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Volunteerism in Engineering Students and Its Relation to Social Responsibility

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Abstract

Addressing how engineering students view their role in society, their social responsibility, is seen as a central aspect toward creating holistic engineers who are able to address complex social issues. The Professional Social Responsibility Development Model (PSRDM) provides a framework for social responsibility development in engineers. Included in this model is a cycle where feelings of professional obligation to help others are enhanced through engaging in service. This study set out to characterize volunteerism among engineering students and to attempted to relate community service activities with views of social responsibility.

Data for this study were collected through the Engineering Professional Responsibility Assessment (EPRA) which was developed to operationalize the PSRDM. The survey was distributed to undergraduate engineering students at 17 universities in the spring of 2014. Over 1880 undergraduate students from a diversity of majors and academic ranks completed the survey, including Likert-type items measuring their views of social responsibility and detailing their previous volunteer histories by both activity and frequency. Students reported their level of participation in 17 different volunteer or community service activities during college, or could write-in their own activity. The most frequently cited activities were: unpaid tutoring of college students; tutoring elementary or secondary children, and donating blood (40-47%). A high percentage of students (25-35%) also participated in service-learning projects, community service via a professional society (ASCE, ASME, AAEE, etc.), unpaid coaching or sports camp volunteer, food bank volunteer, or a short term on-site service project (i.e. spring break service trip, EWB/ESW in-country work). Thirty-six percent of the students also wrote-in a unique service activity. The median activity level during college for most of these common community service activities was more than twice but not routinely. Only 6.5% of the students reported no level of participation in volunteer or community service activities.

Overall volunteerism was quantified using linear and nonlinear weighting systems for both the volunteer activity and volunteer frequency. Weighting systems were explored using the five phases and the four key variables of the Service Learning Model. The quality of each weighting system was explored through correlations with student views of social responsibility. Results showed that, irrespective of the weighting system, volunteerism had poor to moderate correlation with social responsibility attitudes. Looking specifically at the eight dimensions of the PSRDM, the strongest correlations existed between volunteerism and how engineering students weighted the costs and benefits of volunteering and how they saw their professional obligation to help others as engineers or through their profession; though these had only weak correlations (0.3).

Background

Engaging in volunteer activities has been shown to be very beneficial to students, not only in their development of personal values and self-efficacy, but also having positive effects on academic performance measures[1]. When tied to course learning objectives, as is done with service-learning, service has been shown to increased academic learning, the ability to apply what students learn to 'real world' situations, and to have a positive effect on views of civic and social responsibility[1-3]. Furthermore, fostering service engagements in engineering may be a

useful at increasing the attraction and retention of women and underrepresented minorities in the field [4-6].

In addition to the personal and professional benefits, many engineering professional organizations are calling for the development of more holistic engineers[7]. Developing holistic engineers requires that engineering education focus on both technical and professional skills development, as is evident by the accreditation board of ABET criterion 3 (a-k) outcomes which include ethical and professional responsibility and an understanding of the impacts of engineering design in diverse contexts[8]. Additionally, the American Society for Civil Engineers includes attitudinal dispositions in their Body of Knowledge as objectives for the development of successful engineers. Many of these dispositions align well with the personal values that have been shown to develop through service, including tolerance, consideration of others, and sensitivity[9].

With this foundation, this study explored views of social responsibility as the foundational beliefs needed to develop holistic engineers, and how engineering students' engagement in service related to those views. The Professional Social Responsibility Development Model (PSRDM)[10] provided the framework for this exploration. The PSRDM describes the development of social responsibility through three realms. The first realm relates to the development of a personal social awareness through an understanding that there are people who need help (*awareness*), recognizing one's ability to help others (*ability*), and feeling a sense of moral or social obligation to help others (*connectedness*). The second realm addresses one's professional development with respect to social responsibility. For engineers, this realm addresses views of the importance of professional skills (*base*), the ability for engineers or the engineering profession to help others (*professional ability*), and recognizing the importance of including social considerations in the engineering design process (*analyze*). The third realm is a merging of the first two and focuses on professional feelings of obligation to help others (*professional connectedness*) as well and examining the costs and benefits of engaging in such acts of engineering service (*costs/benefits*). Figure 1 shows a conceptualization of the PSRDM.

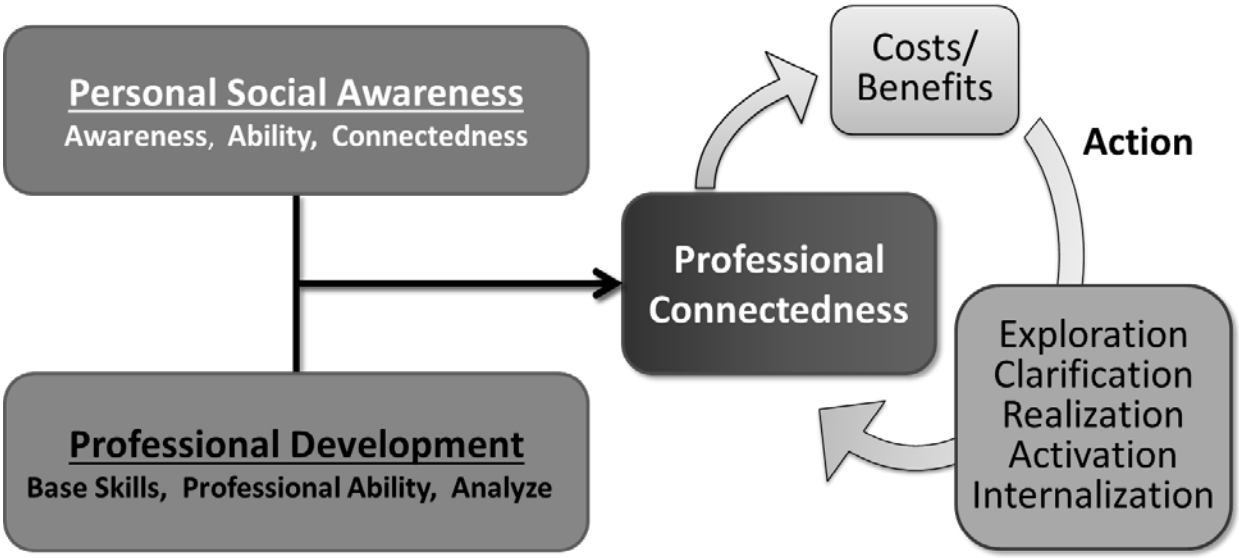

Figure 1. Professional Social Responsibility Development Model[10]

Engagement in service forms a critical component of the PSRDM with respect to how individuals can increase attitudes of professional social responsibility. In the PSRDM, the depth of service engagement as one travels through the cyclical path for professional connectedness is described by the Service Learning Model[11]. This model describes the personal progression of volunteer engagement through five phases with four developmental variables that describe each phase, summarized in Table 1.

Table 1. Summary of Service Learning Model's phases and developmental variables (from [11])

Phases	Description
1. Exploration	New volunteers are generally excited about the opportunities they have to help others, but are generally naïve about the problems facing others. At this phase, participants have little or no emotional connection with a particular social group
2. Clarification	Participants explore many different volunteer opportunities. They may be influenced by peer groups to participated, but progress toward finding groups or issues that are important to them personally.
3. Realization	Described as the 'aha' moment, this phase relates to students realization about "a larger truth about himself or herself" (p. 15) that was fostered by their volunteer activities. Generally the participant becomes more focused on a particular group or social issue at this point.
4. Activation	The participant begins to engage in the complexity of many social issues, fostered by their engagement in service. The participant would generally feel a strong sense of solidarity with the group they are working with and may become an activist for that cause.
5. Internalization	In this phase the participant has fully integrated their volunteer experiences into their life. This may include lifestyle or career changes to live lives more consistent with the values that they gained from their involvement with the social issue.
Developmental Variables	
1. Intervention	Characterizes each phase through the mode (group or individual) and degree of interaction between the volunteer and the community (nondirect, indirect or direct)
2. Commitment	Characterizes each phase through the frequency and duration of an individual's engagement with a given population or volunteer activity
3. Behavior	Characterizes each phase through the relationship that the individual has with the needs of the community they are working with and how participation in that activity affects the personal outlook of that individual (i.e. feeling good, belonging to a group, etc.)
4. Balance	Characterizes each phase through the challenges and support that participants need or receive.

The PSRDM and the Service Learning Model formed the theoretical background for this study. The former was used to relate service engagements with the development of social responsibility and the latter was used to characterize different volunteer experiences in a way that could be quantitatively evaluated.

Research Questions

Focusing on the development of social responsibility in engineering students, specifically through engagement in service, led to the following research questions:

1. What does the landscape of volunteerism among engineering students look like? What activities do they volunteer with and with what frequency?
2. Does volunteerism among engineering students vary by gender or academic rank?
3. Does volunteerism among engineering students correlate with views of social responsibility?

Methods

Using the Engineering Professional Responsibility Assessment (EPRA) tool[12], engineering students at 17 universities with ABET-accredited engineering degrees were surveyed in the spring of 2014. Students representing most engineering majors and all undergraduate academic ranks were solicited using an online survey tool and over 1880 undergraduate students completed the survey (1180 male, 661 female, 257 first-year, 522 sophomore, 536 junior, & 553 senior). Students electronically signed an informed consent form, consistent with the approved Institutional Review Board (IRB) protocol. All solicitation emails, forms and the survey were all approved by the host institution's IRB in compliance with human subjects testing procedures. As an incentive, student participants who completed at least 90% of the survey and correctly answered a "check" question were entered into a drawing for two $50 gift cards from among other participants at their institution.

The EPRA tool consisted largely of 50 7-point Likert-item questions. The average of these 50 items was used to calculate a total social responsibility score. It also asked students four open-response questions pertaining to student definitions of social responsibility, why they chose their major, courses that may have been influential to their views of social responsibility, and a more broad question about "any other influences" to those views. Additionally, students were asked to characterize their typical volunteer activities since beginning college, both the type and frequency, from a list of 17 different activities and with frequency options of "have not participated", "once", "twice", "more than twice but not routinely", "monthly" and "weekly." The list of volunteer activities in the order that students saw them is shown in Table 3. An open response option for other volunteer activities was also included, which also had the same frequency scale. Finally, demographic information such as gender, academic rank, major, and religious preference were asked.

Volunteerism responses were assessed in several ways.

1. Total number of volunteer activities that students participated in, irrespective of the frequency with which they volunteered
2. A weighting system was applied only to the frequency with which a student participated in any activity and all volunteer activities were treated with equal weight. Both linear and nonlinear weighting systems were used, shown in Table 2. The nonlinear weighting system on frequency attempts to account for a significantly greatly level of commitment associated with frequent volunteering at the same activity as opposed to fewer, less routine engagement.

A weighting system was also explored that qualitatively linked different activities to the phases of the Service Learning Model. This approach was explored in order to differentiate volunteerism by the type of activity, believing that donating blood had attributes that were inherently different than traveling internationally for humanitarian purposes. This method

weighted activity, in addition to frequency. This approach used the four development variables of the Service Learning Model to tie each activity to a given phase. For example, donating blood was assessed as a group activity, oftentimes associated with a blood drive, and nondirect as the volunteer never met or interacted with whoever received their blood donation. Feeling good was seen at a common effect of participation. Irrespective of frequency of participation, these attributes would collectively point to donating blood at a Phase 1 activity. Conversely, participating as an international humanitarian volunteer was seen as a Phase 4 activity and possibly Phase 5 because it would most likely be an individually motivated, long-term activity with direct contact with the population being served. Activity weighting systems were combined with frequency weighting systems and double weighted scores were compared to social responsibility scores. No difference was seen in these results with respect to just weighting the frequency (data not shown). Additionally the qualitative assignments of weights to various activities were difficult because an individual could participate in the same activity with different motivation and personal connection and the broad generalizations would not capture this. Because of these, this approach was abandoned.

Correlations between the volunteerism scores and social responsibility, as assessed by average Likert-item responses, were evaluated in IBM SPSS Statistics version 22 using Spearman's rho coefficient, since the SR scores were not normally distributed. Typical rules of thumb for correlation significance were used with rho-values of 0.2-0.4 demonstrating 'weak' correlation, 0.4-0.6 demonstrating 'moderate' correlation and 0.6-0.8 demonstrating 'strong' correlation and >0.8 demonstrating 'very strong' correlation. Significance in differences between demographic populations was determined using univariate analysis of variance, also in IBM SPSS Statistics.

Table 2. Volunteer frequency weighting systems

Volunteer Frequency	Linear Weighting Score	Nonlinear Weighting Score
"Have not participated"	0	0
"Once"	1	1
"Twice"	2	2
"More than twice, but not routinely"	3	5
"Monthly"	4	20
"Weekly"	5	50

Results: Volunteerism among engineering students

The first research question addresses where engineering students in general are volunteering and how frequently. Of the 1885 undergraduate participants who completed the survey, 94% of them had volunteered at least once with one of the 17 activities listed, or wrote in a response for the "other" category. The most common activities that students participated in were unpaid tutoring of college students (47%), and tutoring elementary and secondary children (46%) and donating blood (40%). Participation rates for each activity among the total population are shown in Table 3. Participation in politics as a campaign volunteer and participating in international humanitarian work were the activities with the lowest participation (8% and 4%, respectively). Cost and access are most likely common limiting factors for not participating in international humanitarian work.

Table 3. Activity participation rate and frequency distributions among participants

Activity	% of Total Participated at least once	Frequency distribution among participants*				
		Once	Twice	More than Twice, but not routinely	Monthly	Weekly
Habitat for Humanity Build	16%	55%	23%	21%		
Tutoring elementary or secondary children [G]	46%	16%	13%	46%		17%
Tutoring college students (unpaid) [GR]	47%	11%	12%	49%	14%	15%
Donated Blood [GR]	40%	26%	20%	43%		
In Class Service Learning Project (i.e. service oriented capstone project) [GR]	35%	47%	16%	23%		
Engineers without Borders (EWB), Engineers for a Sustainable World (ESW), Bridges 2 Prosperity Project, or a similar extracurricular engineering service program [G]	19%	30%	12%	21%	11%	27%
Food Bank Volunteer	29%	29%	22%	43%		
Meals on Wheels Volunteer	8%	36%	20%	38%		
Nursing Home Volunteer	16%	29%	23%	40%		
Political Campaign Volunteer [R]	8%	44%	23%	25%		
Big Brother/Big Sister, Boys & Girls Club, Boy/Girl Scouts [R]	18%	20%	11%	39%	11%	18%
Soup Kitchen Volunteer	19%	32%	21%	42%		
Sports Camp, Coaching, etc. (unpaid)	29%	19%	16%	49%		
Professional Society (ASCE, ASME, ASEE, etc.) [GR]	35%	19%	10%	27%	21%	23%
Other: [+]	36%			37%	19%	29%
Short term on-site service project (i.e. Spring Break Service trip, EWB/ESW in-country work)	25%	47%	21%	32%	N/A	N/A
Disaster Relief Volunteer	9%	65%	19%	15%	N/A	N/A
International Humanitarian Volunteer	4%	52%	19%	27%	N/A	N/A
Total across all activities	94%	55%	41%	69%	29%	36%
Max across all activities [GR]		6%	5%	31%	16%	36%

* Distributions less than 10% are not shown for clarity purposes.
[G] Statistically significant difference by gender (male vs. female) for participation frequency
[R] Statistically significant difference by academic rank for participation frequency

Participation frequency of "more than twice, but not routinely" was the median frequency response given in activities where students had participated. The maximum frequency with which an individual ever participated in any activity is shown in Table 3. Surprisingly, 36% of the respondents had volunteered with at least one activity on a weekly basis since they began college. The activities with the highest percentage of participants doing so weekly were Engineers Without Borders (or similar) (27%), professional societies (23%) and "other" (29%).

Some of the "other" activities that students participated in weekly and wrote in responses included volunteering with religious based groups (i.e. church youth groups), non-profits, or conservation agencies. The frequency distributions among participants for all of the activities are shown in Table 3. Habitat for Humanity and Disaster Relief were the activities with the highest percentage of participants only engaging once (55% and 65%, respectively). It should be noted that the nature of some of the activities makes it unlikely or even impossible to participate weekly and sometimes monthly. For example, there is a necessary waiting period between blood donations of three months, making weekly participation impossible.

In addition to looking at where students volunteer and how frequently, it was of interest to see how many different activities students volunteered with. Figure 2 shows a histogram of the number of activities that students participated in. The majority of students participated in two to five activities. Several students had participated nine or ten different activities since coming to college and a few had even participated in up to 16 different activities. The average number of activities participated in by engineering students was 4.4. This is encouraging to see that, despite demanding academic programs, students find time to (or are perhaps forced to) volunteer in several different activities while in college.

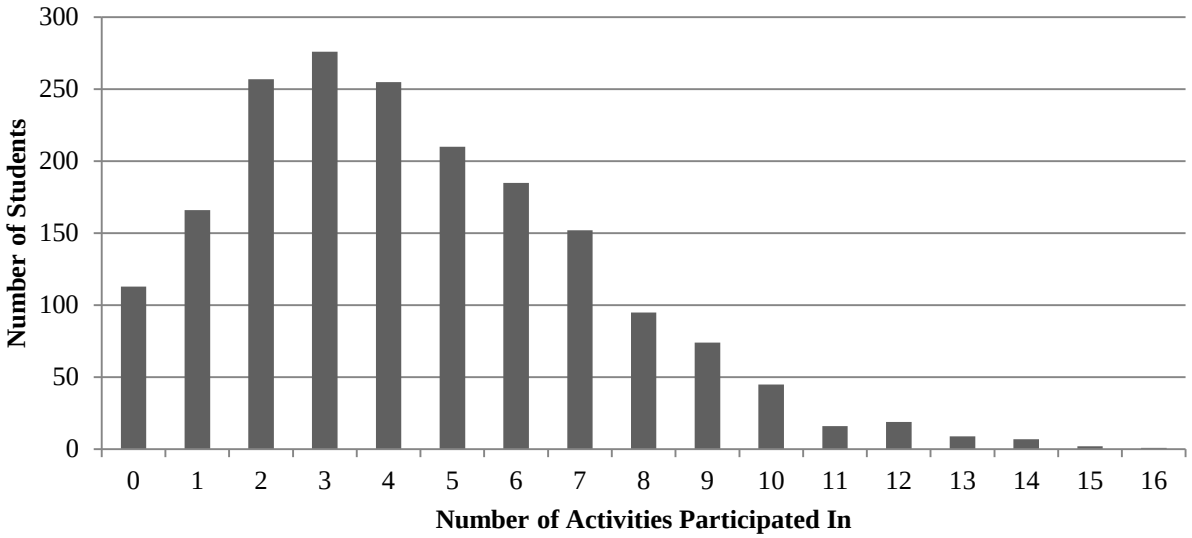

Figure 2. Histogram of number of number of students who participated in various total numbers of different community service activities

Results: Volunteerism by gender

After looking at the global breakdown of student participation in activities and the frequencies with which they volunteer, it was of interest to see if these volunteer trends varied by demographic, specifically gender and academic rank. Examining the results by gender showed that similar percentages of male and female students had participated in at least one volunteer activity since coming to college (94% and 96%, respectively). However, the maximum frequency for participation in any of the activities was significantly different between genders, based on univariate analysis of variance (sig. < 0.05). Examining the frequency of participation in individual activities by gender using univariate analysis of variance (sig. < 0.05) found that eight of the activities had significant differences, as indicated by ^{G} in Table 3. Volunteerism frequency was not significantly different between male and female students across ten of the

activities. The largest differences in percentage where women had participated significantly more than men was seen with EWB (30% female vs. 14% male), professional societies (43% female vs. 32% male), and tutoring elementary and secondary students (53% female vs. 43% male). Donating blood, tutoring college students and disaster relief volunteer were the only activities where the difference between male and female participation was greater than 2% with a higher percentage of males participated than females.

Comparing the maximum frequency with which an individual volunteered with an activity by gender showed that male students were more likely to participate more than twice, but not routinely (34% male vs. 26% female) and female students were more likely to participate weekly (44% female vs. 32% male). The distribution of the number of activities participated in by gender, however, showed similar distributions between male and female students. This shows that, while male and female students tend to have the same number of activities that they participate in during college, female students tend to do so, at least with some activities, more frequently than male students. These results support what have been reported in other studies regarding gender and volunteerism[13].

Results: Volunteerism by academic rank

Since the survey question about volunteer experiences asked students to account for all activities since coming to college, it was expected that students would have more experiences as they moved from first-year to senior year. This was supported by the data. For six activities there was a statistically significant difference in the frequency of participation between different academic ranks, shown in Table 3 with an ^{R} (based on univariate analysis of variance, sig. < 0.05). For most activities, a progressively higher percentage of students reported having participated at least once in them moving from first-year to senior academic rank. Service learning and professional societies, however, showed a significant jump in the number of seniors participating. For service learning, 32-34% of first-year, sophomore and junior students had participated, but 43% of seniors had participated. This could be due to capstone projects that were service oriented. For professional societies 48% of seniors reported having participated while 25% of first-year, 29% of sophomore, and 35% of juniors had. The trend of increasing participation with increasing academic rank was also supported in the number of activities that an individual had participated in. The average number of activities participated in by a senior was 4.8, a junior was 4.6, a sophomore was 4.3, and a first-year student was 3.7. This suggests that, generally, students continue to accrue volunteer experiences throughout college and that they aren't concentrated during a single academic year. The maximum frequency of participation in any event also differed across the four academic ranks.

Results: Correlation between volunteerism and social responsibility

Thus far, engineering student volunteer activity has been explored by both activity and frequency. Frequency distributions as well as number of activities and maximum participation by individuals have been used to characterize volunteerism. It would be easier to discuss student volunteerism, however, if the aggregate of an individual's volunteer history could be distilled down into a single measure. Then this one number could more easily be compared to other pieces of the EPRA survey such as social responsibility scores. Several approaches to distilling volunteer frequency to a single measure were attempted and correlations with social responsibility were explored as a metric for success in that process.

As mentioned above, several approaches were taken to distill volunteer histories down. The first approach ignored frequencies and simply scored students based upon the number of activities that they had participated in. This approach would generally set a positive bias toward senior students who had a higher average number of activities than other academic ranks. The second approach used the linear and nonlinear weighting systems for frequency discussed earlier. In these approaches the weighted frequencies were summed over all activities. As an example, if a student reported volunteering twice at a food bank and tutored monthly, their score using the linear approach would be 6 (2+4) and using the nonlinear approach would be 22 (2+20). Correlations between these approaches and social responsibility (SR) scores (the average of all 50 Likert items) are shown in Table 4. Also shown are correlations between the volunteer score approaches and average scores for Likert-items addressing each of the eight dimensions of the PSRDM.

Table 4. Correlations between volunteer and social responsibility scores (total and dimensions)

Approach	Spearman rho coefficient								
	Total SR	*Aware*	*Ability*	*Conn*	*Base*	*ProfAb*	*Analyze*	*ProfCon*	*CB*
# of Activities	0.272	0.065	0.221	0.233	0.075	-0.033	0.103	0.303	0.293
Linear weighted frequency	0.302	0.094	0.258	0.254	0.075	0.008	0.123	0.329	0.311
Nonlinear weighted frequency	0.287	0.108	0.250	0.235	0.057	0.031	0.139	0.308	0.289

Note: All rho values are significant ($p<0.05$) except for all approaches with the *ProfAb* dimension

Examining the results showed that correlations between the volunteer score approaches and social responsibility were all weak. Looking at correlations with individual dimensions also showed insignificant to weak correlations. All correlations, however, were seen to be significant ($p<0.05$). The best correlations were seen in the *Connectedness*, *Professional Connectedness*, and *Costs/Benefits* dimensions where the PSRDM posits that volunteerism would have the most effect on personal and professional social responsibility development.

Conclusions

This study set out to characterize the volunteer activities of undergraduate engineering students including what activities they volunteer with, the frequency with which they volunteer, and if those vary by gender and academic rank. Overall, nearly all engineering students had at least one volunteer experience while in college with most students engaging in two to five different activities before graduation. Tutoring and donating blood were the most common volunteer activities among undergraduate engineering students. The median frequency that students participated in activities was more than twice, but not routinely. Thirty-six percent of the students who had some volunteer experiences reported that they had at least one activity that they engaged with weekly.

Examining the data by gender showed that male and female students engage in a similar number of activities, but female students tend to engage with more frequency in those activities. Involvement in EWB (or similar), tutoring elementary and secondary students, and professional

societies was more common among female students than among male students, while donating blood and tutoring college students were more common among male students. Volunteer trends by academic rank generally met expectations with student having more experiences as they move through college. These results point to engineering students having volunteering experiences that are distributed throughout their undergraduate careers as opposed to concentrated in a single year.

Distilling volunteer activities to a single score did not provide strong correlation between social responsibility and volunteerism, but correlations that were seen were significant. Developing a volunteerism score was explored through several approaches, though they all behaved similarly with respect to correlation with total social responsibility scores and with dimensional averages. It's important to clarify that these results do not mean that the relationship between volunteerism and social responsibility is insignificant. Previous work has shown that individuals who volunteer more frequently have statistically significantly higher dimensional averages (using unpaired t-test) than others who participated less frequently with the same activity[14]. Similarly, individuals with higher volunteerism scores using the nonlinear weighting system examined here had significantly higher dimensional average scores than individuals with lower weighted scores. Therefore, the weak correlation results may simply suggest that engineering student views of personal and professional responsibility are complex and that volunteerism is just one of many elements that may influence those views. Future work could examine other ways to view student volunteerism and the potential effects that those experiences have on the attitudes of personal and professional social responsibility in engineering students.

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