM

The first two years of college for most STEM undergraduate students focus on gateway courses in calculus, physics, and chemistry. This process of completing pre-requisite courses while sitting in large lecture halls "weeds out" many students, with most dropouts from STEM majors occurring in the first two years (Griffith, 2010), and women and URM students leaving STEM majors at disproportionately higher rates (McDade, 1988; Chen & Thomas, 2009; Tyson, Lee, Borman, & Hanson, 2007). Hynes and Swenson (2013) believe that not only does it "weed" out students with weaker math and science skills; it also "weeds" out "people who may have been excited about working with people to solve problems that contribute to society." Previous research in STEM suggests female students prefer curricula that reflect real-world issues and focus on socially relevant material (Farrell, 2002; Thompson & Windschitl, 2005; Litchfield & Javernick-Will, 2015; Schaffhauser, 2017).

In 1985 the National Research Council (NRC) recommended that social context should be included in engineering and that engineers should be prepared "not just from a technical standpoint, but on a social basis as well." Recent reports from the NRC (2003) and the American

Association of Colleges and Universities (Global, 2007; Integrated, 2007) on STEM education have promoted integration for undergraduates because this is better preparation to address the interdisciplinary nature of current STEM problems. Several institutions (Amber, 1998) have integrated liberal arts content into STEM including the D80 Center at Michigan Technological University (Paterson & Fuchs, 2007), the Mortenson Center Engineering for Developing Communities at the University of Colorado (Amadei, 2003; Amadei & Sandekian, 2010), and the National Academy of Engineering's Grand Challenges initiative at several institutions (2008; 2017).

Research into motivation has demonstrated that student motivation can be changed by changing instruction. A key predictor of motivation is the relevance of the STEM course material. According to Cromley et al., this is "the students' perception that the content is valuable to them, either now or for future goals, such as their degree or career. Unfortunately, research shows that many undergraduates do not see the relevance of much gateway course content, such as calculus, and struggle in these required courses" (Cromley, Perez, & Kaplan, 2015). Research has shown that motivation is related to grades (Ironsmith, Marva, Harju, & Eppler, 2003; Obrentz, 2012; Zusho, Pintrich, & Coppola, 2003) and retention in a STEM major (Hurtado, Newman, Tran, & Chang, 2010; Jones, Paretti, Hein, & Knott, 2010).

For future engineers, industry has been calling for a more holistic approach to engineering education to provide graduates with better communication skills, a more thorough knowledge of the impact of engineering on society (Spinks, Silburn, & Birchall, 2006; Black, 1994), and an ability to understand the social impact of new technologies globally (Layton, 1986; Shuman, Besterfield-Sacre, & McGourt, 2005; Jonassen, Shen, Marra, Cho, Lo, L., & Lohani, 2009). Crane and Chiles note that one way to develop this critical understanding is through the partnership of STEM and Liberal Arts faculty (2011). The integration of GE and engineering content also addresses a retention issue with women engineering students: research into retention shows that women are retained in higher numbers if the engineering content *emphasizes the social aspect of engineering* (Berenson, Slaten, Williams, & Ho, 2004; Duncan, & Zeng, 2005; Zastavker, Ong, & Page, 2006; Swan, Paterson, & Bielefeldt, 2014).

One of the first initiatives to integrate liberal arts into engineering was the Sloan Foundation's New Liberal Arts Initiative of the 1980s-1990s. Despite this investment, there was little dissemination of the curriculum, and STEM knowledge was not well integrated in the liberal arts education in most universities. More recently, the Teague Foundation and the American Society for Engineering Education (ASEE) partnered on a new project that integrates liberal arts and engineering (2018). This ASEE project has resulted in over a dozen courses and programs across the US.

Faculty Learning Community

A key piece of this project has been the use of the faculty learning communities (FLCs) to create a cadre of engineering faculty committed to integrated liberal arts content in engineering coursework. The change model underlying our work for facilitating organizational change is the social-cognition model. Change is non-linear; further, it "is a multifaceted, interconnected, overlapping series of processes, obstacles and individuals" (Kezar & Reich, 2012). The metaphor

for change is based on the brain and includes complex and interrelated systems, mental models, and interpretation of new situations. A key to this model is sensemaking—a process of making sense out of change and ambiguity in the educational environment (Weick, 1995; Weick, Sutcliffe, & Obstfeld, 2005). The faculty work together in a multidisciplinary team through an FLC. Using the theory of change model (Eckel & Kezar, 2003), interdisciplinary teams facilitate discussions about beliefs and assumptions because faculty typically work in silos and are not asked why they hold particular beliefs or embrace particular techniques of teaching (Gioia, Thomas, Clark, & Chittipeddi, 1996). As Paguyo et al. note, "This part of professional identity development is a process of negotiation between the roles and expectations placed on a profession by society and the individual who enters the negotiation with their own abilities and desires" (Paguyo, Atadero, Rambo-Hernadez, & Francis, 2015).

Based on the social cognition model, we used the community of inquiry (CoI) framework as the basis for our curricular development and our FLCs. The CoI has three components: cognitive presence, social presence, and teaching presence. Social presence is defined as the "ability to project one's self and establish personal and purposeful relationships" (Garrison, 2007). Cognitive presence is a cyclic process whereby participants move from understanding the problem to exploration, integration, and application. Teaching presence includes two factors: design of the instructional environment and "directed facilitation" (Shea, 2006). Originally developed by Garrison and Vaughn (2007) for blended learning with online and in-class components, we apply this model to our revised classes. At the same time, we see the CoI framework as guiding the discussions in our FLCs.

We have aligned our plan for FLCs with our project's theory of change; FLCs foster constructive interactions and allow faculty to explore their mental models about teaching. We have purposefully designed our FLC to foster faculty leadership and empower faculty to be change agents in their departments and at SJSU (Kezar & Reich, 2012). Research shows that successful FLCs are aligned with organizational goals (Shulman, Cox, & Richlin, 2004), cognitively independent and socially interdependent (Vaughan, 2004), and include people capable of leading and influencing change within their department or the university (Vaughan, 2004). Facilitation is important for fostering an inclusive and action-oriented FLC (Sandell, Wigley, & Kovalchick, 2004). Also, women and other URM STEM faculty are generally "socialized in collectivistic cultures where collaboration rather than competition serves as the energizing force and underlying value" (Petrone & Ortquist-Ahrens, 2004). The FLC model can become a place where "teachers develop powerful pedagogical strategies that support the learning of all students" (Decker Lardner, 2003).

The senior project faculty, along with the general education faculty who teach ENGR 195A and ENGR 195B, have formed an FLC aligned with the GE content of the senior project class. Each semester, the engineering senior project faculty and course coordinators meet with the ENGR 195A/B coordinator and instructors of the GE senior project courses to discuss issues and potential improvements to the course. Each semester, our goal is to improve the GE content and delivery in ENGR 195A and B as well as enhance the interrelation between those courses and the senior project classes.

Structure of the Engineering SJSU Studies Course Sequence

To receive credit for SJSU Studies, students must complete a two-semester course sequence, consisting of four complementary courses, and maintain grades of C or better. The two general courses, ENGR 195A and ENGR 195B, coincide with Semester 1 and Semester 2 of students' senior project courses, which are specific to each major. ENGR 195A and ENGR 195B meet two hours per week for mini-lectures and presentations, followed by small group discussions. Three modules are completed each semester.

ENGR 195A and ENGR 195B is a two-course sequence that supports the integration of SJSU Studies Area S (Self, Society, & Equality in the U.S.) and Area V (Culture, Civilization, & Global Understanding) into the engineering major. The goal of UDGE at SJSU is to assist students in becoming critical thinkers who can connect ideas and concepts across various spheres. The College of Engineering holds that it is crucial to the success of engineering students to have integrated UDGE student learning outcomes within the engineering curriculum. These two courses challenge students to understand the role and importance of engineering and thus their work and responsibilities as future engineers, both domestically and to the greater global community. This class sequence uses a case study approach where students can reflect on the social, ethical, and cultural aspects of engineering. Each case study addresses one or more of the student learning objectives (LOs) in Areas S and V. Assignments in the ENGR course sequence are tied to activities and assignments in the senior project courses, which are discipline-specific.

Implementation of the Course Sequence

The 2013-2014 academic year piloted a modules-based system developed by the GE faculty. This system was developed with flexibility in mind. The new system allowed changes to be made by additional faculty members and encouraged more discipline-focused case studies. Every case study module has specific materials for students' learning experiences, including written material and resource links, a set of discussion questions, and a series of written assignments. The various themes addressed in each module provide the foundation for end-of-semester "application papers," where students address social, environmental, and cultural issues inherent in their own senior design project. The ENGR 195A/B courses are already included into the syllabi of senior project courses.

All LOs in UDGE Areas S and V are adequately addressed in ENGR 195A/B when integrated with the complementary student senior project work. The eight CoE programs offer many case studies and discussion questions relevant to each discipline. In addition to the case studies covered in ENGR 195 A/B, this system has students apply these concepts to their own senior project. Case study and discussion themes are listed in all senior project syllabi to emphasize the relationship between the content in the co-requisite courses.

A professor in the College of Engineering acts as the course coordinator for ENGR 195 A/B. All assignments in ENGR 195A/B require grading rubrics, which are reviewed by the coordinator to ensure that they meet the global rubrics for Areas S and V. The coordinator also schedules the instructors for the ENGR195A/B courses, provides an orientation for the students in ENGR 195A/B in the first weeks of class each semester, works with all faculty in ENGR 195A/B and

the senior project classes on creating and revising rubrics for GE assignments, completes and submits the "GE Coordinator Summary Report to Undergraduate Studies," manages semester schedules for ENGR 195A/B and collaborates with the instructors in the senior project classes to ensure the schedules are complementary to their classes, and revises the composite syllabi for ENGR 195A/B, making sure that the assignments for each senior project class and ENGR 195A/B have been updated.

The engineering senior project classes involve either a one-year team or individual project. In the first course in the sequence, students work on project definition, analysis, and design. In the second course, generally they work on construction and testing. Regular class sessions of the senior project courses involve a few lectures, but most course time involves team meetings, project work sessions, and/or presentations. In addition to an engineering project, senior engineering students also participate in discussions of GE topics in relation to their chosen profession in engineering.

The first two pilot years of ENGR 195A/B were taught by three different instructors in each class, one per module. This led to inconsistencies in grading of the assignments. There was no relationship between the grades from the instructor of Module 1 to the grades from instructors for Modules 2 and 3. Students surveyed in the class believed that they did not know how to improve their submissions over the semester since each instructor graded the work totally differently. This led to a change in the staffing of the courses for the 2016-2017 academic year. Instead of three different module instructors in each course, one instructor for each course teaches all three modules.

The faculty teaching the engineering senior project classes requested graders from the College of Engineering to assist in grading GE assignments. As a pilot, the College of Engineering hired a team of graders in 2016-2017 to work with all the engineering senior project instructors in grading the UDGE assignments for the engineering senior project classes. The course coordinator of ENGR 195A/B trains and supervises the graders. Training and coordination of the graders have led to more consistency across the senior project classes in the grading of UDGE assignments. In response to problems in the coordination between the ENGR 195A/B classes and the senior project classes, additional efforts were put in place in AY 2016-2017 to improve the synchronization between the paired courses. These efforts included additional training for the engineering faculty, regular meetings between the coordinator and engineering faculty, and a collaborative meeting each semester between the coordinator, senior project faculty, and the ENGR 195A/B instructors.

Each department can decide whether to allow students to begin their senior project in any semester or only the fall semester. Based on that curricular decision, enrollment for ENGR 195A/B fluctuates. Enrollment for ENGR 195A is larger in the fall semesters and enrollment for ENGR 195B is larger in the spring semesters. Table 1 displays the enrollment in ENGR 195A and ENGR 195 B for the last academic year.

Table 1. Distribution of students by major, AY 2017-2018 ENGR 195A & ENGR 195B.

	Fall 2017		Spring 2018	
Major	**ENGR 195A**	**ENGR 195B**	**ENGR 195A**	**ENGR 195B**
Aerospace Engineering	61	1		57
Biomedical Engineering	61			58
Chemical Engineering	35			37
Computer Engineering	22	27	21	22
Electrical Engineering	57	49	68	56
Materials Engineering	6			6
Mechanical Engineering	164	4	1	165
Software Engineering	48	33	46	47
Other	2	1	1	
Total	456	115	137	448

Assessment of This SJSU Studies Sequence

The composite ENGR 195A/B syllabi and the individual department senior project syllabi both include GE assignments. Students write their papers individually based on Area S LOs (in ENGR 195A and in the first senior project course) and based on Area V LOs (in ENGR 195B and in the second senior project course). Figure 2 shows the ENGR 195A assignments and the senior project assignments for student learning objective V-LO3.

V-LO3: Explain how a culture outside the U.S. has changed in response to internal and external pressures.

- ENGR 195B Reflection Paper 3 (500-750 words): Locate some technology, such as an application, mobile technology, or non-software based technology. Do research on how that technology has had a social impact on a culture or group of people outside of the US, regardless of where it was first designed and developed. Write an essay that addresses the topic above. You should be specific and cite specific details from the readings, class lectures, or your own research. You should cite specific events and/or cultures. Also, you should make sure to cite your sources in your response and include a reference list at the end of your essay. (Word count: 500-750 words; up to 1500 words maximum).
- AE171B – Essay 3 (minimum 500 words): Assume your airplane will go into production in the US. Describe how your product will put pressure on a culture outside the US. (Choose a specific country.) Use the social and cultural processes introduced in ENGR 195A&B to guide your answer.
- AE172B – Essay 3 (minimum 500 words): Assume your spacecraft will go into production in the US. Describe how your product will put pressure on a culture outside the U.S. (choose a specific country.) Use the social and cultural processes introduced in ENGR 195A&B to guide your answer.
- BME 198B Case Study 1: Explain how an African community has been affected by the availability of medical care or lack thereof (minimum 500 words).
- CMPE/SE 195B, BME 198B, MatE Essay 3: Assume your project has become very successful in the U.S. Describe how your product will put pressure on a culture outside the U.S. (You have to choose a specific country). Use the social and cultural processes introduced in ENGR195A&B to guide your answer (minimum 500 words).
- ENGR 195D Case Study 1: Pick a societal problem (homelessness, mass incarceration, cyber security, etc.). Select a country whose culture has changed to address this problem based on internal and external pressures (minimum 500 words).
- ENGR 195D Case Study 2: Select how a product related to your major has put pressure on a specific culture outside the USA. How has the culture been changed by this specific product? (500-750 words)
- ME 195b Individual Writing Assignment 2: Research one of the following renewable energy projects. Describe the cultural and social factors that led to these projects. Describe how these projects (Narmada Valley Dam Project (India), 3 Gorges Dam Project (China), Nam Theun-Hinboun Hydropower Project

(Laos)) have evolved and influenced the culture of the country where they are located. If you were working on one of these projects and were a member of the National Society of Professional Engineers, what aspects of their codes of ethics would affect your work? In what way? Minimum word count: 400

Figure 2. Sample assignments for ENGR 195A and ENGR 195B for Area V.

Like all SJSU general education courses, there is a minimum word count requirement for these courses. All students, independent of their discipline, complete the same writing assignments for ENGR 195A and ENGR 195B, three essays in each class. In addition, there are minimum length complementary essays in each senior project course.

Detailed rubrics were developed in Canvas, SJSU's learning management system, to assess student achievement of the LOs (does not meet, meets, exceeds). Students receive written feedback both on grammar/sentence structure/organization and on content using the SpeedGrader function in Canvas.

The Fall 2017 enrollment was significantly higher than previous years. Overall, there were 460 students enrolled in ENGR 195A in Fall 2017 and 115 students enrolled in ENGR 195B. This increased number reflects the reduction to 120 units (discussed previously) as well as an SJSU effort to enroll more engineering majors as freshmen and transfer students.

In Fall 2017, the SJSU College of Engineering undertook its ABET reaccreditation. As part of the process, the College presented the senior project sequence as meeting ABET criteria (j) "a knowledge of contemporary issues" and (h) "the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context." As well, SJSU uses the senior project sequence to partially fulfill ABET criteria (f) "an understanding of professional and ethical responsibility" (ABET, 2013).

Each year, all GE courses at SJSU must submit an assessment report that records the effectiveness of the course in meeting the GE learning objectives. The college submits two assessment reports each year to the university, one for ENGR 195A and one for ENGR 195B. In addition, each of the engineering departments submits an assessment report for the partnered senior project course sequences.

ENGR 195A Assessment Results

For ENGR 195A, there are four required GE student LOs. S-LO 1 is "Describe how identities (i.e., religious, gender, ethnic, racial, class, sexual orientation, disability, and/or age) are shaped by cultural and societal influences within contexts of equality and inequality" (SJSU, 2014). The results for S-LO1 for AY 2017-2018 are shown in Table 2.

Table 2. Results of student achievement on S-LO1, AY 2017-2018.

Number of students	Fall 2016	Fall 2017	Spring 2018	Total (2017-2018)
Students who did not meet the criterion	35	4	21	25 (4%)
Students who met the criterion	89	65	25	90 (15%)
Students who exceeded the criterion	261	385	87	472 (80%)

Students who did not submit assignment	0	2	4	6
Total Students	384	456	137	593

Because students traditionally had difficulty with this LO, it was moved it to the last essay in the class. Comparing Fall 2017 and Spring 2018 to Fall 2016, more students met or exceeded the criterion after this change was implemented.

S-LO 2 is "Describe historical, social, political, and economic processes producing diversity, equality, and structured inequalities in the U.S." (SJSU, 2014). Overall, the results from the AY 2017-2018 assessment are consistent with the 2016-2017 results. The instructor worked on the rubric and grading in the class; therefore, fewer students in 2017-2018 received "exceeded the criterion." However, the combined numbers of met or exceeded the criterion are similar to 2016-2017.

Table 3. Results of student achievement on S-LO2, AY 2017-2018.

Number of students	Fall 2017	Spring 2018	Total 2017-18	Total 2016-17
Students who did not meet the criterion	13	9	22 (4%)	0
Students who met the criterion	76	56	132 (22%)	52 (10.4%)
Students who exceeded the criterion	359	70	429 (72%)	442 (85.6%)
Students who did not submit assignment	8	2	10 (2 %)	5 (1 %)
Total Students	456	137	593	499

Overall, the results from the AY 2017-2018 assessment are consistent with the 2016-2017 results. The instructor worked on the rubric and grading in the class; therefore, fewer students in 2017-2018 received "exceeded the criterion." However, the combined numbers of met or exceeded the criterion are similar to 2016-2017.

One assignment in the class was used to assess both S-LO3 ("Describe social actions which have led to greater equality and social justice in the U.S.") and S-LO4 ("Recognize and appreciate constructive interactions between people from different cultural, racial, and ethnic groups within the U.S.") (SJSU, 2014). Overall, the results from the AY 2017-2018 assessment are consistent with the 2016-2017 results. The combined numbers of met or exceeded the criterion are similar to 2016-2017.

Table 4. Results of student achievement on S-LO3 and S-LO4, AY 2017-2018.

Number of students	**Fall 2017**	**Spring 2018**	**Total 2017-18**	**Total 2016-2017**
Students who did not meet the criterion	4	21	25 (4%)	4 (<1%)
Students who met the criterion	65	25	90 (15%)	43 (8.6%)
Students who exceeded the criterion	385	87	472 (80%)	446 (89.4%)
Students who did not submit assignment	2	4	6	6
Total Students	456	137	593	499

For all the S-LOs, the achievement numbers are lower in the Spring semesters when compared to the Fall semesters. As shown in Table 1, there are different majors in the class in Spring, predominately Computer Engineering, Electrical Engineering, and Software Engineering. The course coordinator will work with the department coordinators of these majors on strategies to

improve achievement numbers. Also, in Fall 2018, the lead instructor for ENGR 195A will work with the engineering faculty on the content and course assignments for both ENGR 195A and the accompanying major assignments.

ENGR 195B Assessment Results

There are three GE student learning objectives for ENGR 195B; V-LO1 is "Compare systematically the ideas, values, images, cultural artifacts, economic structures, technological developments, and/or attitudes of people from more than one culture outside the U.S." (SJSU, 2014).

The results from the assessment of LO V-LO1 are displayed in Table 5. 94% of the students in AY 2017-2018 either met or exceeded the criteria for this LO. This is an improvement over the results from 2016-2017. The instructor of this class has worked on improving the class content related to this LO so that students understand the material in greater depth.

Table 5. Results of student achievement on V-LO1, AY 2017-2018.

Number of students	Fall 2017	Spring 2018	Total 2017-2018	Total 2016-2017
Students who did not meet the criterion	8	18	26 (5%)	10 (2.3%)
Students who met the criterion	74	115	189 (34%)	139 (32%)
Students who exceeded the criterion	32	308	340 (60%)	282 (64.8%)
Students who did not submit assignment	1	7	8 (1%)	4 (<1%)
Total Students	115	448	563	435

V-LO2 is "Identify the historical context of ideas and cultural traditions outside the U.S. and how they have influenced American culture" (SJSU, 2014). 94% of the students in AY 2017-2018 either met or exceeded the criteria for this LO (see Table 6). This is an improvement over the results from 2016-2017. The instructor of this class has worked on improving the class content related to this LO so that students understand the material in greater depth.

Table 6. Results of student achievement on V-LO2, AY 2017-2018.

Number of students	Fall 2017	Spring 2018	Total 2017-2018	Total 2016-2017
Students who did not meet the criterion	5	14	19 (3%)	10 (2.3%)
Students who met the criterion	55	75	130 (23%)	139 (32%)
Students who exceeded the criterion	52	345	397 (71%)	282 (64.8%)
Students who did not submit assignment	3	14	17 (3%)	4 (<1%)
Total Students	115	448	563	435

V-LO3 is "Explain how a culture outside the U.S. has changed in response to internal and external pressures" (SJSU, 2014). The achievement level of students on this LO is lower in 2017-2018 as compared to 2016-2017 (see Table 7). The instructor gave the students more time (until 5/23 in Spring 2018). Inadvertently, this might have caused the reduction in student achievement. Since the students in ENGR 195B are finishing their senior projects at that time, they probably did not spend enough time on this assignment. The course coordinator and instructor for this class will meet to discuss this LO and work on improvement strategies.

Table 7. Results of student achievement on V-LO3, AY 2016-2017.

Number of students	**Fall 2017**	**Spring 2018**	**Total 2017-2018**	**Total 2016-2017**
Students who did not meet the criterion	12	84	96 (17%)	17 (3.9%)
Students who met the criterion	48	138	186 (33%)	197 (45.3%)
Students who exceeded the criterion	51	216	267 (47%)	214 (49.2%)
Students who did not submit assignment	4	10	14 (2%)	8 (1.8%)
Total Students	115	448	563	435

Assessment of the Complementary Senior Project Courses

As part of the continuous improvement of the GE portion of the senior project classes, the College undertook an analysis of the student outcomes from the engineering senior project courses. We investigated the mean, median and standard deviation of all GE essays in the engineering senior project classes in Fall 2017 (see Table 8) and Spring 2018 (see Table 9). In particular, we focused on essays that had low mean grades (indicated in yellow) and those with high standard deviations (indicated in green). The course coordinator and the engineering senior project instructors are going to work on these assignments.

Table 8. Assessment results of engineering senior project classes, Fall 2017.

AE 171A	Essay 1--Identity	Essay 2--Diversity and Equality	Essay 3--Social Justice	Essay 4--Environmental Responsibility
Maximum points	50	55	55	50
Mean	43.5 (87%)	47.15 (85.7%)	47.26 (85.9%)	39.9 (79.8%)
Median	46.50	47.00	48.50	42.00
SD	8.45	4.61	6.05	10.79

AE 172A	Reflection 1--Consider a negative side effect of space technology.	Reflection 2--Diversity and Equality	Reflection 3--Social Justice	Reflection 4--Identity
Maximum points	50	60	60	50
Mean	41.75 (83.5%)	48.16 (80.3%)	53.08 (88.5%)	48.5 (97%)
Median	42.00	49.00	54.50	49.00
SD	7.15	9.48	6.63	1.70

BME 198A (combined)	Reflection 1--Identity	Reflection 2--inequalities in healthcare	Reflection 3--access and beneficence	Reflection 4--Interactions between classes
Maximum points	60	65	45	65
Mean	52.39 (87.3%)	58.37 (89.8%)	35.37 (78.6%)	50.8 (78.2%)
Median	55.00	61.00	36.00	53.50
SD	9.29	9.09	7.83	12.08

CMPE 195A	Essay 1--Identity	Essay 2--Diversity and Equality	Essay 3--Social Justice	Essay 4--Interactions
Maximum points	50	75	50	75
Mean	42.17 (84.3%)	56.67 (75.6%)	42.05 (84.1%)	63.3 (84.3%)
Median	49.00	58.00	44.00	69.00
SD	12.07	11.84	8.54	13.15

CMPE 195B	Essay 1--Culture outside U.S.	Essay 2--Influences on U.S. culture	Essay 3 Case Study--Cultural change outside U.S.
Maximum points	35	35	30
Mean	27.02 (77.1%)	26.47 (75.6%)	24.2 (80.7%)
Median	28.50	28.50	25.00
SD	7.46	9.58	7.14

EE 198A	*5 year plan (includes identities)	*Area S: SV Symposium	Reflection Paper 1--Social Justice	*Area S Meeting 1 (includes GELO2)
Maximum points	50	5	50	40
Mean	46.3 (92.7%)	4.3 (86.7%)	38.87 (77.7%)	37.16 (92.9%)
Median	47.00	5.00	40.00	38.00
SD	3.39	1.71	10.21	2.95

EE 198B	GELO 2, Essay 1: "Technology invented outside of the U.S."	GELO 1, Reflection paper 1: "Successful Company"	Area V Meeting 1 (includes GELO 2)	Area V Meeting 2 (includes GELO 2)
Maximum points	100	100	40	30
Mean	82.65	87.56	39.22	27.31
Median	88.00	94.00	40.00	30.00
SD	14.69	11.66	1.42	4.30

ENGR 195C	Essay 1--GELO 4	Essay 2--Diversity and Equality	Essay 3--Social Justice	Essay 4--GELO 1
Maximum points	65	55	55	50
Mean	57.8 (88.9%)	36.4 (66.2%)	45.03 (81.2%)	43.25 (86.5%)
Median	59.00	38.00	45.50	42.00
SD	4.94	14.32	7.77	5.11

MatE 198A	Reflection 1--Identity	Reflection 2--Diversity and Equality	Reflection 3--Social Justice	Reflection 4--Interactions between cultures and classes
Maximum points	50	50	55	60
Mean	42 (84%)	41.5 (83%)	41.7 (75.8%)	only 4 out of 7 students submitted assignment
Median	42.50	42.00	45.50	
SD	6.58	5.19	12.35	

ME 195A	Ind Writing Assignment 1: Diversity & Equality	Ind Writing Assignment 2: Identities and Interactions	Ind Writing Assignment 3: Social Actions
,aximum points	100	100	100
Mean	83.42	83.22	80.33
Median	84.00	85.00	78.00
SD	11.33	14.36	11.40

Table 9. Assessment results of engineering senior project classes, Spring 2018.

Spring 2018 Assessment Results				
AE 171B	Reflection 1--SLO 1	Reflection 2--SLO 2	Reflection 3--SLO 3	Reflection 4-SLO 3
Maximum points	50	50	50	50
Mean	38.97 (77.9%)	37.14 (74.2%)	40.55 (81.1%)	38.56 (77.1%)
Median	42.00	39.50	42.00	39.50
SD	7.69	11.79	6.66	5.93

AE 172B	Reflection 1--SLO 1	Reflection 2--SLO 2	Reflection 3--SLO 3	Reflection 4-SLO 3
Maximum points	50	50	50	50
Mean	40.68 (81.4%)	43.86 (87.7%)	38.84 (77.7%)	44.6 (89.2%)
Median	41.00	47.00	39.00	46.00
SD	7.85	6.69	6.19	5.49

BME 198B	Reflection 1--SLO 1	Paper 2--SLO 2	Paper 3--SLO 3	Case Study 1--SLO 3
Maximum points	60	60	60	40
Mean	56.58 (94.3%)	55.25 (90%)	57.39 (95.7%)	35.47 (88.7%)
Median	57.00	56.00	57.50	35.00
SD	2.54	3.74	2.53	2.28

CMPE 195A	Essay 1--SLO 1 Identity	Essay 2--SLO 2 Diversity and Equality	Essay 3--SLO 3 Social Justice	Essay 4--SLO 4 Interactions
Maximum points	50	75	50	75
Mean	40.8 (81.6%)	57.14 (78.7%)	41.6 (83.2%)	56.1 (74.7%)
Median	41.00	59.00	41.00	55.00
SD	7.18	14.20	6.13	16.17

CMPE 195B	Essay 1--SLO 1 Culture outside U.S.	Essay 2--SLO 2 Influences on U.S. culture	Essay 3 Case Study--SLO 3 Cultural change outside U.S.	# 7 students received grades of zero--w/o zeros, mean would have been 26.4 (75%); ##6 students received grades of zero--without zeros, mean would have been 22.7 (65%)
Maximum points	35	35	30	
Mean	26.36 (75.3%)	#22.85 (65%)	##20.3 (58%)	
Median	29.00	24.00	21.00	
SD	9.38	9.93	8.00	

EE 198A	*5 year plan (includes SLO 1 identities)	Essay 2: SLO 2 Your project's implication in Area S	Lead Free Essay: SLO 3 Social Actions	
Maximum points	50	50	50	
Mean	40.5 (81%)	40.47 (81%)	40.8 (81.6%)	
Median	41.00	41.00	42.00	
SD	4.74	7.11	5.06	

EE 198B	GELO 2, Essay 1: "Technology invented outside of the U.S."	GELO 1, Reflection paper 1: "Successful Company"	*Area V Meeting 1 (includes GELO 2)	*Area V Meeting 2 (includes GELO 1)
Maximum points	100	100	40	40
Mean	76.04	77.82	37.7 (94%)	27.7 (69%)
Median	75.00	79.00	40.00	30.00
SD	10.41	13.63	3.16	5.74
*graded by EE coordinator and/or EE faculty				

ENGR 195D (ENGR Projects in Comm. Service)	***Area VLO 1 Essay	***Area VLO 2 Essay	Area VLO 3 Essay 1	Area VLO 3 Essay 2
Maximum points	100	100	50	50
Mean	83.38	58.16	39.47 (79%)	33.9 (67%)
Median	95.00	64.00	39.00	36.00
SD	28.17	22.52	8.53	11.48

MatE 198B	Essay 1--SLO 1	Essay 2--SLO 2	Essay 3--SLO 3
word count min.	500	500	500
maximum points	100	100	55
Mean	83.00	74.00	83.00
Median	75.50	80.00	83.00
SD	7.76	12.22	8.84

ME 195B	Online Module and Individual Writing Assignment #1--SLO 2	Individual Writing Assignment #2--SLO 1	Individual Writing Assignment #3--SLO 3	
Maximum points	100	100	100	
Mean	72.6	79.4	82.2	
Median	76	84	88	
SD	21	18.6	20.3	

Summary

As a result of the mandated unit reduction at SJSU, the upper-division general education requirements, known as SJSU Studies, for the College of Engineering was incorporated into the engineering curriculum. Each semester of the two-semester disciplinary senior project course sequence was linked to a one-unit course to cover the upper division GE requirements for Areas S and V and incorporate the GE content into students' senior projects. A series of interconnected modules and projects were developed to assist students in reflecting on the GE outcomes in an engineering context.

Since 2015-2016, most senior students took ENGR 195A/B concurrently with their two-semester senior project classes. The overall assessment results indicate that this innovative structure has worked, as most students have met the GE learning objectives and improved their social, environmental, and cultural awareness within their engineering discipline.

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Biographies

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Appendix

These sample rubrics assess V-LO2, “Identify the historical context of ideas and cultural traditions outside the U.S. and how they have influenced American culture”

ENGR 195B: Mechanical Clock Social Impact Analysis Paper

Assignment Instructions:

Technology is often the product of people and their circumstances, yet its influence also far surpasses its immediate environment. Explain the historical context and cultural traditions that led to the development of the mechanical clock. How did the adoption of the mechanical clock in Europe later affect the United States? Be sure to give examples. Lastly, consider your own experience with either mechanized, electrical, or atomic timekeeping. How much of an influence does it have on your everyday life, especially as someone studying engineering? Again, give examples.

- Discuss the history of the mechanical clock from its early beginnings to the present. Please discuss **at least three different events** in the history of the mechanical clock **in detail**.
- Describe at least **one influence** (e.g., historical, cultural, social, economic, political) that led to the development of the mechanical clock.
- How did the development and use of the mechanical clock affect Europe in the Early Modern period?
- Overall, how did the mechanical clock affect the United States?
- How does mechanical timekeeping affect you in your everyday life, especially as an Engineer?

Rubric for this assignment

Criteria	Ratings					Pts
Thesis Statement	5 pts Clearly stated and appropriately focused.	4 pts Clearly stated but focus needed to be sharper.	3 pts Thesis stated but not appropriately focused.	2 pts Thesis is inferred but not stated.	0 pts No statement of thesis or objective	5 pts

History of the mechanical clock from its early beginnings to the present; Please discuss at least three different events in the history of the mechanical clock.	10 pts Information clearly related to the main topic, included consistent supporting details and/or examples. Discussed three events in detail.	8 pts Information clearly related to the main topic, provided adequate supporting details and/or examples. Discussed two events in detail or three events without much detail.	6 pts Discussion of at least one of relevant event in the history of the mechanical clock.	4 pts Information related to the main topic, no details or examples provided. Did not discuss specific events.	0 pts Information had little or nothing to do with main topic.	10 pts
Describe one influence (e.g., historical, cultural, social, economic, political) that led to the development of the mechanical clock.	10 pts Clear and detailed identification and discussion of influence.	8 pts Discussion of several factors influencing the technology but without supporting details.	6 pts Discussion of a limited number of relevant factors or discussion of impact of technology rather than a cause of its development	4 pts Some identification of the relevant factors but without much supporting detail.	0 pts Little or no discussion related to influences.	10 pts
Discussion as to how the development and use of the technology affected Europe in the Early Modern period.	20 pts Clear and detailed identification and discussion of the impact of the mechanical clock on Early Modern Europe.	16 pts Discussion of several factors related to the technology but without supporting details.	12 pts Discussion of a limited number of relevant factors.	8 pts Some identification of the relevant factors but without much supporting detail.	4 pts No discussion or incomplete discussion of the effects on Europe in the Early Modern period.	20 pts

Discussion as to how technology affected the United States as a whole.	20 pts Clear and detailed identification with examples and discussion of the impact of the technology on the United States.	16 pts Discussion of several factors related to the technology but without supporting details.	12 pts Discussion of a limited number of relevant factors.	8 pts Some identification of the relevant factors but without much supporting detail.	4 pts No discussion or incomplete discussion of the effects on the United States.	20 pts
Discussion as to how mechanical, electrical, or atomic timekeeping affect you in your everyday life, especially as an Engineer.	20 pts Clear and detailed identification and discussion of the impact of timekeeping in one's everyday life, with a clear connection to one's experience as an engineer.	16 pts Discussion of several factors related to the technology but without supporting details in one's everyday life, or as an engineer.	12 pts Discussion of a limited number of relevant factors.	8 pts Some identification of the relevant factors but without much supporting detail.	4 pts No discussion or incomplete discussion of the effects on one's everyday life.	20 pts
Organization and Paragraph Construction	5 pts Information is logically organized. All paragraphs include introductory sentence, explanations or details, concluding sentence with a transition.	4 pts Information is adequately organized. Most paragraphs include introductory sentence, explanations or details, concluding sentence with a transition.	3 pts Information is somewhat organized. Paragraphs included related information, but were typically not constructed well.	2 pts Obvious lack of organization. Paragraph structure was not clear and sentences were not typically related within the paragraphs.	0 pts No observable organization.	5 pts

Mechanics	5 pts No grammatical, spelling or punctuation errors observed.	4 pts Almost no grammatical, spelling or punctuation errors observed.	3 pts A few grammatical, spelling or punctuation errors observed.	2 pts Many grammatical, spelling or punctuation errors observed.	0 pts No observable effort in the area of mechanics.	5 pts
Quality & Use of References	5 pts Compelling evidence from professionally legitimate sources is given to support claims. Attribution is clear and fairly represented. Two independent references are listed and used in the narrative along with the source website.	4 pts Professionally legitimate sources that support claims are generally present and attribution is, for the most part, clear and fairly represented.	3 pts Although attributions are occasionally given, many statements seem unsubstantiated. Although most of the references are professionally legitimate, a few are questionable (e.g., trade books, internet sources, popular magazines)	2 pts References are seldom cited to support statements. Most of the references are from sources that are not peer-reviewed and have uncertain reliability.	0 pts There are no references cited to support statements in the narrative. There are virtually no sources that are professionally reliable.	5 pts
Influences on US culture	5 pts Exceeds Expectations		3 pts Meets Expectations	0 pts Does Not Meet Expectations		--
Total Points: 100.0						

EE 198B: Technology Invented outside the U.S. Paper

Assignment Instructions:

EE198B Essay 1. Consider a technology invented outside of the U.S. in your discipline. (a) Describe the cultural and social factors that led to this technology's "invention." (b) Describe how this invention has evolved and influenced the culture of the U.S. (750 words minimum).

Rubric for this assignment

Criteria	Ratings					Pts
Organization and Paragraph Construction	5 pts Information is logically organized. All paragraphs include introductory sentence, explanations or details, concluding sentence with a transition.	4 pts Information is adequately organized. Most paragraphs include introductory sentence, explanations or details, concluding sentence with a transition.	3 pts Information is somewhat organized. Paragraphs included related information, but were typically not constructed well.	2 pts Information is somewhat organized. Paragraphs included related information, but were typically not constructed well.	0 pts Written in a manner that makes it hard to evaluate the plan. There are many spelling mistakes, grammatical errors, and awkward sentences.	5 pts
Mechanics	10 pts No grammatical, spelling or punctuation errors observed.	8 pts A few grammatical, spelling or punctuation errors observed.	4 pts Many grammatical, spelling or punctuation errors observed.	0 pts No marks		10 pts
GE LO 2A: Describe the cultural and social factors that lead to your discipline's technology "invention."	40 pts Clear and detailed identification and discussion of at least two cultural and two social factors that affected the technology's development.	30 pts Discussion of several factors related to the cultural and social forces impacting the technology but without supporting details. Or, student gave details of only one social and one cultural factor that affected the development of this technology.	20 pts Discussion of a limited number of relevant factors or discussion of impact of technology rather a discussion of the specific factors that led to the development of this technology.	0 pts The essay does not address the topic directly.		40 pts

GE LO 2B: Discussion as to how technology evolved and influenced the United States as a whole.	40 pts Clear and detailed identification with several examples and discussion of the impact of the technology on the United States.	30 pts Discussion of a limited number of relevant factors or little specifics as to how the technology impacted the U.S.	20 pts Some identification of the relevant factors but without much supporting detail.	0 pts No discussion or incomplete discussion of the effects on the United States.	40 pts
Thesis Statement	5 pts Clearly stated and appropriately focused.	3 pts Clearly stated but focus needed to be sharper.	2 pts Thesis is inferred but not stated.	1 pts Thesis stated but not appropriately focused.	0 pts No statement of thesis or objective	0 pts
GE LO 2: Threshold 3 pts	5 pts Exceeds Expectations	3 pts Meets Expectations	0 pts Does Not Meet Expectations		
Total Points: 100.0					