Engagement in Practice: Using STEM Outreach as a Platform to Improve Social Awareness and Learning Skills

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Introduction

STEM Outreach in the Community is a course taught at Santa Clara University (SCU) with the goal of satisfying SCU's Experiential Learning for Social Justice (ELSJ) requirement and providing an avenue for SCU students to make a difference in the local community. The course consists of an outreach component where students teach engineering lessons after school at local partner sites to 20-25 at-risk K-12 students. Most partners have students from 4th-6th grade as it is an ideal time for STEM outreach [1]. In addition to benefiting the K-12 students, STEM outreach has also been shown to provide gains to the engineering students who deliver it [2]. While likely similar to other STEM Outreach courses in most ways, this course has been specifically designed to cover concepts and strategies that not only prepare the college students to perform their outreach, but also assist in addressing their own academic challenges. Growth mindset, productive failure, privilege, and stereotype and stereotype threat are explored both the context of the outreach settings and college life allowing the college students to improve as both educators and learners.

Course Logistics and Learning Objectives

STEM Outreach in the Community is an elective taught within the General Engineering department and contains two lecture units and one lab unit. Lecture meets once per week for one hour and forty minutes. The lab contains the outreach component and meets once a week for two hours and forty-five minutes allowing for travel to the partner site, set up, instruction/activity/homework help, clean up, and travel back to SCU. Each quarter, four lab sections are held Monday through Thursday and each is capped at eight students. The lecture, held on Friday afternoons, includes all students in the course and, thus, has a maximum of 32 students.

The course satisfies SCU's Experiential Learning for Social Justice (ELSJ) requirement. The ELSJ component of SCU's Core Curriculum cultivates social justice, civic life, perspective, and civic engagement. It involves community-based learning with a social justice emphasis. Students are required to (i) engage in 16 hours of community-based learning experiences and (ii) perform critical reflection and evaluation of their experiences. A primary goal of the ELSJ requirement is to foster a disciplined sensibility toward power and privilege, an understanding of the causes of human suffering, and a sense of personal and civic responsibility for cultural change.

The specific learning objectives of an ELSJ class are as follows:
ELSJ LO1. Recognize the benefits of life-long responsible citizenship and civic engagement in personal and professional activities (Civic Life);
ELSJ LO2. Interact appropriately, sensitively and self-critically with people in the communities in which they work and appreciate the formal and informal knowledge, wisdom, and skills that individuals in these communities possess (Perspective);
ELSJ LO3. Recognize, analyze, and understand social reality and injustices in contemporary society, including recognizing the relative privilege or marginalization of their own and other groups (Social Justice);
ELSJ LO4. Make vocational choices in light of both their greatest gifts and the world's greatest needs (Civic Engagement).

The STEM Outreach course was developed (i) to give Engineering students an opportunity to take an Engineering class to satisfy their ELSJ requirement, (ii) to provide meaningful outreach to the community, (iii) to promote STEM to under-served communities close to SCU. In addition to the ELSJ learning objectives, this course was designed with the hope that students would also:
- Develop educational materials and hands-on STEM activities as a service to the community
- Develop project/time management, organizational, and leadership skills.
- Develop effective listening/collaboration skills while working with community partners.
- Recognize and understand ethical responsibilities of engineers.

Course History:
This course was created in 2014 and was, initially, a two-unit course that served as a vehicle for the outreach, discussions with partner liaisons, and assignments. Soon after, one to two "lunch and learns" were included each quarter to provide a more convenient avenue for guest speakers and discussions. In 2015, the course took on its current three-unit format with a lecture and a lab. For a year, lecture focused on inequity and social injustice. Since 2017, the course has had its current instructor and the lecture content has included the material as described throughout this paper.

College Students:
The course is open to the entire SCU community. While many students are from the School of Engineering, the class also has students from the College of Arts and Sciences and the School of Business who have expressed that they want to learn more about STEM. While the college, as a whole, has a good gender balance, the STEM Outreach class tends to follow the percentages found in the School of Engineering and has 25-30% females. 41% of Santa Clara's students are white and 28% are underrepresented minorities. The students found in STEM Outreach tend to match these statistics. While SCU has many programs supportive of lower socio-economic students and first-generation college students, only 2.2% are from the lowest 20% quintile. 71% of the student body comes from a family in the upper-most 20% economic quintile.

Partners:
The course has four partners. Each runs an afterschool program led by an instructor who acts as a liaison to SCU. Each site has 20-25 high risk K-12 students who face significant social-economic hardships, are English language learners, and/or face other types of learning challenges. Three of the four partner sites (Washington Elementary, Kennedy Elementary, and Third Street Community Center) support elementary school students in afterschool STEM programs. The fourth site, Apollo High School, recruits students from the San Jose High School District who are low on credits and helps them create unique education plans to get "back on track." Each site leads an orientation during the first week. From there, teams visit their site 6-8 times for 2-2.5 hours per visit. A typical daily schedule is provided in Table 1.

Travel to site	20 minutes
Set up	20 minutes
Rapport building (recess, HW help, etc.)	30-45 minutes
Lesson/Activity	60-90 minutes
Clean up	10 minutes
Return to campus	20 minutes

Table 1: A typical schedule when visiting a partner site.

Course Structure

As mentioned above, the course is divided into the lab component and a lecture component. The lab component includes the outreach visits and teaching summary assignments that are turned in after each visit. The lecture component consists of a weekly class meetings and a variety of reflection and research-based paper assignments.

Lab Material:

Attending the outreach sessions for the required 16 hours for the quarter satisfies most of the students' lab grade. In addition, each week, students are required to submit a one paragraph summary of their outreach. They are encouraged to include things that went particularly well, things that didn't go well, things they would change next time, and, anything that stands out that they want to capture. While this is intended to help them reflect on each visit, it is also very useful for them to refer to later when working on their lecture-based reflection assignments.

Lecture Material:

The course meets nine times throughout the quarter. The lecture content includes instructor-led discussion, guest lectures/workshops, in-class activities, and group work. Below is a description of the content of each lecture in a typical quarter.

Lecture 1: Introductions, Course Logistics, Goal Brainstorm, Meet groups, Lessons: big picture

In this meeting, students are introduced to the instructor and other resources (admin, TA) and to each other. Course logistics are discussed. Then, the students brainstorm about what they want to get out of the class. In addition to some of the more obvious goals that come out (e.g. escape the SCU bubble, learn how to teach kids), students are encouraged to include more personal goals (e.g. improve patience, learn how to communicate with a team of educators, etc.). Students are then put into their groups (by lab day/partner site) to discuss travel logistics and, ultimately, sharing interests and considering their big picture breakdown of what the quarter of lessons will look like. For one partner, the lessons align with external STEM lessons that are taking place throughout the rest of their week; but, for the most part, the specific lesson content is left up to the SCU students.

Lecture 2: Teaching Brainstorm, Growth Mindset, Self-Concept (Math), Lesson plans

Each day, the class begins with each lab group sharing how things went the previous week and the plan for the following week. During this week, students are mostly reacting to their orientations and are beginning to think more about their first lessons. To help prepare for their lessons, the class has a brainstorm about what good teaching looks like. Next, the concept of growth mindset is discussed. Specifically, students are given tools to consider how to transform a fixed mindset to a growth mindset. The importance of self-concept in learning is discussed. The day ends with students spending time working on their lesson plans in greater detail.

Lecture 3: Productive Failure, Common Core/Math Anxiety

In this lecture, productive failure – or, the idea that we can and should learn from our mistakes – is explored in greater detail. A TED talk featuring a student who laments being "fast and accurate" at math in high school and now struggling in college is dissected to find insight into improved teaching. The value of struggle is explored further. Since Common Core is foreign to many of the college students, it is discussed further to develop strategies to approach something that may look unfamiliar with the appropriate attitude. Students are also warned of math anxiety that they may see stemming from the teachers they meet and parents that they hear about.

Lecture 4: Stereotypes/Stereotype Threat
This discussion focuses on the damaging impact of stereotypes. Students learn how, even if one doesn't believe the stereotype applies to them, they can still be negatively impacted by the knowledge of a stereotype [3]. 'Positive' stereotypes, and the negative impact they can have, is also explored. The concept of a model minority is discussed as well. This conversation usually results in deep exploration of stereotypes that exist within engineering and of the lectures, this is the one that usually hits the deepest. This all ties back to the idea of growth mindset through an article on research that shows that girls are most likely to suffer from a fixed mindset.
Lecture 5: Perspectives workshop (run by SCU)
On this day, professionals from the Office for Multicultural Learning come to the classroom and give a workshop titled: The Myth of the American Dream. In this workshop, students explore more about privilege, perspective, and how hard work – while it makes a difference – may not get one as far if there are systemic hurdles in their way. The role of one's community on the individual's success is discussed further as well.
Lecture 6: Teaching with Constraints
In this activity, students put into groups and asked to design a typical lab lesson. They are told that they have access to a standard laboratory classroom, will have a diverse class among many dimensions stressing that there will be students of varying familiarity with the material, ethnicities and socio-economic backgrounds. They are told that the materials for their lab cost about $300 and to plan accordingly. After the initial lesson is designed, each group is given constraints to work around and asked to modify their lesson plans. The constraints either stifle their resources (down to $40), their classroom (now a standard classroom instead of a lab), or the diversity of their student population (all inexperienced in the specific content from financially under-privileged families). In the end, all groups are given two of the three constraints. The discussion that follows makes it clear that in many cases, teachers of the classes they are working with are forced to routinely approach all three constraints simultaneously – every single day.
Lecture 7: Continuing Education, Community College
This lecture is typically given by a guest from the Santa Clara County Office of Education. The talk, titled "Success for All," focuses on alternatives to four-year college, the multiple pathways one can take to get into a four-year college, career technical education, The End of Average (which considers that there is no "average" student), and work-based and individual-based learning.
Lecture 8: Income Equity in the US
The key goal of this meeting is to discuss income inequity, highlight the rising cost of education, and discuss the impact of the combination of these two statistics.
Lecture 9: Final Reflection
Finally, the class meets and reflects on the course as a whole in a live discussion that culminates with each student sharing a highlight from their outreach experience.

Lecture Assignments:
The course has five major assignments – one due every two weeks: Lesson Plan, three response and research papers, and a final reflection.
Lesson Plans: The first assignment is a draft lesson plan that guides their on-site lesson. The second assignment is a revision based on things learned through outreach experience, in-class discussions, and the other assignments.
Response and Research Papers: Students read articles, watch videos, perform research, and reflect on a number of topics, including: equity in the educational system, inequity and civic engagement,

and impact of social injustice on the educational opportunities of students in certain communities. While many of the learning objectives are organically covered through the outreach, these assignments are tailored to meet the reflection requirement and aligns with ELSJ LO3.

Final Reflection: Students are asked to reflect on all readings, videos, their outreach experience, lecture discussions and activities, and their own personal observations.

Course Assessment

The course is assessed in multiple ways. Students complete a survey at the beginning of the quarter and an exit survey at the end of the quarter. The survey seeks to assess ELSJ program objectives through a variety of questions that seek to discover their perspective on social injustice – both locally and globally – before and after the course. The survey also looks to learn more about their comfort working with kids, teaching STEM, and managing a classroom. Students also complete the standard evaluation of teaching (SET) where they assess the course and the instructor.

Successes and Lessons Learned

This class seems to satisfy many of the learning objectives quite well. When assessing their own abilities, students who completed both the intro and the exit survey over the last two years showed a 20% improvement in their ability to "communicate STEM to younger students", a 23% improvement in their ability to "manage a classroom", a 51% improvement in "developing STEM lessons", a 32% improvement in "classroom time management", and a 39% improvement in "working with peer instructors." Students were also asked about how extensive and how unjust social, economic, and educational injustice is (i) world-wide, (ii) nationally, (iii) in the Bay Area (California), (iv) in neighborhoods surrounding SCU, and (v) at SCU. In almost all of these questions, their views of the world, and even the US as a country remained fairly unchanged. However, when considering the neighborhood around SCU, their eyes were opened as there was a 10% increase in level of extensiveness or unjustness as opposed to virtually no change when considering nation-wide or world-wide geographies.

A benefit of the class is the impact that the conversations have on the students in the room as students. One female student, after the discussion on stereotypes wrote: "Most guys do not realize that it is a true obstacle that many girls face, even in college. I have noticed that sometimes people need to hear examples that happen in settings that they are comfortable in, in order to see that there are concrete effects caused by the things that we are reading about. Thank you for creating a classroom environment where we can have these types of conversations. Many of the articles that we read and the class discussions that we have really impact me now, and I remember myself (and still see myself) acting in many of the ways mentioned, so it is good for me personally as well." During classroom discussions, a conscious effort is made to focus on things that the SCU students can do as educators to address fixed mindsets, stereotypes, and other hurdles that they see in the K-12 students during their outreach; but, an equal amount of energy is spent considering strategies to help our students as college students since many suffer from similar hurdles.

While the instructor has received above average scores and has been generally praised in the SETs, this class is far from perfect and there are challenges each quarter. One early lesson was to set expectations regarding the workload. SETs have shown that 80% of the students spend five or less hours working outside of class; yet, comments from the first two quarters focused on the

"excessive" amount of writing. While the workload has remained identical, setting expectations at the beginning of each quarter has reduced these complaints dramatically. Another challenge comes from the fact that having delicate conversations in these classrooms takes finesse as some students are invested and open to exploring the topics at hand while others are either reluctant or disinterested in opening up.

Future Work
A careful investigation of the final reflections, SETs, and intro/exit surveys could reveal further insights and improvements that can be made on the course. Deeper study on the source of the gains would help motivate adjustments to the class structure – for example, does the Class Constraints exercise, on the heels of the Perspectives workshop, really provide learning gains?

One of our sites assesses their elementary school students to learn how much their critical thinking is improved over the course of the year. Another avenue for future work would be to expand on this to more rigorously evaluate the impact across sites.

At an initial glance, there are notable differences in the gains suggested by women when compared to the men in the course. The self-reported surveys reflect a lower initial score in areas where confidence could be a factor. Further investigation could determine if the course is increasing skills, increasing confidence, or both.

Finally, finding other colleges or universities that teach a similar STEM Outreach course could allow for deeper exploration of the impact of including specific lecture material around the outreach.

References
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