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Integration of General Education into the Senior Capstone Class in Engineering

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Dr. Backer been a faculty at SJSU since 1990 and held positions as an assistant professor, associate professor, professor, department chair, and director. Since coming to San Jose State University in 1990, I have been involved in the General Education program. Currently, Dr. Backer serves as the PI for two SJSU grants: the AANAPISI grant and the Title III Strengthening grant both from the U.S. Department of Education.

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Integration of General Education into the Senior Capstone Class in Engineering

Abstract

Over the past few years, San José State University (SJSU) has mandated that all of the undergraduate degree programs including engineering degrees be set at 120 units. With the existing number of units for the BS engineering degrees, this mandatory requirement has led to new innovations in General Education (GE) at SJSU. We have created a two-course sequence to support the integration of upper division General Education into the engineering major. Advanced GE at SJSU is designed to help students become integrated thinkers who can see connections between and among a variety of concepts and ideas. In the College of Engineering at SJSU, we believe that it is critical that engineering students integrate the GE student learning outcomes into their engineering studies. In these two courses, students are challenged to understand the relationship of engineering to the broader community both in the U.S. and worldwide. In addition to the assignments in this course, the engineering faculty have created linked activities in the senior project courses that allow the students to apply these concepts to your engineering disciplines. The engineering senior level general education classes take a case study approach. This paper will describe the implementation of this hybrid GE/senior project course and will present the assessment of the first year of this program's implementation.

Introduction

In January 2013, the California State University Board of Trustees mandated that, unless excepted, undergraduate degree programs, including engineering degrees, be limited to 120 units. Title 5 § 40508 [1] states that "[a]s of the fall term of the 2014-2015 academic year, no baccalaureate degree programs shall extend the unit requirement beyond 120 semester units…" This mandate and short timeline for implementation necessitated swift action for proposals to be submitted and approved via campus curriculum committees and appropriate governing boards by April 2013. Many programs looked towards "double-counting," essentially the practice of meeting multiple General Education (GE) requirements within a single course or within major courses.

The College of Engineering (CoE) at SJSU elected to move more upper division GE Student Learning Outcomes (SLOs) into major courses, with the expectation to simultaneously satisfy all GE requirements, ABET requirements, and unit caps while graduating a technical person. The CoE offers eight programs (Aerospace Engineering, Mechanical Engineering, Civil Engineering, Chemical Engineering, Materials Engineering, Electrical Engineering, Computer Engineering, Industrial & Systems Engineering), which are accredited by the Engineering Accreditation Commission of ABET, Inc. The Biomedical Engineering and Software Engineering programs are preparing for accreditation in the next review cycle. Also, a special interdisciplinary General Engineering program is offered that is not accredited. At SJSU, BS Engineering programs are treated as accredited, since all programs are designed with assessment and accreditation in mind.

Rationalization for the Course Sequence: The 120 Unit Plan

Discussions of reduction in units to earn a baccalaureate degree have occurred within the California State University (CSU) system since the 1990's. Much progress was made to reduce programs in the late 1990's and early 2000's. By 2008 approximately 81% of degree programs met the 120-unit limit [2]. With the financial crisis that struck the country in 2008, efforts to manage the fiscal crisis replaced those to reduce the curriculum of the approximately 19% of degrees that remained above the 120-unit limit within the 23 campus system. The CSU Board of Trustees presented a proposal in September 2012 to achieve the unit reduction, in part, by eliminating all advanced GE requirements. This proposal was prepared with no faculty input, in direct contradiction to the deeply engrained shared governance culture within the CSU system. Faculty and campus outcry was immediate and aggressive.

The Academic Senate at SJSU, in response to a mandate from the SJSU president, developed an alternative proposal that preserved advanced General Education (known as XXX Studies on campus) and delayed the implementation to Fall 2014. This proposal was submitted to the Board of Trustees and was utilized to modify the original Fall 2012 proposal. In January 2013, the State of California Board of Trustees passed the modified proposal.

Prior to the unit reduction, SJSU BS Engineering programs required between 130 and 134 units, including a minimum of 35 units of general education and other campus requirements, and between 95 and 105 technical units (math, science and engineering courses). The plan for reducing Engineering programs to 120 units called for:

- Limiting all BS Engineering programs to a maximum of 96 technical units, a reduction of 1 to 8 units in each program.
- Reducing the independent units of GE and campus requirements to 24 from 35, a reduction of 11 units.

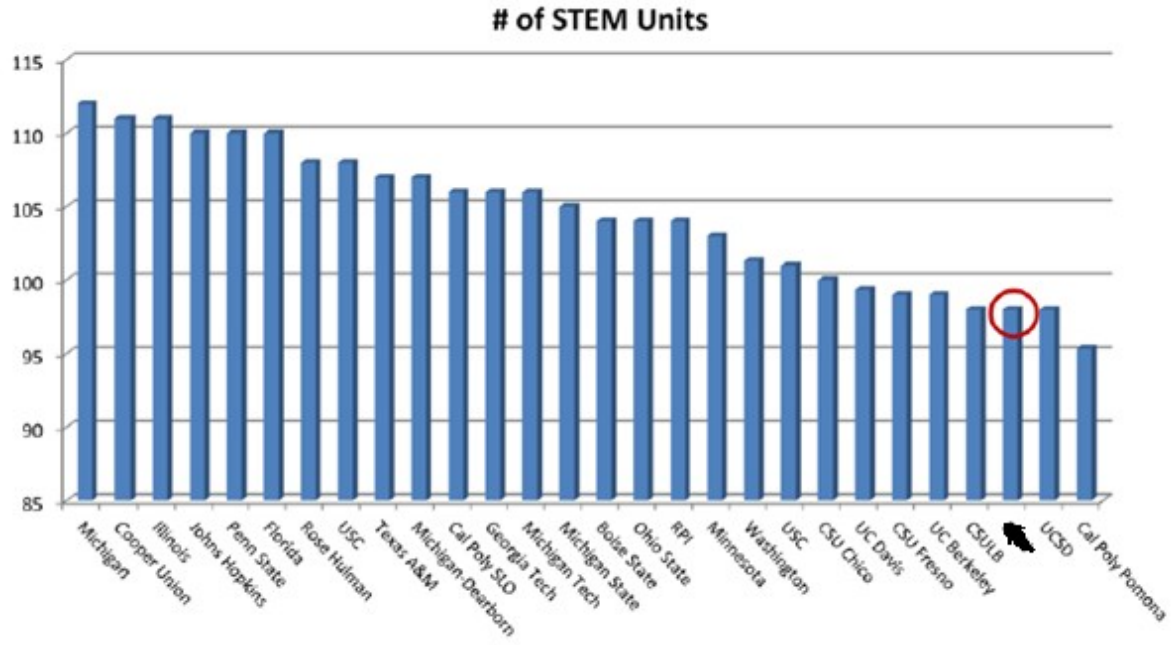
Reduction to 96 Technical Units

Technical (or STEM) units in engineering programs are comprised of math, science and lower division engineering prep (Engineering Core), plus required upper division units in the discipline and additional advanced math and science. ABET has specified program requirements for at least 75 technical units for all 120-unit programs, and the remainder of the technical units are determined by the need to meet program-specific Student Outcomes or additional program criteria specified by ABET. Figure 1 shows the number of technical units required at various accredited Engineering programs in the nation.

Within the ABET-specified 75 units are required basic math and science (30 units) and "Engineering Core" classes, which are engineering fundamentals required to ensure that every student completes a program which contributes to their education as a broadly education technical professional. Many of the core classes are taken by all engineers and are therefore outside their specialized discipline. The Engineering Core can be thought of as "GE for Engineers," and ensures that technical professionals are not narrow-minded and are versed in the common, international language of engineering. The initial accredited programs had from 40 to 57 units in required math, science and Engineering Core. Most of these courses can be completed at California Community Colleges. Every major, at each CSU, UC, or any other institution, has a

slightly different configuration of these required lower division math, science, and engineering core units.

Figure 1. Total number of STEM units required for a variety of accredited engineering programs in the US.



With the reduction, each major was limited to 21 additional units to prepare their students for entry-level employment in the workplace and meet discipline-specific ABET student outcomes. Engineering degrees with technical units below this limit are not likely to produce employable graduates who will be in demand in Silicon Valley and beyond. This reduction often meant reducing elective units and/or reducing units in discipline courses from 4 to 3.

General Education at SJSU

The General Education (GE) program at SJSU is different from many in the United States. Instead of specifying a particular series of courses as part of the GE of each student, SJSU has five Core GE areas (Skills, Science, Humanities & Arts, Social Sciences, and Human Understanding & Development). Students can satisfy the area requirements in a variety of ways using a variety of single and/or combination courses. In addition, every SJSU student must take Advanced GE courses in four areas: Earth & Environment; Self, Society & Equality in the U.S.; Culture, Civilization & Global Understanding; and Written Communication. Any department across the university may propose a course for any area of GE.

Prior to the 120-unit mandate, the CoE already included 2 of the 4 Advanced GE areas within the curriculum. All CoE students take ENGR 100W, a comprehensive writing course that incorporates technical writing (Written Communication GE Area) and environmental issues (Earth & Environment GE Area). This upper division writing course is often the first intensive writing in the major that students experience and, for many, one of the few experiences they have.

The number of non-double counted GE requirements was reduced to 24 from 35, which is more in line with other universities in the country with engineering programs. Figure 2 shows the percentage of each program used by GE requirements in various accredited Engineering programs across the nation. SJSU, and the CSU in general, have the highest percentages. This high percentage is laudable, and is not a concern, as long as the total units surpass 120; this is why SJSU has traditionally had high units majors in Engineering. It should be noted that it is sometimes difficult to determine exactly what GE is required in programs. In this analysis, for example, Economics, where it was required, was counted as GE rather than as a technical unit, even when it was taught in a course offered by an Engineering department. This was to ensure consistency in analysis.

Prior to the 120-unit plan at SJSU, campus requirements plus GE comprised 53 non-double counted units. Engineering students took 35 non-double counted GE and campus requirements, including ENGR 100W. Engineering had some GE area waivers based on their major requirements. Engineering had waivers of Areas A3 (Critical Thinking) and B2 (Biology), along with a potential waiver of D1 (Human Behavior) if they took a specific course sequence called American Studies.

To reduce the requirements from 35 non-double counted units to 24, the plan called for the above-mentioned waivers to continue and to make the following changes:

- Waive 2-unit Kinesiology requirement [*Reduction of 2 units*]
- Waive Area E (Human Understanding and Development) and move outcomes into ENGR 10 (Freshman Engineering) [*Reduction of 3 units*]
- Waive Area S and move outcomes into major courses. [*Reduction of 3 units*]
- Waive Area V and move outcomes into major courses. [*Reduction of 3 units*]

Table 1 shows a summary of the original campus and Engineering requirements, along with the new Engineering requirements. The waivers and movement of Areas S and V into major courses are the focus of this paper.

Incorporating GE into STEM

Many universities offer courses for general education under the general theme of science, technology, and society. Frostburg State University [3] offers an interdisciplinary course titled “Science Technology and Society” as a freshmen level general education course for non-science and non-engineering majors. At the University of Denver [4], an interdisciplinary team including faculty from the Department of Engineering has offered a three-quarter long course called “Technology 21” for fourteen years to approximately 100 students each year. This course is used by non-engineering and non-science students to meet their university’s science general education requirement. A general education course titled “Technology and the Engineering Method” at the University of Dayton [5] also fulfills a science education requirement and is taken by a diverse group of non-engineering students. Other universities that have engineering courses as part of the General Education programs at their institutions include Miami University [6], Penn State

University [7], Old Dominion University [8], North Carolina State University [9], and the University of Texas at Austin [10].

Table 1. Summary of General Education Requirements

Title 5 Area	Campus Area	Course/Area	New ENGR Program	Old ENGR Program	Campus Requirements
A	A1	Oral Comm	3	3	3
A	A2	Written Comm	3	3	3
A	A3	Critical Thinking	Satisfied with ENGR major	Satisfied with ENGR Major	3
B	B1, B2, B3, B4	Math & Sci	Satisfied with ENGR major	Satisfied with ENGR Major	12
C, D	C1, C2, D2, D3	Am Studies	12	12	12
C	C3	Engl 1B	3	3	3
C	V	Culture, Civ & Global	Integrate some outcomes into ENGR major	3	3
D	D1	Hum Behavior	Satisfied with American Studies	Satisfied with American Studies	3
D	S	Self, Society, & Equality	Integrate some outcomes into ENGR major	3	3
E	E	Human Understanding	Integrate some outcomes into Freshman ENGR	3	3
PE	Kin	Kinesiology	Waive for ENGR	2	2
GW AR	100W	100W	3	3	3
Total independent GE units + campus Requirements			24	35	53

The following three principles were incorporated into this approach.

1. ***Graduate technically competent engineers who expect to engage in lifelong learning in the profession.*** To be competitive in the employment market, engineers must have a solid, fundamental technical education in their discipline which meets ABET general and program criteria; this cannot be accomplished with less than 96 units of technical content. However, to meet the level needed for an entry-level engineering professional, their programs need not be so specialized that they are unable to communicate with either the public or other technical professionals in different disciplines.

2. ***Keep the needs of pre-major students in mind.*** This includes community college students (40-50% of SJSU engineering students) and native frosh and sophomores, who frequently change major before junior year. Restraining the tendency towards divergence in the majors at the lower division prevents students from accumulating units that they will ultimately not need in their major program, helps students to find the right major for their interests and aptitudes, and maintains the quality of, and the articulation with, community college feeder schools.

   According to the SJSU University guidelines [11], “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."

3. ***Meet some General Education outcomes in the context of Engineering practice.*** In the new GE plan, the goal of our engineering programs grew to include the ideal to graduate a "virtuous, knowledgeable, and articulate technical professional," and that in order to accomplish this, the GE program should be specially designed to include both stand-alone GE courses, and an upper division program which is integrated with the major.

Structure of the Engineering General Education course

In order to receive credit for upper division general education, student must complete four courses with grades of C or better in each course. The overall course structure would be for every senior student registering for 1-unit ENGR 195A (in the first semester) and ENGR 195B (in the second semester). These two courses are aligned with Semester 1 and Semester 2 of the senior project in the student's major. In Semester 1, for example, ENGR 195A meets two hours per week for mini-lectures and presentations by the GE faculty, followed by small group discussions. The GE and ENGR faculty involved are expected to assist the small group discussions. Three modules are done each semester:

Week 1-2	Organizing and orientation time, project selection, etc.
Week 3-5	Module 1
Week 6	Students meet with ENGR faculty to relate module 1 to senior project
Week 7-9	Module 2
Week 10	Students meet with ENGR faculty to relate module 2 to senior project
Week 11-13	Module 3
Week 14	Students meet with ENGR faculty to relate module 3 to senior project

ENGR 195A/B is taught by traditional GE faculty and the class is scheduled in a combination lecture/discussion format. The College of Engineering provides resources to traditional GE faculty to develop new case studies to ensure that the case studies in ENGR 195A/B remain relevant.

ENGR 195A is the first course in a two-course sequence to support the integration of General Education (GE) Area S (SELF, SOCIETY, & EQUALITY IN THE U.S.) and Area V (CULTURE, CIVILIZATION, & GLOBAL UNDERSTANDING) into the engineering major. ENGR 195B is the second course in the two-course sequence. Advanced GE at SJSU is designed to help students become integrated thinkers who can see connections between and among a variety of concepts and ideas. The College of Engineering at SJSU believes that it is critical that engineering students integrate the GE student learning outcomes into their engineering studies. In these two courses (ENGR 195A and ENGR 195B), the students are challenged to understand the relationship of engineering to the broader community, both in the U.S. and worldwide. In addition to the assignments in this course, engineering faculty in the disciplines created linked

activities in the senior project courses that allow application of these concepts to the students' engineering disciplines.

This class takes a case study approach so that students might appreciate the social, ethical and cultural perspectives of engineering. Over the course of the year, there are case studies that specifically address each student learning objective (SLO) in Areas S and V.

In the pilot year (2013-2014), the GE faculty created a structure for the modules so that additional faculty members could create new case studies in the future, so that the course is sustainable and will constantly be renewed with new materials. Each case study module has specific deliverables including written materials and resource links, a set of discussion questions, and a set of written assignments. In addition, the themes addressed (and the discussion questions) for each module would then provide guidance for the students in writing their end of semester "application papers" where they consider the issues inherent in their own senior design project. The ENGR 195A/B courses are integrated into the syllabi of the senior project courses.

Each SLO for GE Areas S and V are addressed in ENGR 195A/B and the senior project classes. Since the College of Engineering has many disciplines, there are different case studies and discussion questions for each major. These are shown in the syllabi for the senior project classes. As well as having the students consider Area S and V concepts in ENGR 195A/B, this integrated GE experience requires students to apply these concepts in their senior project classes. There is a course coordinator of the ENGR 195A/B class who is a professor in the College of Engineering. Grading rubrics are required for all assignments in ENGR 195A and ENGR 195B. The coordinator is responsible for reviewing all rubrics and making sure that the global GE rubrics for Areas S and V are included. The coordinator: schedules the instructors for the ENGR195A/B courses, goes to the first class meetings of ENGR 195A and B each semester and does an orientation for the students, works with new and existing faculty in ENGR 195A, ENGR 195B and the senior project classes on creating and revising rubrics for the GE assignments in the classes, completes the GE coordinator summary report and submit to Undergraduate Studies, creates the semester schedules for ENGR 195A and B and communicate these schedules to the instructors in these classes as well as the instructors in the senior project classes, and revises the composite syllabi for ENGR 195A and ENGR 195B making sure that the assignments for each senior project class and ENGR 195A/B have been updated.

Tables 2a and 2b below show samples ENGR 195A and ENGR 195B assignment and the accompanying assignments in each of the major senior project courses. There are two assignments related to this student learning objective (SLO) in ENGR 195A. As well, there are different assignments for each engineering major.

Three departments in the College of Engineering (Industrial & Systems Engineering, Electrical Engineering, and Computer Engineering) allow their students to start the senior project sequence in either the Fall or Spring semester. The other departments require that students begin the senior project sequence in the Fall semester. Therefore, for the first year of this course, we offered the ENGR 195A class in the Fall 2014 and Spring 2015 semesters. ENGR 195B only was offered in the Spring 2015 semester. Overall, over the year, 237 students took ENGR 195A and 148 students took ENGR 195B.

Table 2a. Sample Assignments for ENGR 195A and ENGR 195B for Area S.

S-LO3: Describe social actions which have led to greater equality and social justice in the U.S. (i.e. religious, gender, ethnic, racial, class, sexual orientation, disability, and/or age).
• ENGR 195A Refection paper 1: Describe social actions within the borders of the United States that have led to greater equality and social justice in your life (i.e., religious, gender, ethnic, racial, class, sexual orientation, disability, and/or age). Discuss how your current or past projects have or will contribute to social justice in the United States (750-1250 words). • ENGR 195A Reflection Paper 2: In his essay, Dyson gives some historical examples of technological innovations that he claims have increased social justice. Considering the technological innovations in your discipline, please describe another example and indicate how it has increased social justice in the U.S. (250-500 words) • Aerospace Engr 171A – Reflection Paper 3 (250-500 words): Consider the technological innovations in aerospace engineering in general and aircraft design in particular, describe a historical example and indicate how it has increased social justice in the U.S. and the world. • Aerospace Engr 172A – Reflection Paper 3 (250-500 words): Consider the technological innovations in aerospace engineering in general and spacecraft design in particular, describe a historical example and indicate how it has increased social justice in the U.S. and the world. • Biomedical Engr 198A Refection paper 1: An important consideration in BME is access and beneficence; what groups will have access to the treatment/device you are developing? Which will not? What groups are likely to benefit most from the result of your work? (250-500 words) • Chemical Engr 165 Reflection paper 2: Based upon the seminar speakers discussion of permits, audits and regulation. Discuss how the regulations, permits and audits of chemical processing increased social justice in the U.S. (250-500 words) • Computer Engr 195A Refection paper 1: Describe how social actions that leverage social networking sites such as Facebook and Twitter have led to greater equality and social justice in the US**.** (250-500 words) • Electrical Engr 198A Refection paper 1: Describe how the push for a lead free standard in electronic products (RoSH) increased social justice in the US. (250-500 words) • Industrial & Systems Engr 195A Refection paper 1: Social entrepreneurs use entrepreneurial methods to create social ventures that provide solutions to social issues. Social entrepreneurs work to create social change by generating profit along with creating social capital in creative and innovative ways. Research a social entrepreneurship project in your local area. In this reflection paper, indicate how this project has led to greater equality and social justice in the U.S. (250-500 words) • Materials Engr 198A Refection paper 1: Describe how the push for a lead free standard in electronic products (RoSH) increased social justice in the US. (250-500 words)

Table 2b. Sample Assignments for ENGR 195A and ENGR 195B for Area V.

V-LO1: 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.
• ENGR 195B: GMO Social Impact Analysis Paper (300-500 words): Consider the ways in which small, rural, farmers in Mexico and India might be affected by the introduction of genetically modified crops. Oftentimes, the introduction of such technologies require small, rural, farmers to adapt or change their lifestyles, that is, the way they work, where they work, and how they live. Is there anything morally problematic, or morally questionable, about this? If there is, what is it? If there is not, please explain. (300-500 words) • Aerospace Engr 171B – Reflection Paper 1 (500 –750 words): Assume that your airplane will go into production. Using the studies provided in Engr195A&B as a background, write about how you will take into account at least two aspects (e.g. ideas, values, images, cultural artifacts, economic structures, or technological developments) while evaluating your decision to manufacture your airplane in 2 other countries. • Aerospace Engr 172B – Reflection Paper 1 (500 – 750 words): Assume that your spacecraft will go into production. Using the studies provided in Engr195A&B as a background, write about how you will take into account at least two aspects (e.g. ideas, values, images, cultural artifacts, economic structures, technological developments) while evaluating your decision to manufacture your spacecraft in two other countries. • Biomedical Engr 198B Refection paper 1: Medical care is not viewed or treated in the same way in every country. There are wide variations in both the availability and the desired outcome of care. In the U.S., we have the advantage of wealth that drives innovation in medical practice and biomedical technology. This leads to significant cost, but also improvement in treatment outcomes. Consider how two other countries view the priorities of medical treatment and the development of medical technology. Are all medical practices in all countries aimed at extending life, regardless of cost? Consider and provide example ideas, values, images, cultural artifacts, economic structures, or technological developments that illustrate your thesis argument. (500-750 words) • Chemical Engr 165 Final Design Report: Assume that your project design is successfully implemented. Using the studies provided in ENGR195A/B as a background, write about how to take into account at least two aspects (for example ideas, values, images, cultural artifacts, economic structures, or technological developments) while evaluating a decision to manufacture your product in 2 other countries. (500-750 words) • Computer Engr 195B Reflection Paper 1: Assume that your project is about to turn into a successful company. Using the studies provided in ENGR195A/B as a background, write about how to take into account at least two aspects (for example ideas, values, images, cultural artifacts, economic structures, or technological developments) while evaluating a decision to manufacture your product in 2 other countries. (500-750 words) • Electrical Engr 198B Refection paper 1: Assume that your project is about to turn into a successful company. Using the studies provided in ENGR195A/B as a background, write about how to take into account at least two aspects (for example ideas, values, images, cultural artifacts, economic structures, or technological developments) while evaluating a decision to manufacture your product in 2 other countries. (500-750 words) • Industrial & Systems Engr 195B Paper 2: An article from the designated Industrial Engineer magazine that compares strategies and ideas from other countries outside of the US in regards to their economic structures, technological developments, and/or attitudes. (500 words). • Materials Engr 198B Reflection paper 1: Assume that your project is about to turn into a successful company. Using the studies provided in ENGR195A/B as a background, write about how to take into account at least two aspects (for example ideas, values, images, cultural artifacts, economic structures, or technological developments) while evaluating a decision to manufacture your product in 2 other countries. (500-750 words) • Mechanical Engr 195b Essay 1: In ME 195a, you addressed how your project may affect society□□ locally and/or globally□□if implemented and how human behavior will affect the success of your design. Expand upon that assignment, using what you learned in Engr 195a/b to do a more comprehensive analysis. Now that you have a final design, you will also be able to address some of the questions more fully. In addition, add a new section discussing how you would recommend changing your design, if at all, if your project were to be implemented in a country with a distinctly different culture than in the United States. Also address the human, social, and cultural barriers that may result in difficulties implementing your project in a country outside of the United States. (Minimum 1800 words – 900 words individually plus 900 word team revision after feedback)

Assessment of ENGR 195A

For the first year of our project, the focus of ENGR 195A was on the Area S (SELF, SOCIETY, & EQUALITY IN THE U.S.) GE SLOs. We had one student assignment for S-LO1 and one assignment for S-LO2. There were two assignments each for S-LO3 and S-LO4. The descriptions of the assignments are below. Each of the assignments was graded by the General Education instructor for the module. Each instructor used a rubric for the grading and indicated whether the student did not meet, met, or exceeded the criterion for the SLO.

S-LO1: 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;

- ENGR 195A Testimony 1: Discuss and provide examples of how your identities (i.e., religious, gender, ethnic, racial, class, sexual orientation, disability and/or age, among others) are shaped by cultural and societal influences within contexts of equality and inequality (400-600 words).

Table 2. Student Achievement of General Education S-LO1

Number of students	Fall 2014	Spring 2015	Total
Students who did not meet the criterion	0	0	0
Students who met the criterion	47	31	78
Students who exceeded the criterion	132	25	157
Students who did not submit assignment	2	0	2
Total Students	181	56	237

→Overall, 0 students did not meet the criterion for this SLO, 78 (33%) met the criterion for this SLO, and 157 (66%) students exceeded the criterion for this SLO for this assignment. Two students did not submit the assignment.

S-LO2: Describe historical, social, political, and economic processes producing diversity, equality, and structured inequalities in the U.S.;

- ENGR 195A Reflection paper 2: “Secrets of Silicon Valley” reflection paper (250 words)

Table 3. Student Achievement of General Education S-LO2

Number of students	Fall 2014	Spring 2015	Total
Students who did not meet the criterion	14	4	18
Students who met the criterion	51	37	88
Students who exceeded the criterion	112	15	127
Students who did not submit assignment	4	0	4
Total Students	181	56	237

→Overall, 18 (7.6%) students did not meet the criterion for this SLO, 88 (37%) met the criterion for this SLO, and 127 (53.6%) students exceeded the criterion for this SLO for this assignment. Four students did not submit this assignment.

S-LO3: Describe social actions which have led to greater equality and social justice in the U.S. (i.e. religious, gender, ethnic, racial, class, sexual orientation, disability, and/or age).; and

- ENGR 195A Refection paper 1: Describe social actions within the borders of the United

States that have led to greater equality and social justice in your life (i.e., religious, gender, ethnic, racial, class, sexual orientation, disability, and/or age). Discuss how your current or past projects have or will contribute to social justice in the United States (750-1250 words).

- ENGR 195A Reflection paper 3: In her chapter "Inequality," Danah Boyd describes some of the ways that online technologies like social media have, and have not, addressed existing social divisions in the U.S. Consider technological innovations in your field and describe an example of one such innovation that has increased social justice in the U.S. Be explicit about how you think it has increased social justice. (250-500 words)

Table 4. Student Achievement of General Education S-LO3

	ENGR 195A Refection paper 1			**ENGR 195A Reflection paper 3**		
Number of students	**Fall 2014**	**Spring 2015**	**Total**	**Fall 2014**	**Spring 2015**	**Total**
Students who did not meet the criterion	9	12	21	8	0	8
Students who met the criterion	11	8	19	56	13	69
Students who exceeded the criterion	156	36	192	114	42	156
Students who did not submit assignment	5	0	5	3	1	4
Total Students	181	56	237	181	56	237

→Overall, for ENGR 195A Reflection Paper 1, 21 (8.9%) students did not meet the criterion for this SLO, 19 (8%) met the criterion for this SLO, and 192 (81%) students exceeded the criterion for this SLO for this assignment. Five students did not submit the assignment. For ENGR 195A Reflection Paper 3, 8 (3.3%) students did not meet the criterion for this SLO, 69 (29%) met the criterion for this SLO, and 156 (65.8%) students exceeded the criterion for this SLO for this assignment. Four students did not submit the assignment.

S-LO4: Recognize and appreciate constructive interactions between people from different cultural, racial, and ethnic groups within the U.S.

- ENGR 195A Organization Website Analysis: Environmental and social justice issues are addressed at many different levels and in different ways by groups and organizations. This assignment addresses the broad GE learning objective of "recognizing and appreciating constructive interactions between people from different cultural, racial, and ethnic groups in the U.S." and the specific course learning objective to "Identify, compare, and contrast how local community organizations, groups, and agencies address social issues relevant to the environment and quality of life in the Santa Clara Valley. (750 words).
- ENGR 195A Reflection Paper 4: In class, you worked with a group to come up with a strategy to make an engineering club's weekend "hackathon" event as productive and inclusive as possible. How was your group's solution to the "hackathon" problem influenced by your understanding of accessibility and inclusion? How was it influenced by your own experiences of inclusion and exclusion? Do you think the composition of your group may have influenced your group's solution to the "hackathon" problem? If so, how? If not, why not? What changes to the group's composition do you think might have led to a better and/or more innovative solution? What conditions might make it hard to build that kind of group? What benchmarks would you use to evaluate whether your strategy for a productive and inclusive "hackathon" actually works? What values

are you taking into account or balancing to judge whether a solution to the "hackathon" problem would be acceptable? (250-500 words)

Table 5. Student Achievement of General Education S-LO4

	ENGR 195A Organization Website Analysis			ENGR 195A Reflection paper 4		
Number of students	**Fall 2014**	**Spring 2015**	**Total**	**Fall 2014**	**Spring 2015**	**Total**
Students who did not meet the criterion	51	0	51	10	1	11
Students who met the criterion	68	32	100	26	8	34
Students who exceeded the criterion	53	19	72	141	46	187
Students who did not submit assignment	9	5	14	4	1	5
Total Students	181	56	237	181	56	237

→Overall, for ENGR 195A Organization Website Analysis, 51 (21.5%) students did not meet the criterion for this SLO, 100 (42.2%) met the criterion for this SLO, and 72 (30.4%) students exceeded the criterion for this SLO for this assignment. Fourteen students did not submit the assignment. After the results of the Fall 2014 class, the instructor revised the instructions for this assignment (ENGR 195A Organization Website Analysis) and the percent of students who met or exceeded the criterion for this assignment increased for the Spring 2015 class. For ENGR 195A Reflection Paper 4, 11 (4.6%) students did not meet the criterion for this SLO, 34 (14.3%) met the criterion for this SLO, and 187 (78.9%) students exceeded the criterion for this SLO for this assignment. Five students did not submit the assignment.

Assessment of ENGR 195B

The focus of ENGR 195B was on the SLOs for Area V (Culture, Civilization & Global Understanding) of GE. We had one student assignment for V-LO1 and one assignment for V-LO2. There were two assignments for V-LO3. The description of the assignments are below. Each of the assignments was graded by the General Education instructor for the module. Each instructor used a rubric for the grading and indicated whether the student did not meet, met, or exceeded the criterion for the SLO.

V-LO1: 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.

ENGR 195B: GMO Social Impact Analysis Paper (300-500 words): Consider the ways in which small, rural, farmers in Mexico and India might be affected by the introduction of genetically modified crops. Oftentimes, the introduction of such technologies require small, rural, farmers to adapt or change their lifestyles, that is, the way they work, where they work, and how they live. Is there anything morally problematic, or morally questionable, about this? If there is, what is it? If there is not, please explain. (300-500 words)

→Overall, 6 students did not meet the criterion for this SLO, 84 met the criterion for this SLO, and 55 students exceeded the criterion for this SLO for this assignment. Three students did not submit the assignment.

V-LO2: identify the historical context of ideas and cultural traditions outside the U.S. and how they have influenced American culture

ENGR 195B Essay 1: Choose one of the following technological developments that were discussed in the web tutorial: the mechanical clock, gunpowder, the Great or Jersey wheel, printing, or the compass. Write an essay that addresses the following topics. When you respond to these topics, you should be specific and cite specific details either from the web tutorial or your own research. You should cite specific events and/or cultures as you answer these questions. (minimum length 500 words). Discuss the history of the technology from its early beginnings to the Renaissance. Please discuss at least three different events in the history of the mechanical clock. Describe one force (e.g., historical, cultural, social, economic, political) that affected the development of the technology? How did the development and use of the technology affect Europe in the Middle Ages? Overall, how did the technology affect the United States?

→Overall, 35 students did not meet the criterion for this SLO, 86 met the criterion for this SLO, and 27 students exceeded the criterion for this SLO for this assignment. All students submitted this assignment.

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

ENGR 195B Essay 2: Imagine you are part as part of a group of Engineers to Guatemala at the request of Habitat for Humanity. You have been hired to come up with a plan that will alleviate or at least mitigate the effects of Hurricane Stan on the Mayan communities in the Highlands. When thinking about your plan, you must consider all angles of the problem (for example, language barriers, culture, disease, landforms, seasonal weather, transportation, building materials, distrust and fear, etc.) (1000 words)

→Overall, 16 students did not meet the criterion for this SLO, 92 met the criterion for this SLO, and 39 students exceeded the criterion for this SLO for this assignment. One student did not submit the assignment.

Technology Social Impact Analysis Paper: Locate some technology, such as an application, mobile technology, or non-software based technology. Do research either on (i) how that technology has had a social impact on a culture or group of people outside of the US, or (ii) on how that technology, which was, developed in the US has affected a culture outside of the US. More details on this assignment are available on the course website. (400-600 words)

→Overall, 35 students did not meet the criterion for this SLO, 103 met the criterion for this SLO, and 8 students exceeded the criterion for this SLO for this assignment. Two students did not submit the assignment.

Summary

Overall, over the year, 237 students took first course and 148 students took the second course in the General Education senior project sequence in the same semesters as their two-semester senior project classes. In order to receive credit for General Education, a student needed to receive a

grade of C or better in both engineering Senior Project General Education courses (ENGR 195A and ENGR 195B) and the two major senior project classes. In the first year, only nine students failed ENGR 195A out of 238 students and eleven students failed ENGR 195B out of 148 students. When reviewing the student learning outcomes, the vast majority of students met the learning outcomes.

The reduction in units at SJSU University necessitated a restructuring of the General Education requirements for all engineering majors at SJSU. Upper division GE Student Learning Outcomes were brought into senior project courses and 1-unit co-requisite courses that encouraged students to view engineering in the broader community, both in the U.S. and worldwide. By developing linked assignments in both the project and partner courses, students were able to reflect on the GE outcomes in the context of engineering, in general, and then tie the concept into their major and senior project. The case study approach provided opportunity to develop unique insight into the broader implications of engineering design, which students then could apply to their individual senior projects. During the first year, most students were able to successfully meet the GE outcomes with these well-tailored courses.

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