Engineering Students’ Varied and Changing Views of Social Responsibility

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Greg Rulifson is a Civil Engineering doctoral candidate focused on qualitative engineering education research while also completing the Engineering in Developing Communities certificate. Greg earned his bachelor’s degree in Civil Engineering with a minor in Global Poverty and Practice from UC Berkeley where he developed a strong desire to use engineering to facilitate developing communities’ capacity for success. and earned his master’s degree in Structural Engineering and Risk Analysis from Stanford University. His dissertation will focus on how student’s connections of social responsibility and engineering change throughout college as well as how engineering service is valued in employment and supported in the workplace.

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Abstract

Engineering students have been found to have a wide range of opinions on their social responsibilities as engineers. These ideas relate to a variety of microethical and macroethical issues from safety to equality. A previous large quantitative study found that 43% of the engineering students experienced statistically significant changes in their social responsibility attitudes over 1½ years. Two research questions are being explored in this research: (i) How do engineering students change their understanding of social responsibility from the end of their first year in college to the end of their second year of college? (ii) What experiences seemed to cause these changes? To answer these research questions, a qualitative approach was used.

Thirty-four students were interviewed in their second semester of college, and thirty-two of these students were interviewed again one year later. In the second round, students represented six different engineering majors (primarily civil, environmental and mechanical), seven different institutions (initially four institutions), and seven students were no longer engineering majors. Students were again asked to define SR and what influenced these changes or reinforced the same definition from the previous year. Interviews were analyzed for important themes using the code book developed for the first round of interviews while remaining open to new codes.

Definitions of and influences on SR were usually more developed and detailed due to influences from a variety of factors ranging from internships and college extracurricular activities to popular media coverage of natural and economic disasters. Students still enrolled in an engineering program rarely attributed their definition change or reinforcement to the classes offered at their institution.

The varied and rich experiences of these 25 students will guide a discussion around the gap of socially relevant content in engineering courses, especially during the sophomore year. Recommendations and references for relating courses to student interests and passions will be presented to move forward in educating the holistic, socially engaged engineer. Third and fourth round interviews will be conducted in future years to paint a longer and even more comprehensive picture of these students’ developmental trajectories through college.

Background

Engineers are responsible to society in myriad ways and this responsibility seems to be increasing\(^1\). All types of development centrally involve the engineer - unprecedented technological growth to allow for automatic financial trading, diagnostics and reporting, mitigation efforts, reconstruction and recovery – though their engagement with society may be peripheral. With these many global issues intersecting, the engineer’s utility and importance are rising; therefore, the ways that engineers consider themselves socially responsible and act on this responsibility are important to understand.
Social responsibility (SR) is a broad concept; people define what it means for them personally and for other entities on many different continua, depending on their personal situation, ethical perspective, and worldview. For this study, SR is defined as an ethical duty one has to act in ways that benefit all of society and the environment proportional to the opportunities and skills which one has been afforded. An engineer’s SR must encompass protecting public welfare, and may also extend to concerns around sustainability, the social context of their engineering designs, empathy and caring, striving for social justice and peace, and pro bono work.

While SR’s importance has been recognized, some believe that current engineering education does not adequately provide opportunities for SR-related learning outcomes. It has been stated that emotion has been largely stripped out of the engineer’s toolkit and personality, and engineering has been decontextualized socially and politically. At the same time, perceptions of engineering as masculine and uncaring may contribute to the low representation of women in engineering; about 20% of engineering Bachelor’s graduates are women and only about 10% of practicing engineers are women. Possibly, if engineering education can be more socially relevant and caring, it will attract and retain more women whom the profession needs.

In a step towards alignment, many engineering bodies describe a less technocentric engineer in their documents. The National Academy of Engineering (NAE) described the large diversity of skills and traits needed in order to address the many challenges that lay ahead. The standards for accrediting engineering programs include some of these non-technical skills, such as criteria h (understand the impact of engineering solutions in a global, economic, environmental, and societal context), f (understanding of professional and ethical responsibility), and c (design to meet desired needs within realistic constraints such as social, political, ethical, health and safety, and sustainability); these outcomes all touch on elements of SR.

Professional societies are also promoting broader calls for the engineer’s professional responsibilities. The American Society of Civil Engineers Body of Knowledge for the 21st Century states: “The manner in which civil engineering is practiced must change.” Further, the vision of the society is that “Civil engineers are global leaders building a better quality of life.” The American Society of Mechanical Engineers’ mission “is to serve diverse global communities by advancing, disseminating and applying engineering knowledge for improving the quality of life.” The Institute of Electrical and Electronics Engineers’ tagline is “Advancing Technology for Humanity.” Professional societies represent a large proportion of the engineering workforce, and it is clear that consideration of the engineer’s larger role in this changing world is being discussed beyond academia. Engineering societies are also one of the most significant connections between the profession and education.

To empower engineering students with their SR more effectively through engineering education, we need to understand students’ ideas about SR and how SR affects decision-making. Though students may not have realized their highest SR potential yet, university education can and should play a significant role in SR development. Additionally, the current generation of students overall appears to be more motivated to serve society than previous generations, and engineering students are no exception based on the growing number of students choosing to be involved with Learning Through Service (LTS) activities that include service-learning through EPICS and co-curricular groups such as Engineers Without Borders USA (EWB).
While these efforts show that some engineering education is working towards increases in SR attitudes, some quantitative studies have shown that SR decreases more for women than men over one year – 23.6% of first-year women decreased while only 9.1% increased, 15.1% of men decreased while 19.8% increased\(^3\). Further, engineering students’ perceived importance of the social impacts of engineering (such as “professional/ethical responsibilities” and the “consequences of technology”) were found to decrease from the first to fourth years indicating a “culture of disengagement” in engineering education\(^3\).

The overall goals of the research are to explore the SR development of engineering students through college, using qualitative methods. This study will identify influences in engineering students’ lives that shape SR understanding. It will explore if there are differences in these ideas by gender. Specific research questions explored in this study are (i) how are student ideas about SR changing from their first to second years of college and (ii) what are major influences that cause these changes?

**Methods**

In September 2013, first year civil (CE), environmental (EnvE), and mechanical (ME) engineering students from five institutions were invited to participate in an online survey of SR. At two institutions where students don’t declare a major until after the first year, the survey invitation was sent out to all engineering students. The Engineering Professional Responsibility Assessment (EPRA)\(^3\) was used to assess views of SR and was distributed electronically. At the beginning of the EPRA survey, it included a definition of SR: “an obligation that an individual (or company) has to act with concern and sensitivity, aware of the impacts of their action on others, particularly the disadvantaged.” It also defined community service, social justice, and pro bono. EPRA then included 50 items that students rated on a 7-point Likert scale from ‘strongly disagree’ to ’strongly agree’. These 50 questions measured the eight dimensions of the Professional Social Responsibility Development Model (PRSDM)\(^3\), which is based on the Ethic of Care philosophy\(^3\). This resulted in a total SR “score” calculated by averaging the student Likert responses for each dimension and then adding the dimension average scores; the total SR score could range from 8 to 56. The survey also asked students to report their volunteer history in the previous year. The survey concluded with range of demographic questions including institution, major, rank, gender, race/ethnicity, age, previous work experience. The survey was conducted in accordance with methods approved by the Human Subjects Research Institutional Review Board (IRB). There were 236 first year students who responded to the survey with validated responses. At the end of the survey, students were asked if they would be willing to be contacted about participating in a series of longitudinal interviews. There were 75 first year students from four institutions who indicated a willingness to participate in interviews.

To understand the experiences of the students for deeply, and answer some of the research’s ‘how’ and ‘why’ questions, qualitative methods were chosen for the next phase of the study. Among the group who consented to be interviewed, intentional sampling methods were used to select individuals at different levels of SR as quantified by the survey instrument, and representing multiple institutions and each of the three targeted majors. It was also the intent to significantly over-sample female students, at a desired ratio of 3 female interviewees to 1 male. This ideal mix of individuals was impossible to obtain even with an incentive of $100 per
Many students did not respond to the email solicitations. The students were assigned pseudonyms in compliance with standard procedures. Table 1 summarizes the demographic characteristics of the students who participated in the study. The majority had a total SR score (shown in column 1) that was 0.5 to 1.5 standard deviations above the mean SR score of all the first year respondents (n=12); the next most prevalent group had a total SR score within 0.5 standard deviations of the mean (n=11). The results show a bias that individuals with higher SR scores were more likely to desire to participate in the interviews. The institution acronyms used in Table 1 are as follows - LRU: Large Research-Intensive Public University in the Western US; SRU: Small Research-Intensive Public University in the Eastern US; TU: Technical University, highly technical in the Midwestern US; MPU: Midsize-Private Research-Intensive University in the Eastern US; N1/N2/N3: new universities not part of the original study sample. The majors of the students are also shown, and many changed over time.

The interviews with the first year students were conducted in the Spring of 2013. All email correspondence, consent forms and interview questions were approved by the CU Boulder Human Subjects Research IRB. Questions from year 1 can be seen in a previous publication. The interviews were 30-60 minutes in length. Half of the initial 14 interviews were conducted in person and half by phone to see what were the effects the different formats. The phone interviews were more candid, so the rest of the interviews were conducted by phone or Skype. In a previous paper, students were assigned an ‘SR Type’ that described how they envisioned engineering integrating with their own SR-related endeavors. These types are shown in Table 1. The majority of these students also repeated the EPRA survey, which included a new open-ended question that asked the students to identify any courses that had impacted their views of SR.

Table 1: SR Types Identified from Year 1 Interviews

<table>
<thead>
<tr>
<th>SR Type 1 - These students indicated that their reasons for choosing engineering as a major were or had become strongly related to their sense of SR. Largely, these students were or wanted to be involved with extracurricular activities with the purpose of alleviating hardships, such as EWB, and believed that engineering had significant potential to improve the lives of the marginalized or disadvantaged. (2 Men, 7 Women)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SR Type 2 – These students wanted to better society at large with engineering through technological improvements or infrastructure that would positively impact society. These students saw a direct path through engineering to affect these types of changes. (4 Men, 7 Women)</td>
</tr>
<tr>
<td>SR Type 3 – These students believed in helping others and enjoyed it, but did not relate their ideas of SR to engineering or any profession. Rather, SR was an issue to be addressed personally, not necessarily through their profession. (4 Men, 6 Women)</td>
</tr>
<tr>
<td>SR Type 4 – These students had thought little about SR or helping others at all, including through their professions beyond safety and legal professional obligations. Many were focused on their studies and helping those closest to them. (3 Men, 1 Woman)</td>
</tr>
</tbody>
</table>

The students interviewed in year 1 were again contacted for another interview in March-April 2014 by the same male doctoral student. Thirty-two students responded to solicitation emails and signed consent forms approved by the IRB. Most of these students also completed the next
iteration of the EPRA survey such that their total SR scores could be compared across years. The EPRA survey included questions on why the student selected their major, if courses had impacted their views of SR, and volunteer experiences in college. All students had settled on a major, and seven students had left engineering. Some students had a different major when they were interviewed than what they declared entering college or during the EPRA survey, so their survey, first year, and second year major are all noted. Students who left engineering discussed their SR-related experiences in their new major; these results will not be discussed in the current manuscript. Engineering students were interviewed for 50-70 minutes each about their past year, employment expectations, and thoughts on SR. See Table 3 for a full list of questions asked of those students who stayed in engineering.

While most interviews did stay approximately within the structure of the questions, the interviewer was able to follow certain interesting threads and reference the previous year’s interview as necessary to elicit more interesting conversation. Some of the interviews spent more time on the employment expectations than their past year if little occurred besides classes. Some focused more on social responsibility if the student had little ideas of what they wanted for their future.

Each interview was audio recorded then transcribed into Microsoft Word using Dragon voice recognition software. Each interview was then read through and edited while listening to the interview to produce a more accurate transcript. This transcript was then imported into Nvivo 10 for identifying and classifying the multiple themes around SR definitions and influences found in the interviews. For reliability, two researchers coded three interviews each to identify any new codes that were not found in the first year of interviews. Then, three more common interviews were coded by the researchers and the codes were compared and discussed until agreement was reached. This reliable code book, which was very similar to the first year, was then used by one researcher to code the rest of the interviews.

Results

While many subjects were discussed in the interview, changes to students’ ideas of SR will be presented here along with the influences that caused these changes. These are their general ideas separated from engineering, or inclusive of how they see SR in engineering. This component is focused upon because the college experiences that develop SR within or outside of the students’ formal learning environments is of particular interest for this study. The other parts of the interview, such as professional expectations, will be addressed in forthcoming publications.

Largely, ideas around SR did not seem to change significantly from the end of the first to the end of the second year for the engineering students. This seemed due to a lack of time to participate in volunteer activities or non-required classes due to a large course load (as Macy described it, “I put academics first and everything else last”), in addition to their courses having very little social context. This may be indicative of a typical problem in engineering education – first-year courses are interesting and project-based, but then in the second year, all the intense prerequisites must be taken, which limits students’ abilities to engage with social issues within or outside their courses. Additionally, some students chose to be more involved with sororities or sports teams rather than volunteer groups, and their schedules did not allow for both activities.
<table>
<thead>
<tr>
<th>Initial Total SR Score</th>
<th>Pseudonym</th>
<th>Gender</th>
<th>First Gen</th>
<th>Race / Ethnicity</th>
<th>Major (Pre-/Yr 1/Yr 2)*</th>
<th>Institution</th>
<th>Year 1 SR Type</th>
<th>SR score trend</th>
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<tbody>
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<td>35 – 39.5 &lt; -1.5 Ȫ</td>
<td>Thomas</td>
<td>M</td>
<td></td>
<td>White</td>
<td>ME/ME/ME</td>
<td>LRU</td>
<td>4</td>
<td>Increase</td>
</tr>
<tr>
<td></td>
<td>Travis</td>
<td>M</td>
<td></td>
<td>Hispanic</td>
<td>EnvE/EnvE/EnvE</td>
<td>SRU</td>
<td>2</td>
<td>Increase</td>
</tr>
<tr>
<td>39.8 – 44.1 -1.5 Ȫ to -0.5 Ȫ</td>
<td>Todd</td>
<td>M</td>
<td></td>
<td>White</td>
<td>ME/ME/ME</td>
<td>TU</td>
<td>3</td>
<td>No change</td>
</tr>
<tr>
<td></td>
<td>Quinn*</td>
<td>M</td>
<td></td>
<td>White</td>
<td>ME/ME/ME</td>
<td>LRU</td>
<td>3</td>
<td>No change</td>
</tr>
<tr>
<td></td>
<td>Jason</td>
<td>M</td>
<td></td>
<td>White</td>
<td>ME/ME/ME</td>
<td>TU</td>
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<td>No change</td>
</tr>
<tr>
<td></td>
<td>Jackie</td>
<td>F</td>
<td></td>
<td>White</td>
<td>ME/ME/ME</td>
<td>LRU</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Madison</td>
<td>F</td>
<td></td>
<td>White</td>
<td>ME/ME/ME</td>
<td>TU</td>
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<td></td>
<td>White</td>
<td>CE/CE/CE</td>
<td>LRU</td>
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<tr>
<td></td>
<td>Macy</td>
<td>F</td>
<td></td>
<td>Multi</td>
<td>Other/ChE/ChE</td>
<td>MPU</td>
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<td>No change</td>
</tr>
<tr>
<td></td>
<td>Trevor*</td>
<td>M</td>
<td></td>
<td>White</td>
<td>EnvE/CE/CE</td>
<td>SRU</td>
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<td>No change</td>
</tr>
<tr>
<td></td>
<td>Ashley</td>
<td>F</td>
<td></td>
<td>White</td>
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<td>MPU</td>
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<td>No change</td>
</tr>
<tr>
<td></td>
<td>Kim</td>
<td>F</td>
<td></td>
<td>White</td>
<td>EnvE/EnvE/EnvE</td>
<td>LRU</td>
<td>2</td>
<td>No change</td>
</tr>
<tr>
<td></td>
<td>Jamie</td>
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<td>Yes</td>
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<td>ME/ME/ME</td>
<td>TU</td>
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<td>CE/ArchE/ArchE</td>
<td>LRU</td>
<td>2</td>
<td>No change</td>
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<tr>
<td></td>
<td>Alicia**</td>
<td>F</td>
<td></td>
<td>White</td>
<td>ME/ME/Int Phys</td>
<td>LRU</td>
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<td>Miranda**</td>
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<td></td>
<td>White</td>
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<tr>
<td></td>
<td>Kaitlin**</td>
<td>F</td>
<td>Yes</td>
<td>White</td>
<td>EnvE/Env/Arch/Undec</td>
<td>SRU/N3</td>
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<tr>
<td>48.7 – 52.1 0.5 Ȫ to 1.5 Ȫ</td>
<td>Derek</td>
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<td></td>
<td>White</td>
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<td>MPU</td>
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<td>No change</td>
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<td></td>
<td>Julie</td>
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</tr>
<tr>
<td></td>
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<td>Rachael</td>
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<td></td>
<td>Shawn*</td>
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<td></td>
<td>White</td>
<td>EnvE/EnvE/ChE</td>
<td>LRU</td>
<td>2</td>
<td>Decrease</td>
</tr>
<tr>
<td></td>
<td>Sarah</td>
<td>F</td>
<td>Yes</td>
<td>White</td>
<td>CE/CE/CE</td>
<td>TU</td>
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<tr>
<td></td>
<td>Tanya</td>
<td>F</td>
<td>Yes</td>
<td>Afr-Am</td>
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<td></td>
<td>Brandon</td>
<td>M</td>
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<td></td>
<td>Tim</td>
<td>M</td>
<td></td>
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<td>ME/ME/No Interview</td>
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<td>---</td>
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<td></td>
<td>Nathan</td>
<td>M</td>
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<td>CE/CE/CE</td>
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<tr>
<td></td>
<td>Lindsey**</td>
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<td></td>
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<td>Jocelyn</td>
<td>F</td>
<td></td>
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<tr>
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<td>Katie**</td>
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<td></td>
<td>White</td>
<td>CE/CE/EnvStu</td>
<td>LRU</td>
<td>1</td>
<td>Increase</td>
</tr>
<tr>
<td>Initial Total SR Score</td>
<td>Pseudonym</td>
<td>Gender</td>
<td>First Gen</td>
<td>Race / Ethnicity</td>
<td>Major (Pre-/Yr 1/Yr 2)*</td>
<td>Institution</td>
<td>Year 1 SR Type</td>
<td>SR score trend</td>
</tr>
<tr>
<td>------------------------</td>
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<td>-------------------------</td>
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<td>----------------</td>
<td>----------------</td>
</tr>
<tr>
<td>Total (1st Year)</td>
<td>Men: 13 Women: 21</td>
<td>4</td>
<td>1 Asian 2 Hisp 1 Afr-Am 1 Multirace</td>
<td>ME: 12 CE: 7 EnvE: 7 Other Eng: 5 Non Engrg: 3</td>
<td>LRU: 11 SRU: 6 TU: 9 MPU: 8</td>
<td>Type 1: 9 Type 2: 11 Type 3: 10 Type 4: 4</td>
<td>Increase: 2 No change: 22 Decrease: 6</td>
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<tr>
<td>Total (2nd Year)</td>
<td>Men: 11 Women: 21</td>
<td>4</td>
<td>2 Hispanic 1 Afr-Am 1 Multirace</td>
<td>ME: 8 CE: 7 EnvE: 4 Other Engrg: 6 Non-Engrg: 7</td>
<td>LRU: 10 SRU: 5 RU: 9 MPU: 7 N#: 3</td>
<td>Increase: 3 No change: 16 Decrease: 6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*switched major within engineering; **left engineering; 
*ME – Mechanical; EnvE – Environmental; CE – Civil; CompSci – Computer Science; Env Stu – Environmental Studies; ChE – Chemical Engineering; BiomE – Biomedical Engineering; ArchE – Architectural Engineering; Int Phys – Integrated Physiology; Econ – Economics; LandArch – Landscape Architecture; BioChem – Biochemistry; AnimSci – Animal Science; IntlDev – Community and International Development
### Table 3: Interview Questions - End of Sophomore Year

1. Are you still a _______ major? (If not: why did you switch? [Move to SWITCHER set of questions]) How is the second year going? What are some big events that occurred in the last year? What are some things you have enjoyed? Found difficult or frustrating?

2. Why do you like engineering? What is motivating you through the tough classes?
   a. What are your particular interests within _______ engineering?

3. What is your ideal career now? Why?

4. What are some specific qualities of a job and company that you are looking for? Why are these qualities important?
   a. Do you already know of companies where you’d like to work? If so, which ones?
   b. Which quality is the most essential? Why?

5. What do you think engineering employers are looking for in an interview?

6. How do you think about social responsibility? How would you define it?
   a. Describe experiences in this past year that have influenced this understanding of social responsibility.
   b. *If very different from previous definition*: what do you think influenced these changes?

7. How do you expect social responsibility will be part of your future engineering career? How strongly? In what ways?

8. Does your sense of social responsibility move you towards, away, or neither from an engineering career? In what ways? Has this changed significantly since last year?

9. Is there anything else you would like to share, or do you have any questions?

*Used these questions if interviewee did not offer many thoughts about social responsibility initially:*

10. Volunteering
    a. *If there were significant ways that they described helping others in the previous interview*: Are you still involved in [reference previous interview]?
        i. YES: Describe some of your experiences with that in the past year.
        ii. NO: Why not? Are there other activities you are involved with instead?
    b. What are some new ways you have been involved with volunteering in the past year?
        i. *If none or few or difficult question to answer*: what are some reasons you did not volunteer (much) in the last year?

11. Important Social issues
    a. What social issues matter to you? Why?
        i. Are you currently working to address these in any ways?
    b. In our last interview, you mentioned [reference previous interview] as an important issue. Have you become/stayed involved with addressing this issue?
    c. Do you see engineering playing a role in addressing these issues?
    d. How do you think your engineering abilities could help with this goal?
    e. Do you think other majors in or outside of engineering could better help you to reach this goal? Why?

The stories of Jocelyn, Sarah, Ashley, and Tucker are presented in detail in the following section. These students represent the spectrum of responses and experiences, from little change at a low level to a reinforcement at a high level, of the 25 engineering students who remained in the study. They represent each of the four social responsibility types (Table 1) in year 1, include a student who switched universities, one that had intensive experience with engineering practice, one who has become fully absorbed in courses and other non-engineering co-curriculars, and another who has continued little involvement outside typical engineering activities.
Jocelyn, a mechanical engineering student who switched to N2 from LPU, had one of the highest initial social responsibility scores of the incoming first year engineering students. She was characterized as a Type 1 student because she was heavily involved in EWB and wanted to use her engineering skills as a Peace Corps member in the future (she also could be a Type 2 since she wants to work on alternative energy projects further in the future). However, her SR score had already dropped by the end of the first year, from 54.4 to 50.8. This drop in the SR scores over time was commonly found among the engineering students with the highest SR scores (unpublished data). Jocelyn was involved heavily with the Society of Women Engineers (SWE), Engineers Without Borders (EWB), and her sorority in her first year of college at LPU. Due to a long history of volunteerism, family values, and a particular experience in Costa Rica during high school, Jocelyn was interested in joining the Peace Corps after college. While she was very content in her college experience at LPU, she lamented being so far from her family on the east coast, and eventually decided to go to school closer to her mother, sister, and boyfriend. She transferred into the mechanical engineering department at N2 (new university) to start her sophomore year. She also joined SWE, EWB, and continued her membership in her sorority. In terms of her involvement, she seems to have only changed the location of her university experiences.

It is clear through the conversation in the second year, however, that since Jocelyn is closer to her family, and the community in which she grew up, her definition and ways of acting on SR have also become more local. In the first year, she discussed EWB more as a way to act on SR, and in the second year she discussed being involved in local politics, “taking care of or acting on things that you are part of and around and being involved in social decisions.” She further talked about volunteering, like she is doing with Big Brothers and Big Sisters and through her sorority, as a way to be socially responsible. Most significantly, though, is that she considered her future by saying that, “the best way I can act on my social responsibility is by raising four children that are intelligent thinkers that can think for themselves and read every day and worry about politics and like to be involved.” She did not mention this component in the first year, and it stands to reason this was because she was separated from home and perhaps would plan to raise her children. Jocelyn’s SR development will be very interesting to follow, seeing if her future familial concerns continue to be strong influences, or if other collegial experiences also contribute. Her expected Peace Corps experience after college, that she did discuss in the second year, will likely be life-changing.

Sarah was characterized as a Type 2 student at the end of year 1 since she saw engineering as the best way to improve society overall. In the first year interview, Sarah, a civil engineering student at TU, described early on that she wanted to help people: “So I really want to…go and help people in South America to like, better themselves. So I’m working on it, that’s really my goal.” She planned to use her interest in problem-solving and natural leadership abilities to help whichever communities needed engineering assistance. This added up to her definition of SR: “helping…other…people…I guess.” From the language surrounding the definition, these “other people” were not limited to those in her own community. Sarah’s measured SR score did not change significantly over the first year, starting at 52.3 and ending at 54.0; it dropped significantly to 49.0 at the end of the sophomore year, which is considered below.
Sarah had an interesting experience in her second semester of her sophomore year that many engineering students choose: a co-op. When interviewed in her sophomore year, she was in the middle of her 8 month position at a public works office in her home municipality. Even though she had classes the semester before, the co-op dominated the conversation and it was clear the work her office completed had a great influence on her idea of SR, and how she could and should act on it. When asked if there were any other influences on her ideas about SR, she replied, “I want to say yes, but I really can’t think of anything. I mean, my job has social responsibility, you know, make roads and systems better.” In this second year, her definition of SR was “your responsibility to the people around you…to help other people around you.” This definition, while similar to year 1, is significantly more local and that is supported by her discussions around her co-op and the ways she wants to benefit her local community as a career. Additionally, it is possible, that being back in her hometown, working, and living with her family rather than being on the TU campus narrowed her considerations. It leaves one to wonder what her definition might have been with more EWB experience as she had intended at the end of her first year.

Ashley, a chemical engineering major at MPU, had significant influences before college that led her to desire to help people, though this was separate from her interest in engineering. This separation led to her characterization as a Type 3 student. Ashley’s mother manages a food and clothing bank in her hometown, and Ashley has been volunteering there since she was young. This is certainly a big component that she wants to continue being part of, and poverty that persists through generations of the same families is a social issue that is very important to her. Despite this experience, her SR definition in the first year was fairly limited, “that what you are doing is not harming people…make sure the pros outweigh the cons.” Implied in her responses in other parts of the interview, her definition expanded to include assistance to those in poverty and conserving the environment.

In her second year, Ashley admits that, “I mean, maybe a big thing is that I am not as involved. I don’t feel like I’ve been very effective in volunteering or being an active part of social responsibility as I was last year. That might be part of it.” Her time has been taken by a more active role on the ballroom team and an increased course load, and she is not helping through her job with the loss of her work study with the Boys and Girls Club. However, in this recognition, she also has developed her SR definition somewhat, saying “You are responsible to do certain things socially depending on where you are, in your life. So if you have free time and then you can like volunteer your time and if you have I guess extra money to raise money.” This seems to be a development beyond her first year definition, in some of these ideas of redistribution of wealth in time or money and to go beyond not doing harm. She goes on to reiterate that she desires to continue her involvement with volunteering, and that “hopefully” it will be part of her career, though not a priority.

Finally, Tucker, a civil engineering major at LPU, had the least developed definition of any of the students who were interviewed in the first year saying, after a little prodding that, it’s “just like, not be fraudulent and keep to your word and stuff, and having good ethics I guess.” It was fairly obvious that he had not been asked to consider the concept before. Major influences were his engineering ethics module of his intro to civil engineering course and witnessing cheating in
his college courses. Tucker was not involved with any volunteering or even extracurricular activities during his first year of college.

Tucker did become more involved during his second year, but not through activities that would, on the surface, develop social responsibility. He attended seminars put on by the Association of General Contractors and took on a small, but active role on the concrete canoe team. His definition of SR did grow somewhat in that now it includes being “responsible for your own actions every day and following societal rules.” He goes on to describe that communication is also part of your SR, whether on a team or with friends, and his experiences with a lack of communication on the concrete canoe team incorporated this into his definition of SR. Also, the most important factor in a company that he would work for are their ethical practices. It seems that this should not be conflated with SR, but carries significance to look forward to in the third year of interviews after he has a summer internship. Tucker’s SR scores on the survey did not change significantly from his initial score of 45.9 to his score of 45.7 at the end of sophomore year.

Discussion

Certainly, these four second-year engineering students have had very different experiences thus far in college, and this is representative of the larger study population. Students find their passions and priorities in different places and points in time. In the context of engineering education, these results do provide some guidance as to how students can develop their SR further as they approach their professional careers. Students should continue to develop their SR through college, or at least have a strong idea reinforced, and the following are some ways educators can help move this process along.

Notably, only two of the 25 students mentioned a sophomore level engineering class as an influence on their understanding of SR, and it was the same course at SRU. Interestingly, four more students listed a sophomore class such as engineering management and environmental systems as influential on their SR ideas in the EPRA survey, but did not mention them in the interview. Some students still remembered their first year class, and others were looking forward to their service-learning capstone courses that had been described to them. This is an opportunity for educators to bring more social relevance into their core courses, such as Vanasupa et al. were able to achieve in their materials engineering courses. Further, this social relevance may help in the retention of women and underrepresented minorities as they seem to place more value on the social impact of their work. Showing the potential impact of engineering works throughout the curriculum can be very important for social responsibility development in conjunction with engineering knowledge acquisition.

On the other hand, the students who have thought little about SR are very influenced by in-class activities and modules. What is taught really is powerful, and educators can build a student’s SR right there in the classroom. It does seem, however, that these efforts need to be followed up, ideally every year, such that students bring these ideas into all their personal and professional endeavors, like volunteering and internships.
These four students show the diversity of co-curricular activities with which students are involved. It could be useful to somehow leverage their personal volunteer experiences in the engineering classroom. For example, Jocelyn could be encouraged to think about how her engineering skills could be of use to the community in which she volunteers as a Big Sister. Or Ashley could ponder in what ways she thinks engineers could engage with the food and clothing bank to improve their system. Even thinking about pro bono work, if service-learning is not an option, can be useful in connecting the classroom work to the real world the students are experiencing every day. Freeman et al. showed that a theoretical service learning project can have similar value to students as that of a community-based service learning project as a way to enter the space with less barriers such as community partner coordination. In terms of methods, it can be seen that these interviews revealed a lot more about the students’ opinions on SR than simply their definition allowed. Many students don’t think about SR very often, and their definitions can often be vague and ungrounded until they have the time to expand on how they came to that definition. The interview format begot much richer definitions and discussions about what was most important to each student.

Future Work

This research is part of a larger project attempting to understand how SR changes for engineering students throughout college. All students, regardless of their educational choices within or outside of engineering will be interviewed about their SR development. Other publications will discuss the ways engineering students believe SR is connected with engineering and will be part of their futures and careers. With one interview in each of their first three years of college, student trajectories can be compared to identify which experiences are most influential so teaching practices that will develop the SR of engineering students can be incorporated in the future.

The seven students who left engineering also offer unique perspectives on the engineering experience and can compare it to what they go through in their chosen major. Some students chose another major because they found it to be more socially relevant or a better way to act on their sense of SR than engineering would be. Their stories will be analyzed to understand what drives students out of engineering and if there are ways that improvements in engineering education could help in their retention.

Finally, this study is paired with a quantitative study of SR, and the student responses in the interviews can shed light on some of the questions that have arisen from the data analysis such as, “why do SR levels decrease on average for women, and increase for men over their first year of college?”

Summary and Conclusion

The students in this qualitative study reveal some interesting developments in their SR definitions, but largely, it is the lack of development that is most concerning. Engineering education needs to bring more socially relevant material into second year engineering courses not only to produce engineers more aware of the political and economic consequences of their actions, but also to retain and engage underrepresented populations. Many studies have
described how to implement social issues in engineering classes including evaluation of their impact, and these should be drawn upon in tweaking core classes to help develop SR in the engineering curriculum, not just in outside volunteer opportunities. As student continue to connect SR with engineering, they will take this into their careers, and the engineering profession will engage more with society. Future work in this study will find out more ways students are developing their SR through their years in college and foreseeing SR in their engineering careers.

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