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Learning Through Service Engineering Faculty: Characteristics and Changes over Time

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Abstract

This research explored the demographic characteristics of the engineering faculty who offer and mentor Learning Through Service (LTS) experiences. Research has found a burgeoning interest in service; i.e., helping people, among engineering students, and it is important to understand how engineering faculty will help foster this desire and assist in retaining these students in engineering. The research explored how the number and type of engineering faculty who are active in LTS activities has changed over time. The research utilized a data mining approach, characterizing faculty active in the Scholarship of Teaching and Learning (SOTL) around engineering education via the authors of the American Society for Engineering Education (ASEE) Annual Conference papers. Author-supplied biographical information in the papers and online research was used to identify the demographic characteristics of interest, including rank, disciplines, institutional affiliations, and gender. The results identified over 500 unique engineering faculty who have authored papers on LTS at the ASEE annual conference from 1996 to 2014; the rate of new faculty joining the ranks of authors of LTS papers averaged 41 per year from 2003 to 2013. The ranks of these authors averaged 23% assistant professors, 33% associate professors, and 32% full professors. The percentage of non-tenured/tenure track (non-T/TT) engineering faculty among the authors of LTS papers increased from none in 1996-1999 to 23% in 2014. Compared to the disciplines of engineering faculty nationally, engineering faculty authoring LTS papers are over-represented in civil/environmental engineering, industrial engineering, and mechanical engineering, and under-represented in chemical, electrical and computer engineering. The percentage of women among the authors of engineering LTS papers generally increased from 2001 to 2014. The authors of LTS papers were 20% women in 2001 and this increased to 50% in 2014; this includes co-authors who are students, staff, and non-engineering faculty. The engineering faculty authors of LTS papers were 15% women in 2001; this percentage increased to 39% in 2014. This is much higher than the percentage of women among engineering faculty (14% in 2013) and ASEE members (24% in 2013). Further, the engineering faculty authors of LTS papers represented 175 unique institutions; these were 36% Baccalaureate or Master's institutions and 26% research universities with very high activity (Carnegie RU/VH). This institutional representation differed somewhat from engineering faculty nationwide who were employed 16% at Baccalaureate or Master's institutions and 54% at RU/VH institutions. These data indicate the ways in which LTS faculty who are active in SOTL have changed over time and are different than typical engineering faculty.

Background

The Millennium generation of students has an interest in serving society and helping people.[1,2,3] For example, in the nationwide American Freshman study, the percentage of students indicating that "helping others who are in difficulty" was an objective considered to be essential or very important was 71.8% in 2013 compared to 63.6% in 1993.[4,5] Within engineering specifically, the large growth in the service-oriented group Engineers Without Borders (EWB)-USA from its inception in 2002 to the present with student chapters at more than half of the engineering colleges in the U.S. was largely attributed to grassroots interest and students starting chapters.[6,7,8]

More recently is has been found that there are differences in the students and professionals who engage with EWB-USA, compared to average U.S. engineering peers.[9,10] Research has shown that serving society and helping people are more important career goals for women than men.[11-14] Thus, casting engineering through this lens of how it benefits society and people may help close the persistent gender gap in engineering.

It is an open question whether engineering faculty fully embrace these ideals of helping people through engineering, and serve as role models for using engineering to benefit society. Engineering faculty are critically important in meeting goals to educate engineers to have a broad set of skills, knowledge, and attitudes.[15-17] Research on engineering faculty is less prevalent than students, so the values of faculty in this regard are less clear. Service-learning in engineering courses and supporting extracurricular community engagement such as via EWB-USA are ways that faculty can embody this caring and commitment to helping society; these activities have been co-termed Learning Through Service (LTS).[18-25] It is unclear whether there is widespread support for LTS among engineering faculty.[26-29] Further, it is unclear if faculty primarily value LTS for how it improves engineering students' core technical skills, or its benefits to helping people and encouraging social responsibility and caring among future engineers.

Reynaud et al.[30] explored how gender and academic rank impacted the attitudes of engineering faculty toward service-learning (SL). Female faculty had greater agreement about the value of service-learning than male faculty, particularly with regards to the belief that service is an integral part of the engineering profession, SL can be academically rigorous, and SL can make students better citizens. Tenure status did not impact beliefs about service-learning, but other teaching attributes were differentially affected between tenured and untenured faculty.

Stroebel et al.[31] conducted interviews with 7 male engineering faculty in three groups to understand their conceptualizations of care and empathy. The resulting themes indicated that faculty viewed empathy and care as "valuable skills or dispositions for students to develop, although they may not be necessary for one to succeed as an engineer." They also felt that empathetic and caring faculty were helpful in motivating students to learn, and felt that empathy and care were already included in engineering coursework.

Research Questions

The goal of this study was to better characterize faculty who are engaged in LTS. The specific research questions being explored were:

1. How has the number and type of engineering faculty who are active in LTS changed over time?
    a. It is hypothesized that given changes in generational values, younger engineering faculty are more likely to embrace LTS. However, the typical model at research-intensive universities places more value on research as compared to teaching and service, which could disadvantage LTS faculty during promotion and tenure.
    b. The number of LTS active faculty will be defined by authors of LTS related papers at the American Society for Engineering Education (ASEE) annual conference and the number of participants at LTS-related workshops or conferences (PBSL, EPICS, EFELTS). By exploring the authors of ASEE papers,

individuals active in the Scholarship of Teaching and Learning (SOTL) are being identified.[32-33]

   c. The type of faculty will be defined by the demographic characteristics of rank, disciplinary affiliation(s), gender, non-engineering degrees in background, additional administrative roles (Deans, Directors), and institutional characteristics.

2. How are the characteristics of LTS faculty different from other engineering faculty?
   a. It is hypothesized that LTS faculty might be different than other engineering faculty, since differences have been found among the students who engage in LTS; for example, women might be over-represented among LTS faculty compared to engineering faculty overall.
   b. The demographic characteristics for LTS faculty were identified to answer research question 1. The characteristics for engineering faculty overall were taken from national data published by the ASEE.

3. Is there evidence of interdisciplinary and cross institutional collaboration evident among LTS faculty?
   a. Collaboration was characterized based on the co-authors of the LTS papers at the ASEE Annual Conference
   b. For each paper it was determined if the co-authors represented multiple institutions, multiple engineering disciplines (multidisciplinary), non-engineering disciplines (interdisciplinary), and/or students.

The methods used to explore the research questions are described in more detail below.

Methods

The method used for this research primarily involved data mining. There were two initial groups that were explored. Group one was the leaders and participants at NSF funded workshops and sessions on Project Based Service Learning (PBSL) in 2008 and 2009, and longer 2-day workshops on Learning Through Service in 2011-2014. The list of attendees from these workshops was compiled, and sorted to remove duplicates. Information from the applications was supplemented with online searches in 2014 from institutional biographies and author CVs to determine a range of demographic information, including: gender, engineering disciplines of degrees (B.S., M.S., and/or Ph.D.), non-engineering degrees (such as MBA), industrial background, Professional Engineering license (P.E.), University, and Position (academic rank and administrative positions). Individuals were counted as engineering faculty if they were employed in an engineering department and had one or more degrees in engineering, computer science, architecture, math, physics, or chemistry. It was also determined if the individuals were active in Engineering Education Scholarship of Teaching and Learning (SOTL) as indicated by publishing papers at the American Society for Engineering Education (ASEE) Annual Conference, using the author search function on the website (http://www.asee.org/search/proceedings). These searches were conducted in October and November 2014.

The second group were individuals who published papers on LTS associated with the American Society for Engineering Education (ASEE) Annual Conference. An ASEE online proceedings search was conducted to determine faculty involved in the Scholarship of Teaching and Learning

(SOTL) related to LTS over time. Search terms of interest were entered (service learning, community service, EWB, community engagement) along with the year of interest. From among the search results, the abstract of each paper was examined to determine if the main focus of the paper involved LTS. In some cases, for example, service learning was mentioned in the biography of one of the authors but was not the focus of the paper. Once the paper was confirmed to be focused on LTS, the title and authors of the paper were recorded in a database (spreadsheet). The total number of authors for each paper were noted. Next, the biography of the authors that was provided with the ASEE paper was examined. This generally provided information on institutional affiliation, discipline, gender (based on the pronouns used), academic rank, and additional administrative roles (department chair or head, head, program director). The biographies also typically stated if the individual was a licensed P.E. or had significant industry experience. Any non-engineering related degrees were also noted, when provided. This information was also recorded in the database. In cases where a biography for an author was not provided, an online search was conducted in an attempt to locate the information. Online CVs were often found, such that the academic rank and other factors could be determined for the individual in the year of interest.

Once the relevant information was found, each paper was classified as to whether or not it met each the following criteria: authors from different engineering departmental affiliations (multi-disciplinary engineering); authors included individuals from non-engineering departments such as education (interdisciplinary); authors from different institutions; and if there were graduate or undergraduate student co-authors. Finally, the institutional classifications by the Carnegie Foundation were determined.[34]

Once the relevant parameters were populated in the spreadsheet, counts were conducted on the parameters of interest. Initially, overall counts across all authors were conducted. Then the counts were redone to look only at faculty, since some papers had students, post-docs, non-faculty center directors, and others as co-authors. Faculty included assistant, associate, and full professors, as well as instructors, lecturers, clinical professors, and adjunct members. It was considered that lecturers, adjunct, clinical, professors of practice, and research faculty positions were non tenure/tenure-track.[35] Individuals who held faculty rank but had primarily moved into administrative roles (such as Dean or Provost) were still counted as faculty. The counts were also conducted specifically for unique engineering faculty, since in a number of cases the same individual might author multiple LTS publications in the same year (e.g., William Oakes). For example, in 1996 there was a single ASEE paper at the annual conference focused on service learning. It had 6 authors, including 2 engineering faculty, three non-engineering faculty, and an individual from a K-12 school district. Engineering faculty included individuals with degrees in engineering, engineering technology, construction management, physics, and/or architecture.

Additional data was gathered as benchmarks to compare to the LTS faculty. Faculty data was gathered from the ASEE profiles, and more specific information from the ASEE Engineering Data Management System.[36] This provided information on the ranks of engineering faculty for the institutions with engineering degrees around the U.S. When combined with information from the Carnegie Classifications, the distribution of engineering faculty across different types of institutions (public, private, Master's, Bachelor's, etc.) could be determined. Data on the number of ASEE members in different divisions was gathered from the ASEE online member search.

Results and Discussion

Number of Faculty Participating with LTS SOTL Over Time

There is evidence of increasing activity in SOTL around engineering LTS from 1996 to 2014, based on a general increase in the number of ASEE papers, authors of ASEE papers, faculty authors, and unique engineering faculty authors (Figure 1). The peak number of papers and authors was in 2007. In that year the ASEE conference was held in Honolulu, Hawaii, which appears to have been a particularly popular location and therefore had many more papers and authors than in typical years. The difference between all authors (green line) and faculty authors (dark blue line) are primarily graduate students, undergraduate students, post-doctoral researchers, and university staff that co-authored the ASEE papers. The difference in the faculty authors (dark blue line) and unique engineering faculty authors (red line) were faculty members without engineering or technical degrees (most typically education, psychology) and removing replicate counts for faculty that published more than one LTS-related paper within a single year.

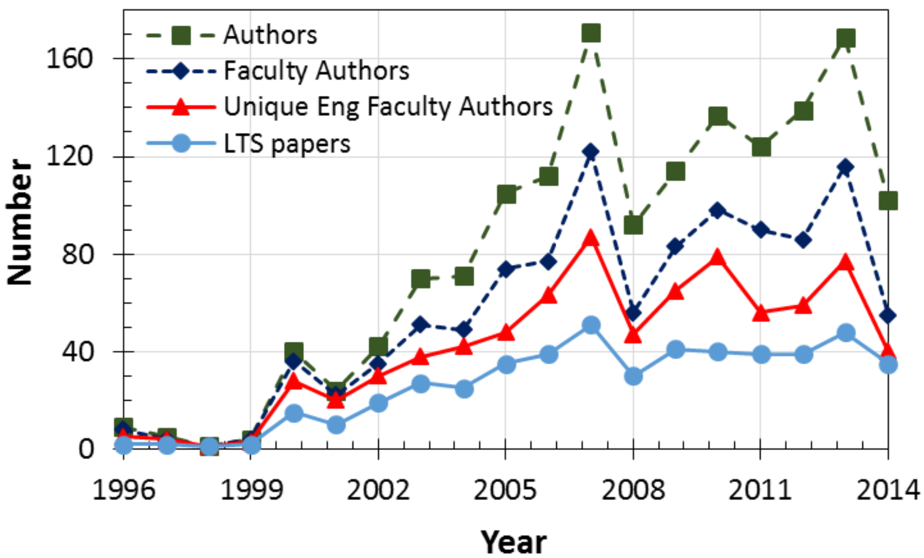

Figure 1. Yearly numbers of LTS papers at ASEE and associated total number of authors, faculty authors, and unique engineering faculty authors

In 1996 to 1999 there were less than five engineering faculty active in engineering LTS SOTL each year (12 total), compared to a peak of 87 engineering faculty active in LTS SOTL in 2007. There may be somewhat more collaboration between engineering faculty and non-engineering faculty authors recently; in 2000 and 2001, 5-8% of the faculty authors were from disciplines outside engineering, math, and physics, compared to 12-18% in 2010-2014.

The cumulative number of unique engineering faculty who have published LTS related papers at the ASEE conference over time is shown in Figure 2. From 2003 to 2013 the rate at which new engineering faculty published ASEE papers related to LTS averaged 41 per year (rsq 0.997). The number of new engineering faculty active in LTS SOTL may be reaching a plateau, based on the drop in the number of engineering authors between 2013 and 2014 in Figure 1 and the fact that there were only 18 new engineering faculty authors in 2014 (Figure 2). Looking at the three year period from 2012 to 2014, there were 135 individual (unique) engineering faculty engaged in LTS; over the entire period from 1996 to 2014 there were 522 engineering faculty engaged in LTS. The Community Engagement in Engineering Education division of ASEE first held sessions in 2012 as a constituent committee and currently has 640 members.[37] A number of LTS papers continue to be presented in other sessions and divisions, such as the NSF grantees poster session, design, civil engineering, and others.

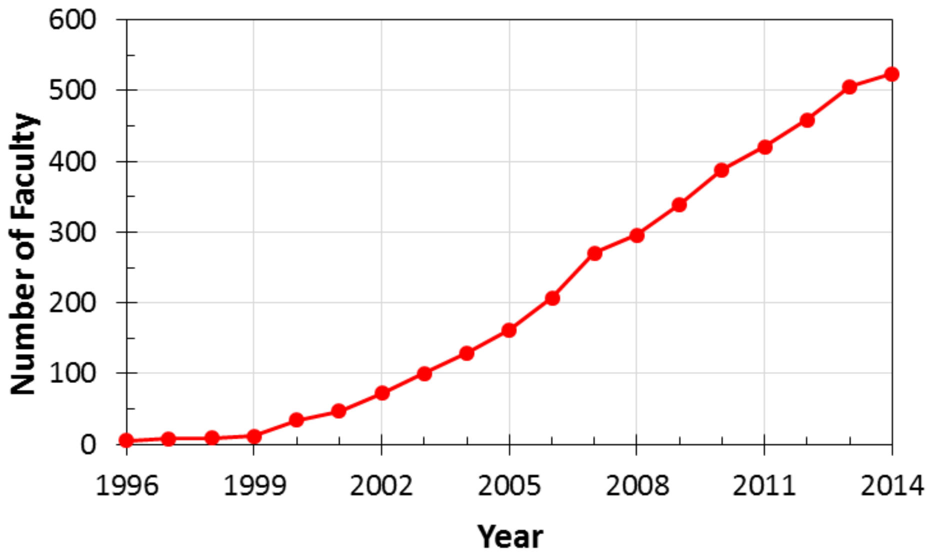

Figure 2. Cumulative total number of unique engineering faculty authoring ASEE conference papers related to LTS

The type and focus of the LTS papers has changed over time. For example, ASEE conference papers that mentioned Engineers Without Borders (EWB) were first found in 2003, increased to a high of 27 papers in 2012 and decreased again to only 16 papers in 2014. Thus, new programs may be initially novel and the subject of SOTL, and then interest may decrease as best practices become identified and disseminated.

Ranks of LTS SOTL Faculty

The ranks of the unique engineering faculty active in LTS SOTL each year are shown in Figure 3. From 1996 to 1999 there were fewer than 10 authors each year, so this data is highly variable; for example, in 1998 the single author of an LTS paper was an Assistant Professor giving 100% at that rank (and off the scale of the graph). From the year 2000 and beyond, there were 20 to 87 unique engineering faculty authors in each year; this range of data will be examined in more detail. The most obvious feature is the emergence of non-tenured/tenure-track (non-T/TT) faculty active in engineering LTS. The first non-T/TT faculty were authors of ASEE LTS papers in 2000 (5%) and since then the percentage has increased to a high of 23% in 2014. The pattern has been variable over this time, but roughly increased at 1% per year (rsq 0.57). This somewhat mirrors the national trend to increasing non-T/TT positions in engineering.[38-39]

Nationally, the percentages of engineering faculty at the assistant, associate, full professor, and non-T/TT ranks in 2013 were 20%, 26%, 45%, and 9%, respectively.[39] Compared to these benchmarks, far fewer of the engineering LTS faculty are full professors and a higher percentage are non-T/TT. This may indicate that LTS interest is higher among young faculty, which would follow the generation shift that has been observed among students. The percentage of assistant professors among LTS authors has been extremely variable, ranging from a high of 44% in 2004 to a low of 15% in 2010, with an average of 23%. Recently, the percentage of assistant professors among LTS faculty has been increasing at a rate of about 3.3% per year (rsq 0.92), from 15% in 2010 to 28% in 2014. The percentage of engineering LTS faculty at the associate professor rank has been similarly variable, ranging from a high of 48% in 2000 to a low of 18% in 2014, with an average of 33%. From 2009 to 2014 the percentage of engineering LTS faculty at the associate professor rank has been steadily decreasing at a rate of about 5% per year (rsq 0.93), from 45% to 18%. The percentage of engineering LTS faculty at the full professor rank (including emeritus) has been quite variable, ranging from a high of 50% in 2001 to a low of 22% in 2009, with an average of 32%. Recently, the percentage of full plus emeritus LTS professors has been increasing at a rate of about 2.1% per year (rsq 0.97), from 27% in 2011 to 33% in 2014.

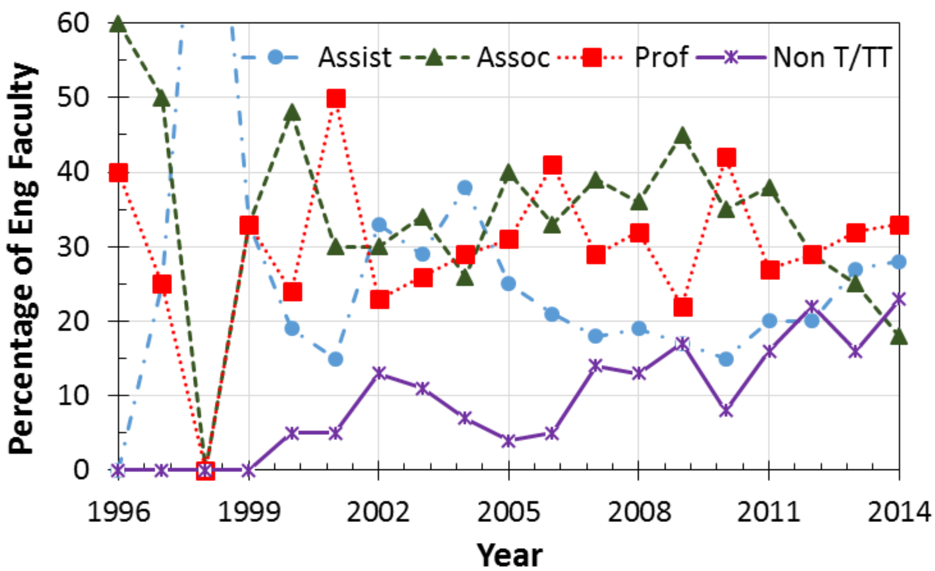

Figure 3. Percentage of the engineering LTS faculty at each rank among the authors in each year

The ranks of some faculty LTS authors were observed to change over time, as would be expected. Among engineering faculty, 7 individuals had advanced from graduate students to instructors or assistant professors, 22 from assistant to associate professor, 14 from associate to full professor, and 2 from full to emeritus professor. It is likely that additional LTS faculty advanced in rank, but that these individuals were not observed among LTS authors at that later time.

Disciplines of LTS SOTL Faculty

The disciplines of the LTS engineering faculty are summarized in Table 1, based on the list of unique engineering faculty who were authors of LTS papers at the ASEE conference. Note that many individuals were associated with multiple disciplines (such as electrical and computer engineering), making accurate counts more difficult. The number of tenured/tenure-track engineering faculty in fall 2013 are presented as a comparison.[42] Civil/environmental engineering faculty are significantly over-represented in LTS SOTL, based on a comparison of their percentage among engineering LTS faculty versus all engineering faculty (1.82x). Industrial and mechanical engineering are also over-represented among LTS faculty; 1.75x and 1.48x, respectively. In marked contrast, electrical and chemical engineering are significantly under-represented among engineering LTS faculty; 0.58x and 0.64x, respectively. Other disciplines are not compared, due to complexity in the comparisons (for example, physics degrees outside of engineering; the LTS counts included architecture and architectural engineering grouped together, etc.). However, there does appear to be clear differences among the engineering disciplines from which faculty are most likely to engage in LTS.

Table 1. Disciplines of Engineering LTS Faculty and Engineering Faculty Overall

Disciplines	Number of LTS engineering faculty authors	% LTS engrg faculty authors	% U.S. engrg faculty[39]	Number of U.S. Engrg Faculty [39]	% LTS eng faculty / % U.S. Eng faculty
All individuals	**559**			**25,628**	
Electrical engineering	73	13.1	22.7	5,811	0.58
Mechanical engineering	147	26.3	17.8	4,554	1.48
Civil, Civil/Environmental, Environmental engineering	136	24.3	13.4	3,435	1.82
Computer Science/Engrg.	38	6.8	13.1	3,346	0.52
Chemical engineering	27	4.8	7.6	1947	0.64
Biological/biomed engrg.	23	4.1	5.5	1414	0.75
Industrial engineering	41	7.3	4.2	1072	1.75
Materials/metallurgical	18	3.2	3.3	853	0.97
Physics	19	3.4	1.2	300	2.9
Architectural/architects	14	2.5	0.5	126	5.1
Math	13				
Construction eng/mgmt	10				

It is also interesting to note that a number of LTS engineering faculty members had additional degrees outside of engineering and technical subjects, most commonly education and business, and also topics such as theology. Among the LTS engineering faculty, twenty percent described industry experience and fourteen percent indicated that they held a Professional Engineer (PE) license; these may under-represent the actual percentages since individuals may not have elected to include this information within the biography of their ASEE paper.

Gender of LTS SOTL Faculty

Women are quite active in engineering LTS SOTL (Figure 4), with up to 31-51% women among all of the authors of the ASEE LTS papers each year from 2002-2014. The percentages of women among the LTS authors decreases when comparing all authors, faculty authors, engineering faculty authors, and unique engineering faculty authors; these averaged 41%, 36%, 32%, and 30% over the entire period from 1996 to 2014. This indicates that there is a larger percentage of women among the non-faculty authors (primarily graduate students, undergraduate students, and staff) than among the faculty authors. There is also a larger percentage of women among the non-engineering faculty as compared to the engineering faculty. The percentage of women among the LTS authors had a weak increasing trend from 2002-2014, increasing an average of 1.3%/year for all authors and faculty authors, and 1.5%/year for engineering faculty authors (rsq 0.67, 0.48, 0.55, respectively).

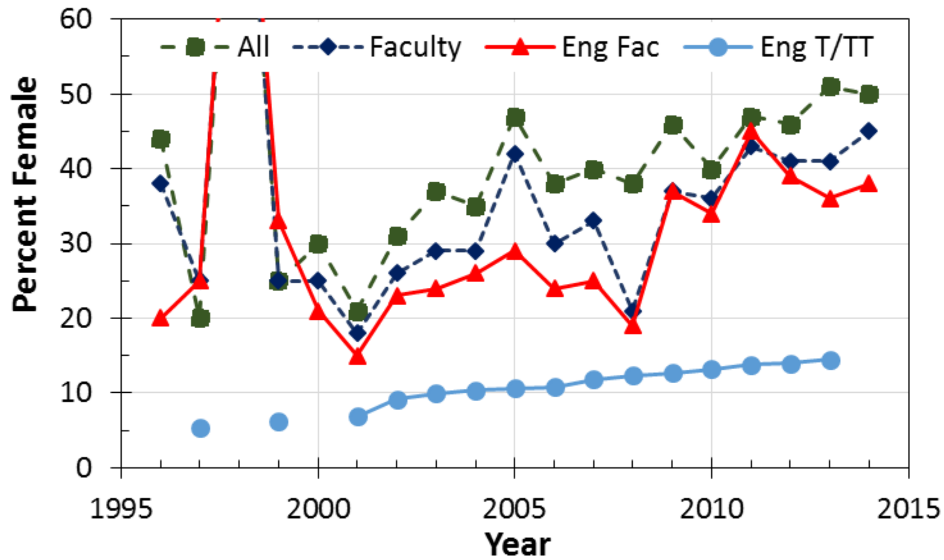

Figure 4. Percentage of women among the authors of engineering LTS papers: all authors, faculty authors, and unique engineering faculty authors; percentage of women among tenured/tenure-track engineering faculty in the U.S. from the literature shown for comparison (light blue circles)

The percentage of women among the engineering LTS papers is far greater than the percentage of women among T/TT faculty in engineering during this time period, which increased from 5.4% to 14.5%.[38-40] The percentage of women among the authors of the engineering LTS papers is also higher than the percentage of ASEE members who are women[41] (24% in 2013). The high representation of women among those active in engineering LTS SOTL mirrors the popularity of engineering LTS among female students. The rate of increase in the representation of women within the ranks of engineering T/TT faculty was 0.48%/year (rsq 0.99), which is similar to the rate of increase of women among the cumulative unique engineering LTS authors over time (Figure 5, 0.73%/yr, rsq 0.89 from 2003-2014). However, the LTS authors include non-T/TT. More exploration of gender representation at the different ranks will be presented next.

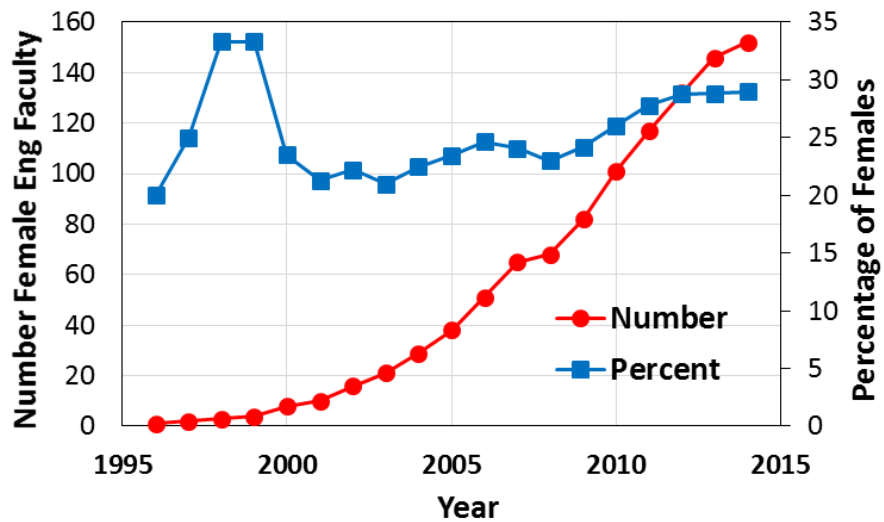

Figure 5. Cumulative number of female engineering faculty among the LTS authors and there representation among all of the engineering faculty authors

The percentage of women among the faculty at different ranks was also explored. While nationally the percentage of women among faculty has been on the rise, there is a wide disparity among different academic ranks. The ASEE statistics for fall 2013 reported the percentage of women among assistant, associate, and full professors as 22.8, 17, and 9.4.[39] Similar disparity was found among the engineering LTS faculty, although the trends are more varied due to the low numbers of female faculty in each year (15 to 38 from 2000 to 2014). The percentage of women among the engineering LTS faculty at each rank over time are shown in Figure 6. The percentage of women among the engineering LTS faculty at the different ranks averaged 51.2, 33.5, 28.6, and 18.9 at the non-T/TT, assistant, associate, and full professor ranks, respectively (averaged from the yearly percentages from 2000 to 2014).

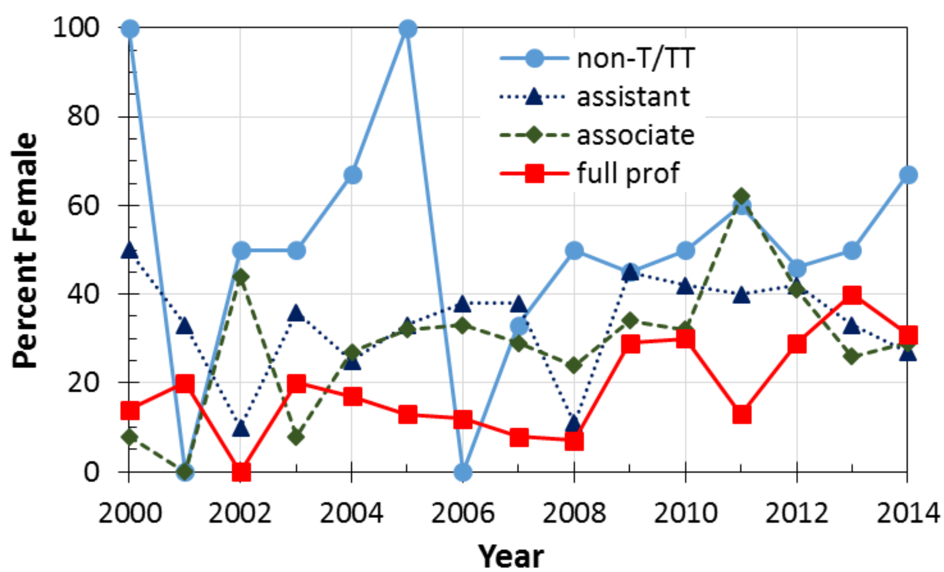

Figure 6. Percentage of women among the engineering LTS faculty at different ranks in each year

The representation of females among non-T/TT faculty was widely variable from 2000-2006, ranging from 0 to 100% (Figure 6). This variability was largely due to the low numbers of total non-T/TT individuals among the engineering LTS faculty; only 1 to 4 each year. From 2007-2014 there has been a weak positive trend in the data, averaging an increase of 3.0%/year in the percent of women among the engineering LTS non-T/TT faculty (rsq 0.52). National data to compare to these percentages of women among engineering non-T/TT faculty were not found.

The comparisons of the percentage of females among engineering faculty at different T/TT ranks among LTS authors to national percentages for engineering faculty are shown in Figure 7. Among LTS assistant professors, the percentage of women was variable from 2000 to 2008, ranging from 10-50%. However, there has been a downward trend from 2009 to 2014 from 45% to 27%, an average decrease of 3.3% per year (rsq 0.82). The reason for this decrease is unknown. Perhaps female LTS faculty who were initially assistant professors and have been promoted to the associate professor rank and a higher rate than new female faculty are adopting LTS. The percentage of women among LTS associate professors has been fairly consistent at 26-34% from 2004-2014, with the exception of a high excursion to 62% and 41% in 2011-2012. There are no trends in the data over time. The percentage of women among engineering LTS full professors has varied each year, ranging from 7% to 40% over the period from 2003 to 2014. There appeared to be a downward trend from 2003-2008 of 20% to 7%, but since that time there has generally been a much higher level of 29-40% (excluding a single low year in 2011). The greatest disparity between the engineering LTS faculty and engineering faculty overall in the percentage of women appears to be at the full professor rank in 2009-2010 and 2012-2013, a difference of ~20%.

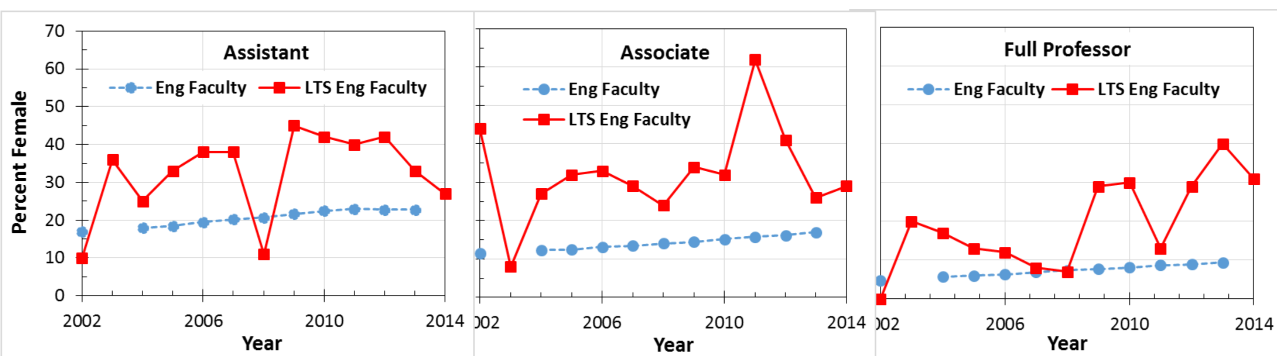

Figure 7. Comparison of percentage of women among engineering faculty and LTS engineering faculty at assistant, associate, and full professor ranks.

Among all engineering faculty, the fastest growth had been in assistant professor ranks, with an average increase of 0.70%/year from 2002 to 2011 (rsq 0.99); but the percentage of females among assistant professors actually dropped from 23.0% in 2011 to 22.8% in 2012 and 2013.[38-40,42-43] Growth rates at the associate and full professor ranks have been steady, averaging 0.50%/year and 0.42%/year from 2002-2014, respectively (rsq 0.99 and 0.99, respectively). Comparing and contrasting the trends in gender representation among LTS engineering faculty to those across engineering should continue.

Among the cumulative, unique list of 523 engineering faculty active in LTS SOTL, 152 (29%) were women (Figure 5). Among those, the ranks when the individual first authored an ASEE LTS paper were: 18% non-T/TT, 32% assistant, 32% associate, and 19% full professors. This appears to indicate that a small number of female non-T/TT engineering faculty were active in LTS for many years, leading to their very high representation each year (~50%) but much lower representation on a unique, cumulative basis.

Institutional Affiliations of LTS STOL Faculty

Based on the cumulative list of unique engineering faculty engaged in LTS SOTL from 1996-2014, the types of institutional affiliations of these individuals were explored. The institutional characteristics of interest were public/private, research universities with very high activity (RU/VH), Baccalaureate or Master's institutions, and institutions with the elective community engagement classification (curr eng) from the Carnegie Classifications.[34] Results are summarized in Table 2, with the institutional affiliations of all recent LTS authors, faculty authors, and engineering faculty authors shown. This characterization was based on the institutional affiliation when the individual first authored an ASEE paper on LTS. Twelve individuals changed institutions over time; only 8.6% of the 140 individuals who authored LTS papers in multiple years.

Table 2. Institution Types of Engineering LTS Faculty [34]

Unique LTS authors	# authors	# Unique Institutions	% Individuals at Public Institutions	% Individuals at Private Institutions	% at RU/VH	% at Bac or Master's	% at curr eng
All 2012-2014	278	76	74	26	32	27	38
Faculty 2012-2014	163	73	71	29	25	38	34
Engineering faculty 2012-2014	133	68	71	29	26	38	35
Eng Faculty 1996-2014	523	175	74	26	29	36	47
Eng faculty[39]	27,825	351	74	26	54	16	40

Among the 278 unique authors of the 2012-2014 engineering LTS papers, 92 different institutions or organizations were represented (76 higher education institutions), including engineering faculty from 68 unique institutions. The institutions with the greatest representation among engineering faculty authors were Purdue University and California Polytechnic State University – San Luis Obispo, with 8 and 7 different faculty authors, respectively. There were also 7 engineering faculty authors from Colorado State University Pueblo and Florida A&M University, but in each case these were all co-authors from the single institution on a single paper. The majority of the engineering LTS faculty were from public institutions, with about a third from Master's awarding institutions, and a third from institutions with the optional community engagement classification. The representation of public/private institutions and institutions with the optional community engagement/outreach and partnerships designations for engineering faculty active in LTS were generally similar to the institutional characteristics of engineering faculty overall (tenured/tenure-track plus FTE of part time teaching). However, LTS faculty were much less likely to come from a RU/VH institution and much more likely to represent non-PhD institutions, compared to engineering faculty overall. This result is not surprising. Engineering faculty at RU/VH institutions are likely promoted and retained on the basis of technical research excellence, which would typically mean less time and attention devoted to SOTL and service activities. This directive to focus time an attention on disciplinary research rather than SOTL and/or service is likely to be true more broadly at all PhD-granting institutions. Thus, LTS faculty are over-represented from Bachelor's and Master's institutions.

LTS faculty – a broader view

There were 219 individuals who lead and/or participated in the PBSL and LTS workshops in 2008 – 2014. This group included 64% engineering faculty, 10% non-engineering faculty, 10% university staff/administrators, 12% students, and 4% industrial and other partners (EWB-USA, ESW, consultants, and NSF). By 2014, the status and ranks of some participants had changed, compared to when they participated. The original participants in these workshops included 26 (12%) graduate students, but 5 of these 26 had become assistant professors or instructors by 2014. Among the engineering faculty, 14 (10%) had experienced a promotion in rank. Among the engineering faculty in 2014, 22% were assistant professors, 29% were associate professors, 36% were full professors, and 13% were non-tenure track instructors, lecturers, or adjunct faculty members. Among the university-affiliated individuals, 67% had co-authored an ASEE conference paper. More specifically among the engineering faculty (as of 2014), 75% had co-authored an ASEE conference paper. This indicates a large degree of engineering education scholarship among the individuals interested in LTS. Among the participants, 79% held engineering or engineering related degrees, 16% possessed no engineering or engineering related degrees, and 5% were unknown. This most common degrees were: mechanical engineering (49), civil engineering (46), electrical engineering (29), and education (10 among individuals with engineering degrees, and 20 among individuals without engineering degrees). Many individuals in the group also held administrative responsibilities, including 17 deans, 21 chairs or heads, and 48 directors.

When the list of 219 PBSL and engineering LTS workshop participants was combined with the list of 278 authors of 2012-2014 ASEE LTS papers, the combined list contained 450 unique individuals. This included 45% women, 66% faculty members, and 55% engineering faculty members. The 246 engineering faculty members were 35% women across all ranks, including 31% women within the tenured/tenure-track ranks. This is significantly higher than the percentage of women among T/TT engineering faculty overall of 14.5%.[39] This is similar to the results that have found that LTS programs attract a higher percentage of female engineering students compared to the percentage of females among engineering students overall. The faculty represented all ranks: 26% assistant professors, 26% associate professors, 33% professors, and 15% other non-tenured/tenure-track instructors/lecturers/adjunct faculty. The primary disciplines of the engineering faculty were: mechanical (30%), civil (22%), electrical (19%), and chemical (7%). The 425 individuals from higher education institutions represented 71% public institutions and 29% private institutions, including 4% international. Of the 406 individuals from U.S. institutions with Carnegie classifications, 30% were from non-PhD granting institutions (primarily Master's, with some Baccalaureate and Associate degree colleges) and 37% represented RU/VH.

Collaborations of SOTL LTS Faculty

Trends in the co-author characteristics of the LTS ASEE conference papers over time were examined. The characteristics of interest were: the average number of authors per paper, percentage of the papers with authors from multiple engineering disciplines, percentage of the papers with authors from non-engineering disciplines, percentage of the papers with authors from multiple higher education institutions, and the percentage of papers that included students as co-authors. From 1996 to 1999 there were only 1 or 2 papers each year, so these were not included in the analyses; the data from 2000 to 2014 was examined. The average number of authors per paper was 3.0 and ranged from a low of 2.21 in 2002 to a high of 3.66 in 2012. When a regression analysis was conducted on the average number of paper authors over time, it was determined that the trend was statistically significant based on a method of least squares analysis. The slope was +0.069/year (rsq 0.56; 95% confidence interval 0.032 to 0.106). This indicates an increasing trend to collaboration among individuals authoring ASEE papers related to LTS activities.

The results from the other paper metrics are summarized in Figure 8. There was an average of 33% of the papers with authors from multiple engineering disciplines (± 11% standard deviation; range 11% in 21002 to 53% in 2012); there was not a statistically significant trend in the data over time. The percentage of papers with authors from multiple institutions averaged 12% (± 6% standard deviation; range 3% in 2008 to 21% in 2012); there was not a statistically significant trend in the data over time. On average, 30% of the LTS papers included co-authors from non-engineering disciplines (range 13% in 2006 to 42% in 2012), with an increasing trend over time of 1.2%/year (95% confidence interval 0.4 to 2.0%/yr). There was also an increasing trend in the percentage of LTS papers with students as co-authors, averaging 2.3%/year (95% confidence interval 1.5 to 3.1 %/yr). Over the period of 2000 to 2014 an average of 34% of the LTS papers included students as co-authors range 11% in 2002 to 54% in 2014).

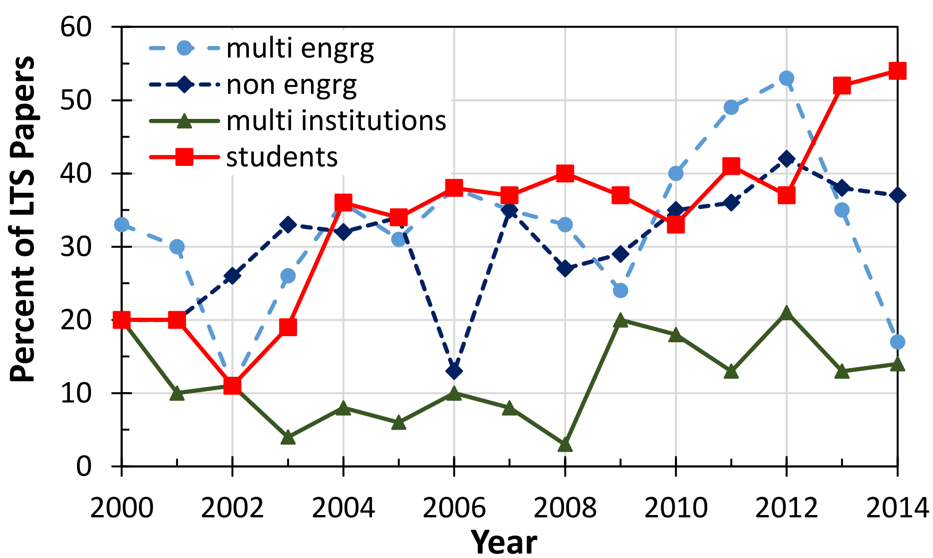

Figure 8. Percentage of ASEE LTS papers that had co-authors from multiple engineering disciplines, non-engineering disciplines, multiple institutions, and students

Limitations and Summary

The research quantified the growing participation of engineering faculty in Learning Through Service as evidenced by co-authoring conference papers at the ASEE annual conference and participating in workshops on LTS. A key limitation of this work is that there are faculty who may participate in LTS activities but not disseminating their activities at the ASEE annual conference and did not participate in the LTS workshops. In the future, additional SOTL venues could be explored, including the FIE conference, regional ASEE conferences, and peer-reviewed journals (including the International Journal for Service Learning in Engineering, International Journal of Engineering Education, Journal of Engineering Education, and others). Data mining NSF grants and university websites might yield the names of additional engineering faculty who are active in LTS. An additional limitation is comparing the characteristics of LTS SOTL faculty to U.S. engineering faculty overall. The characteristics of engineering faculty engaged in SOTL, and in particular those who author ASEE papers, may be different than all engineering faculty. Thus, while this paper illustrates differences between LTS SOTL faculty who author ASEE papers and U.S. engineering faculty, it is unclear if these same differences would be found when comparing LTS ASEE authors to ASEE authors in general.

The research found that the number of individuals authoring ASEE papers on LTS topics has increased over time. The analysis of the authors of ASEE papers related to the Scholarship of Teaching and Learning (SOTL) in engineering education revealed that as a group the individuals involved in LTS differ in some ways compared to their U.S. engineering faculty colleagues. A higher percentage of the engineering faculty who participate in LTS come from the disciplines of civil/environmental, industrial, and mechanical engineering. Many of the engineering LTS faculty also hold administrative positions. Compared to U.S. engineering faculty, fewer of the engineering LTS faculty are full professors and a higher percentage are non-T/TT. There is a higher percentage of women among the engineering faculty authors of LTS papers than their representation among U.S. engineering faculty. A greater percentage of the engineering LTS authors are from Baccalaureate or Master's institutions and a lower percentage are at RU/VH institutions.

The research results opens intriguing questions for future research. Further research should be conducted to examine if differences in the LTS faculty attributes translate into differences in the availability of LTS opportunities at different types of institutions. This requires a more complete exploration, beyond just ASEE papers. The characteristics of engineering faculty who are active in SOTL should be compared to engineering faculty overall, in order to determine the extent to which SOTL is a typical and representative activity among engineering faculty. It would also be interesting to explore if faculty participation in LTS is valued differently in the promotion and tenure processes at different types of institutions or among different engineering disciplines. Is the lower percentage of engineering faculty at the full professor rank merely due to the newness of LTS activities to engineering overall, or does faculty participation in engineering LTS slow their academic advancement? These research questions are critical to understand if the availability of LTS opportunities to engineering students are to continue to grow and flourish.

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