SCIENCE, TECHNOLOGY, & SOCIETY CORE ASSESSMENT

OFFICE OF ASSESSMENT

JUNE 13, 2017

Introduction

The Core student learning objectives identify the educational priorities for all undergraduates in Santa Clara University's Core Curriculum. Assessment of student learning is ongoing in the Core as we seek to understand how students are meeting the learning outcomes of the Core and how to better support faculty teaching in these areas.

When the 2009 Core was approved, STS requirement was described in the following way: "This course will deepen students' understanding of how science or technology work and the roles they play in our lives by focusing on significant topics. Each course should include attention to the underlying workings of relevant science or technologies in order to prepare students to assess their development and impacts on society and nature. Some courses may focus more intensively on science, while others may pay greater attention to technologies." This assessment report summarizes the process and findings from an assessment of the two learning objectives for the Science, Technology, and Society (STS) Core requirement.

The following learning goals motivated the two learning objectives:

- Scientific Inquiry: The principles of scientific inquiry and how they are applied in the natural and social sciences.
- Science & Technology: The formative influences, dynamics, social impacts, and ethical consequences of scientific and technological development.
- Critical Thinking: The ability to identify, reflect upon, evaluate, integrate, and apply different types of information and knowledge to form independent judgments.
- Complexity: An approach to understanding the world that appreciates ambiguity and nuance as well as clarity and precision.

The Assessment Process

In 2016-17, the Office of Assessment asked faculty teaching STS classes in the core curriculum to gather student work related to the two STS learning objectives. Student work was collected from a random sample of students from 20 of the 25 STS courses taught by distinct faculty during Fall 2016 quarter. About 14% of the 866 students who completed STS courses were sampled. Faculty teaching the courses identified the assignments or exam questions providing the clearest evidence for student learning with respect to the two learning objectives:

1.1 *Students will comprehend the relevant science and/or technology and explain how science and/or technology advance through the process of inquiry and experiment.*

1.2 *Students will analyze and evaluate the mutual influence between science and/or technology and society.*

Twelve faculty and one staff member participated in two norming sessions held during the Winter quarter of 2017. A rubric was used to score student work (see Appendix A). The norming group edited the original rubric during the norming session (see Appendix B). The original rubric proved difficult to apply to the student work and therefore a simplified version was created. Instead of using four categories (not proficient, approaching proficiency, proficient, and highly proficient) the revised rubric utilized three categories and each objective was scored on a three-point proficiency scale; however, a "0" could be used if there was no evidence of the learning objective in the student work. This could mean the assignment didn't ask students to demonstrate this objective or that students were asked, but they did not address the learning objective through their work.

After the norming sessions and discussion, student work was distributed among the raters and each piece of student work was scored by two raters. Inter-rater reliability (IRR) was calculated using the software program AgreeStat® for the three learning objectives. The agreement coefficient Gwet's AC2 was interpreted, using simple ordinal weights and Landis-Koch benchmarks (see Table 1). Overall, it appears the faculty raters were consistent with one another in their scoring and their use of the rubric.

Table 1. Agreement Coefficients

Learning Objective	Gwet's AC2	Benchmark
LO1	0.68	Substantial
LO2	0.68	Substantial

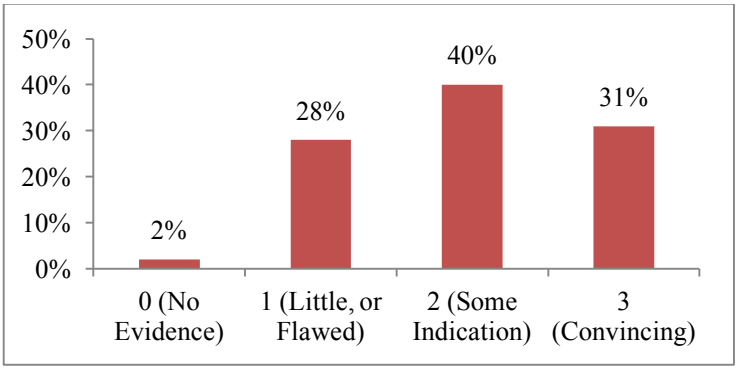
What We Learned

The scores given for work for each learning objective were tabulated and converted into percentages.

LO 1.1 Students will comprehend the relevant science and/or technology and explain how science and/or technology advance through the process of inquiry and experiment

For learning objective 1.1, 31% of student work was rated as demonstrating convincing evidence of meeting the objective (see Figure 1). Another 40% of student work was judged as having some indication of meeting the objective. However, 28% contained little or flawed evidence of the objective. A small percentage of the work was scored as providing no evidence that it addressed relevant science and/or technology and its advances through a process of inquiry or experiment.

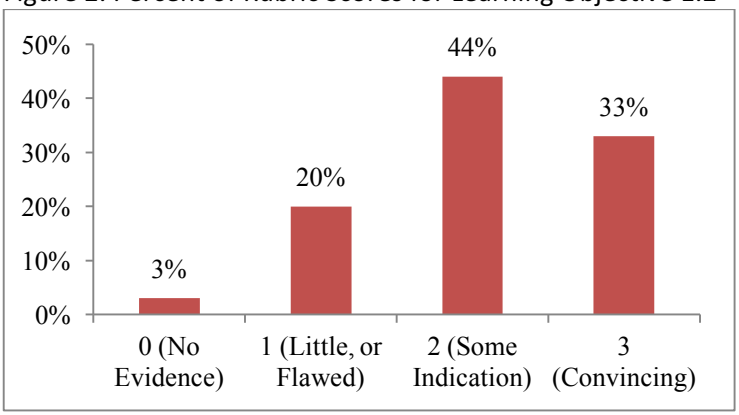
Figure 1. Percent of Rubric Scores for Learning Objective 1.1



LO 1.2 Students will analyze and evaluate the mutual influence between science and/or technology and society.

This learning objective focuses on a very different type of learning and asks the students to engage in analysis and evaluation about the role of science and/or technology and society. The scores for LO 1.2 were similar to those of LO 1.1. Specifically, 33% of the student work contained convincing evidence of the objective, whereas 44% contained some indication of meeting the learning objective. Twenty-percent of the work provided little or flawed evidence of the students engaging in analysis or evaluation about mutual influences. Three percent of the work was scored with a 0, indicating it did not address the objective at all.

Figure 2. Percent of Rubric Scores for Learning Objective 1.2



<u>Further Analyses</u>

Scores were also examined for differences by gender, and race or ethnicity. The sample was evenly distributed among males and females. There were no statistically significant gender differences for LO 1.2; however, for LO 1.2, males scored statistically significantly higher than females.

The sample was generally similar to the general campus population in race and ethnicity except for an underrepresentation of Hispanic students. There were no differences in scores for LO 1.1 or LO 1.2 by race or ethnicity.

Faculty expressed an interest in understanding whether the scores varied according to discipline. Might the humanities and social sciences courses be more successful in promoting student learning for LO 1.2, while the students in science courses gain a better understanding of LO 1.1? To analyze this relationship, we grouped courses into three disciplinary categories: science, humanities/social sciences, and business. We found that there was a disciplinary difference in student proficiency for LO 1.1, but not for LO 1.2. As can be seen in Table 1, students in courses in the science and business courses demonstrated higher levels of knowledge of the relevant science and/or technology and were better able to explain how science and/or technology advance through the process of inquiry and experiment.

Table 1

Discipline	LO 1.1 Mean	LO 1.2 Mean
Science	2.07	2.19
Humanities/Social Science	1.77	2.02
Business	2.12	2.00

In addition, all submitted assignments for the STS courses (n=17) were examined and coded for how well they aligned with LO 1.1 and LO 1.2 on a three-point scale (1 = do not align, 2 = partially align, 3 = fully align). Only 7 of the courses had assignments that were rated as fully aligned for LO 1.1, whereas 10 of the courses had assignments that were rated as fully aligned for LO 1.2. We noted that for LO 1.1, many of assignments asked students about the first part of the objective—asking students to address the relevant technology or science, but they were not asked to explain how the technology or science advanced through a process of inquiry (the second part of LO 1.1) and therefore those assignments were rated as partially aligned.

Table 2 presents the means for each LO for each course alignment rating. As expected, there was a positive correlation between assignment alignment rating and the LO scores. It is worth noting, however, that even for fully aligned assignments the average score is closer to a 2 than a 3, indicating room for improvement.

Table 2. Assignment Alignment of STS Courses with LO 1.1 and 1.2

Assignment Alignment with LOs	LO 1.1 mean	LO 1.2 mean
1 – Does not Align	1.62	1.23
2 – Partially Aligns	1.91	1.95
3 – Fully Aligns	2.23	2.08

Conclusions

Overall, the student work samples are not meeting the goals set by the Core. Throughout the process of reviewing student work and looking at course syllabi and assignments, we can identify several factors that are likely to explain some of the lower scores.

At a very fundamental level, the process of scoring student papers and examining assignments revealed uncertainty about exactly what is to be included as "science" or "technology" for the purposes of this Core area and the learning objectives. For example, is a student paper that discusses how an app is used, but is not contextualized within a broader discussion of its underlying technology (e.g., social media), appropriate for the STS learning objectives? What is the clear distinction between **science** courses that include discussion of societal issues and **STS** courses? What is the distinction between STS courses and many of our social sciences courses? It would be helpful for the STS core area to articulate more clearly how the STS learning objectives should be interpreted across business, science, social science and humanities courses.

Secondly, there were many samples of student work in which it looked like the first part of LO 1.1 was emphasized, but not the second part. In other words, the science or technology might be described in very general terms, but without communicating an understanding of the factors that shaped its development. For the second learning objective, students too often provided a superficial analysis of the *mutual* influences between science or technology and society. In short, the underlying learning goals for this Core area—critical thinking, complexity, and scientific inquiry were not realized in the student work. The scoring team found the original rubric unworkable as it was designed for more developed student work. Even when the work did align with the learning objectives there was a range in format and depth. Some of the work products submitted were lengthy papers, other work was composed of short-answer or multiple-choice exam questions, and some student work was in the form of presentation slides.

Third, the scoring committee observed that many courses that meet the STS requirement also serve major requirements and that their design may be much more heavily influenced by these requirements than the Core. It was also noted that only 7 of the 20 courses included current LOs included in their syllabi. The STS LOs were revised slightly in 2016 for clarity—their inclusion in the course syllabus communicates important information about the nature of the course to students and helps inform instruction, including assignment design.

An important follow-up step to this assessment will be to invite discussion among faculty teaching in the STS Core area about the learning objectives, how we want to interpret the scope of science and technology, and how to support student learning across these two learning objectives—regardless of discipline.

Acknowledgments: The Office of Assessment thanks the STS FCC, the faculty teaching Core courses who participated in the assessment, the faculty members who offered to serve as scorers for the student work, and our student assistants who contribute ongoing support for the assessment process

Appendix A
Revised STS Scoring Rubric

Core Learning Goals	Objective	Criterion	
Scientific Inquiry, Science & Technology, Critical Thinking, Complexity	1.1 Comprehend the relevant science and/or technology and explain how science and/or technology advance through the process of inquiry and experiment.	Comprehend relevant science and/or technology. Demonstrate awareness of science and/or technological advance as an ongoing process.	3 - Convincing 2 - Some indication 1- Little to no, or flawed
Science & Technology, Critical Thinking, Complexity	1.2 Analyze and evaluate the mutual influence between science and/or technology and society.	Explains and draws meaningful, grounded inference about: ● the ways in which science and/or technology is shaped by needs, demands, or other conditions in society ● the impact of science and/or technology on individuals, groups, societies, nations, or the world (e.g., social, political, economic, legal, organizational).	3 - Convincing 2 - Some indication 1- Little to no, or flawed

Appendix B
Original STS Scoring Rubric

Objective	Highly proficient-4	Proficient-3	Approaching proficiency-2	Not proficient-1
1.1 Comprehend the relevant science and/or technology and explain how science and/or technology advance through the process of inquiry and experiment.	All the scientific or technology development is explained fully and clearly, along with how their advancements have been guided by a process of formal or informal inquiry, reasoning, and/or experimentation.	Most of scientific or technology development is explained reasonably clearly, along with how advancements have been guided by a process of formal or informal inquiry, reasoning, and/or experimentation	Some scientific or technology development is described. Limited information is provided about how advancements have been guided by a process of formal or informal inquiry, reasoning, and/or experimentation.	No background or explanation given for the scientific and/or technology development, or the type of advancement is mentioned, but with no information about the process of inquiry.
1.2 Analyze and evaluate the mutual influence between science and/or technology and society.	Makes insightful, evidence-based inferences about ● the ways in which science and/or technology is shaped by needs, demands, or other conditions in society ● the impact of science and/or technology on individuals, groups, societies, nations, or the world (e.g., social, political, economic, legal, organizational).	Draws relevant inferences grounded in some evidence about ● the ways in which science and/or technology is shaped by needs, demands, or other conditions in society ● the impact of science and/or technology on individuals, groups, societies, nations, or the world (e.g., social, political, economic, legal, organizational).	Describes in a limited way and/or with little analysis ● the ways in which science and/or technology is shaped by needs, demands, or other conditions in society ● the impact of science and/or technology on individuals, groups, societies, nations, or the world (e.g., social, political, economic, legal, organizational). The description may rely more on assumptions than evidence.	Provides limited description, with no analysis ● the ways in which science and/or technology is shaped by needs, demands, or other conditions in society ● the impact of science and/or technology on individuals, groups, societies, nations, or the world (e.g., social, political, economic, legal, organizational). Description may contain inaccuracies or significant overgeneralizations.