



Recruiting and Retaining Women Engineers: An Analysis of a Successful College Program

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Abstract

In recent years, the percentage of women graduating nationally with a Bachelor of Science in Civil Engineering (BSCE) has been about 20% to 25%; however, there is a huge disparity in the percentage of women graduating from school to school. At Villanova University, the number of women graduating with a Bachelor of Science in Civil Engineering has been 33% over the past three years, which is above the national average. This paper seeks to explore why this department has been successful in recruiting and retaining women by analyzing the results of the incoming student survey, the senior exit survey, and focus group discussions. Three themes emerged that were particularly important to women at this university: understanding other cultures/study abroad; sense of community, which is enhanced by the significant numbers of women faculty and students; and service opportunities. The results indicate that our overall response to these themes, which forms our department's culture, as opposed to the implementation of specific women-only programs was pivotal in successfully recruiting and retaining women. The approach used to uncover these themes could be used by other departments to determine what they could do or what they are already doing that resonates with women.

Introduction

Institutional Background

Villanova University is a comprehensive Roman Catholic institution founded in 1842 by the friars of the Order of St. Augustine. The University welcomes students of all faiths and is located approximately 10 miles west of Philadelphia. The University offers a wide variety of degree programs through four colleges: the College of Liberal Arts and Sciences, the School of Business, the College of Engineering, and the College of Nursing. The College of Engineering offers BS and MS programs through its four departments: Civil and Environmental, Chemical, Electrical and Computer, and Mechanical. The College also offers a PhD.

The university is described as “more selective” by US News and World Report¹. In the College of Engineering, the combined Scholastic Aptitude Test (SAT) for the 25th to the 75th percentile is typically 1850 to 2100. The breakdown by area of the exam per year is shown as Figure 1. Typically, 95% of the students enrolling ranked in the top 25% of their high schools with the low of 91% occurring in 2009 and the high of 97% occurring in 2011. Nearly all of the students enrolled within the program are considered “traditional,” indicating that they are full-time students that enrolled in college immediately after graduating high school².

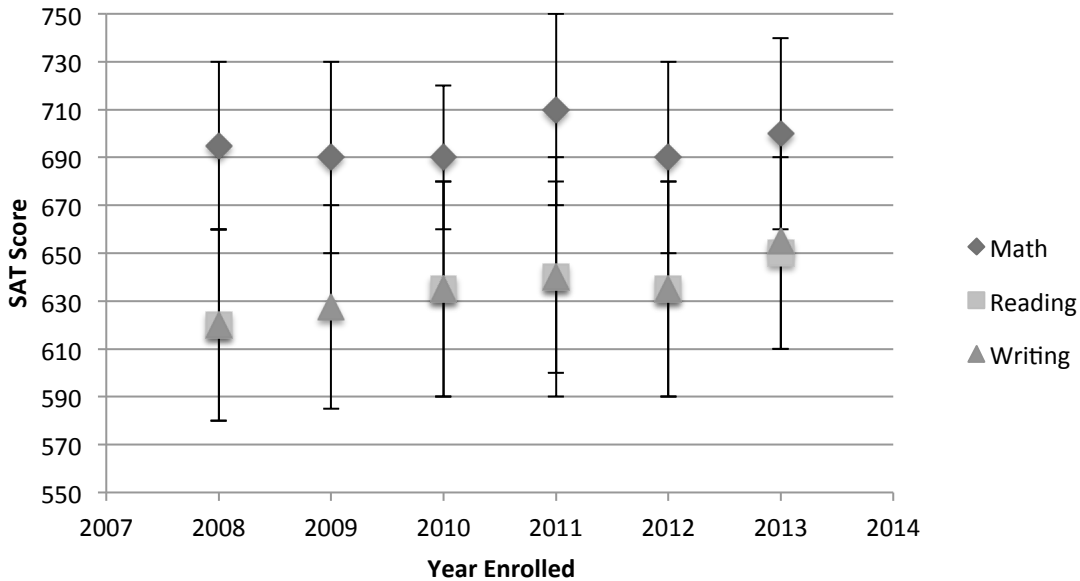


Figure 1. Average SAT Scores of Enrolled Students in the College of Engineering from 2008 to 2013

Key statistics regarding women in engineering were gathered for comparative purposes and are presented in Table 1. Currently there are 1,045 students enrolled in the College of Engineering with 226 of those students in the Civil Engineering degree program. Approximately 28% of the students in the College are women and approximately one third of the Civil Engineering students are women. In 2014, 15 of the 44 students earning a BSCE from Villanova University were women. The College ranked 15th in the country in the percentage of bachelor’s degrees awarded to women in 2012-1013³. At the time of writing, 15 of the 63 full time tenured/track faculty within the college are women and by Fall 2015, six of the 13 full time tenured/tenure track faculty members within the Civil and Environmental Engineering Department will be women.

Table 1. Percentages of Women Earning Bachelor’s Degrees and Women Faculty (nationwide statistics from Yoder³)

| | Engineering | | Civil Engineering | |
|---|-------------|----------------------|-------------------|----------------------|
| | Nationwide | Villanova University | Nationwide | Villanova University |
| % of bachelors degrees awarded to women | 19.1 | 30.7 | 21.0 | 34.0 |
| % of women tenured/tenure-track faculty | 14.5 | 23.8 | 15.4 | 46.0 |

Once women enter an engineering program, they are likely to complete the degree, which highlights the importance of recruitment⁴. For example, Huang, et al.⁵ reported that female students “were more likely than male students to complete an S&E [Science and Engineering] degree and less likely to switch to a non-S&E program.” This experience is the same at

Villanova University with the retention and four-year graduation rate being the same for both men and women. Over the past five years, the four-year graduation rate within Civil Engineering has been 90%.

The authors sought to explain why this particular civil engineering program was succeeding at recruiting and retaining women, especially in light of the fact that there were no programs specifically geared toward that effort. In other words, there appeared to be a culture that was attractive to women. The Oxford Dictionary defines culture as “the ideas, customs, and social behavior of a particular people or society⁶.” The culture is important because as Sonnert, et al.⁴ concluded in their analysis of undergraduate women in engineering “policy efforts should be directed toward departments (or perhaps even to smaller units, such as subfield clusters within departments)” as this has the largest influence on recruiting and retaining women. The institution itself had less of an effect on attracting women to engineering programs⁴. In other words, if a department has policies, social behavior, and customs in place that resonate with women, they will be more likely to recruit and retain those students.

The data analyzed included incoming student and senior exit surveys as well as focus group discussions held with men and women separately. All data are from 2014. The students attending the focus group discussions received complimentary snacks and water during the discussion.

Results of Incoming Student Survey

Since 1989 Villanova University has conducted a survey of incoming students. This survey is comprised of special issue questions for our university and some standardized questions from national surveys. The response rate of the survey was 94% for the entire university in 2014. The response rate in civil engineering was 100%, with 17 women and 39 men completing the survey. The questions were grouped by the following topics and analyzed by gender:

- Expectations of college life (Figure 2), which provides insights into students’ preferences and potential concerns; choices were no, very little, some, and very good chance.
- Reasons for decision to attend (Figure 3) and importance of facilities (Figure 4), which provide information to use in student recruitment; choices were not at all, somewhat, and very important.
- Habits of mind (Figure 5), which provides insights on how to adapt services, academic supports, and teaching techniques to incoming students; choices were not at all, occasionally, and frequently.

Women are more likely to believe that they will be involved in school service, volunteer, and social activities. Women also indicate that they are more likely to believe they will complete their selected major on time (Figure 2). A sense of community, the availability of social outlets, and the ranking of the university were more important to women (Figure 3). Most of the facilities, with the exception of the dining and residence halls, were more important to women when deciding where to attend college (Figure 4).

When considering the best practices for teaching and learning (Figure 5), during their high school years, women were more likely to take notes, accept mistakes as part of the learning

process, seek feedback on your academic work, revise papers to improve writing, look up scientific articles and resources, and explore topics on their own. The survey also revealed that women were less likely to ask questions in class, take a risk because they had more to gain, and seek alternative solutions to a problem. These differences in practices between women and men may suggest different approaches in the classroom to adapt teaching and instructional techniques to engage women. Specifically, the results imply that although women may be less likely to ask questions in class, they may be more likely to seek out mentoring relationships with faculty, which may then provide time for academic inquiry.

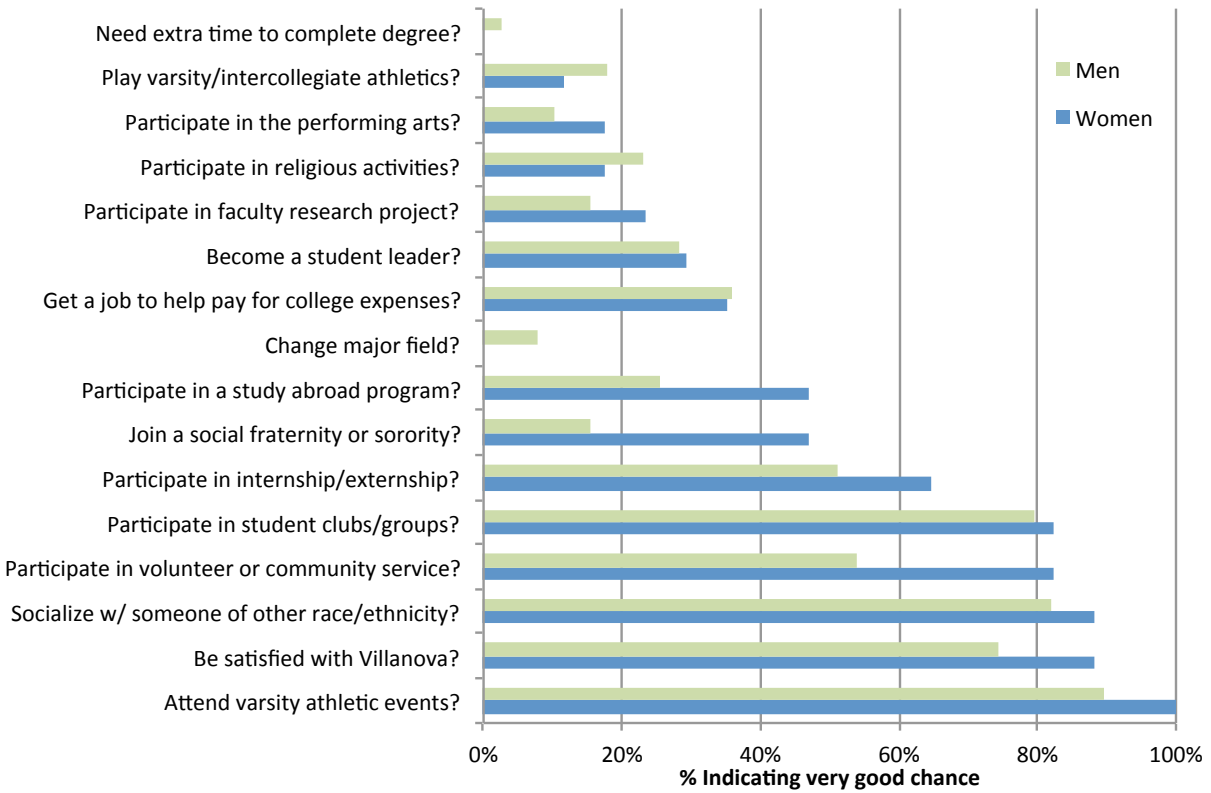


Figure 2. Results of Incoming Student Survey for Expectations of College Life – Question was “What is your best guess as to the chances you will...?”

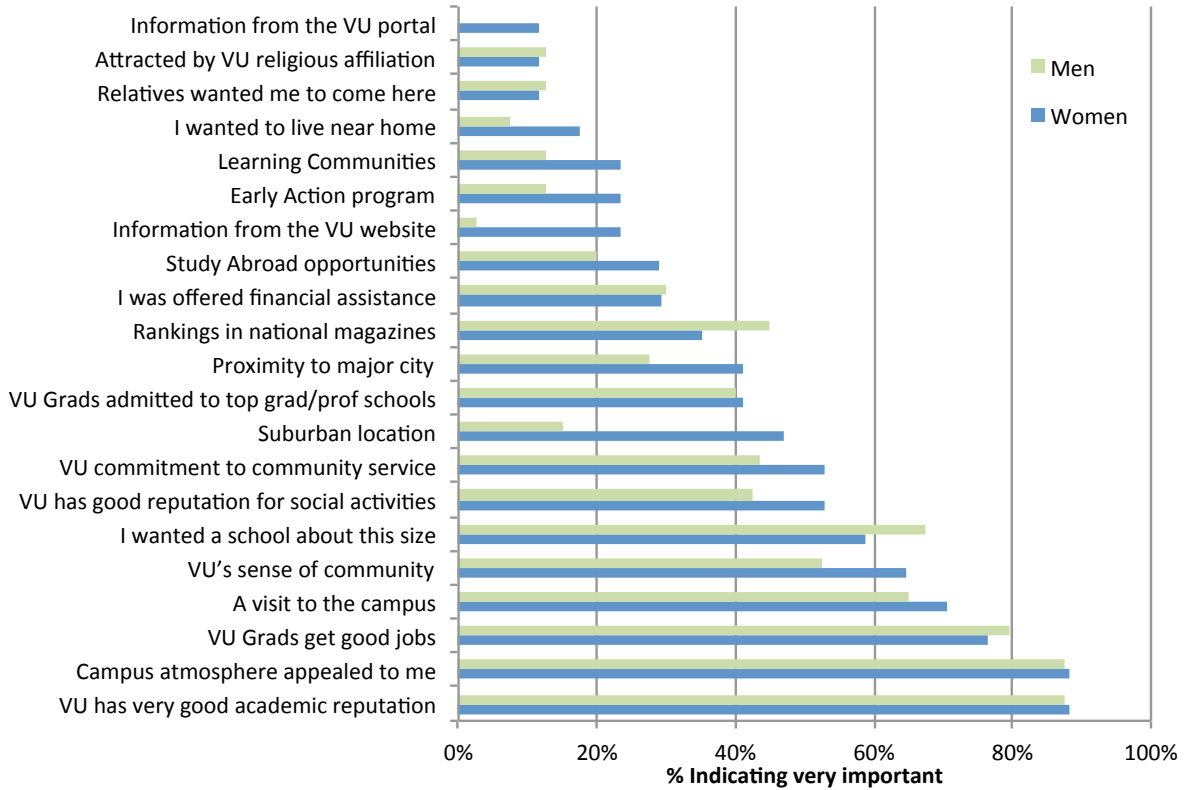


Figure 3. Results of Incoming Student Survey for Reasons for Decision to Attend – Question was “How important was each reason in your decision to come here?”

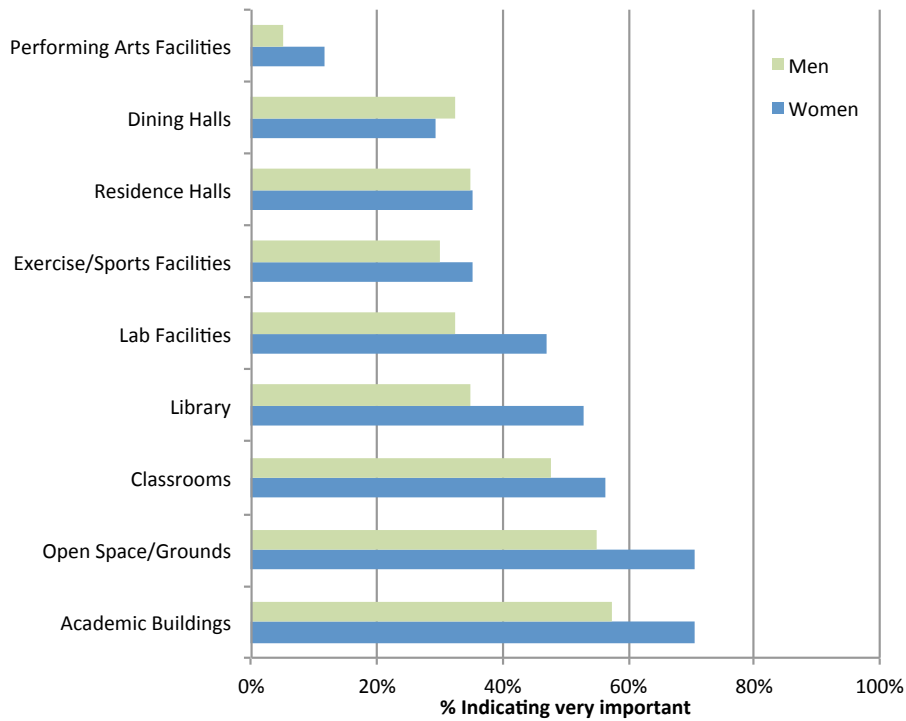


Figure 4. Results of Incoming Student Survey for Importance of Facilities – Question was “How important was each of these facilities in selecting a college?”

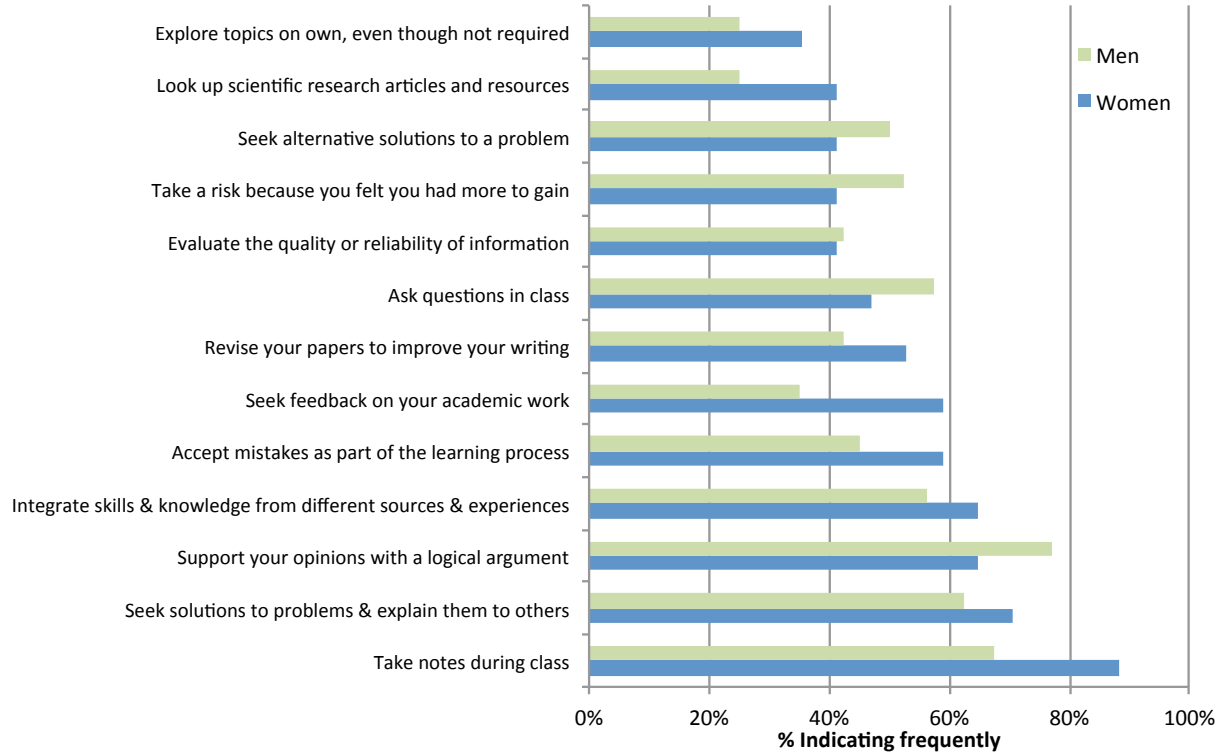


Figure 5. Results of Incoming Student Survey for Habits of Mind – Question was “How often in the past year did you engage in the following?”

Results of Focus Group Discussions

Focus groups of six men and nine women from sophomores to seniors were convened to provide additional, richer data. The focus groups were separated by gender. These discussions focused on the following questions:

- Why did you choose to come to Villanova University?
- Why did you choose to stay at Villanova University?
- What do you think of the faculty/mentors available to you?
- What are the strengths of Villanova University?

The results of the focus group discussions are summarized in Table 2. All students visited the campus before making their choice of college/university to attend and none of the students interviewed had considered transferring to another school.

In addition to the four questions noted above, the women were asked to comment on their experience of being a woman engineering student. Their replies were:

- As prospective female students, almost all immediately noticed and appreciated the relatively high number of women students, which made them more likely to be interested in attending
- They feel comfortable and reassured

- There is a community/network of women, which is easy because there are many
- They see no difference between the men and women on campus, but noticed a difference in the workforce as there are not many women engineers
- The large number of women faculty in the program provide role models

Table 2. Summary of Focus Group Discussions

| Women | Men |
|--|--|
| Why did you choose to come to Villanova University? | |
| <ul style="list-style-type: none"> • Comprehensive university/not a technical school • Community/welcoming atmosphere • Prestige/quality of school • Recommendations of family and school counselors • Male to female ratio is good; noticed on campus visits/open houses • Good number of women faculty | <ul style="list-style-type: none"> • Comprehensive university/not a technical school • Community/welcoming atmosphere • Prestige/quality of school and program • Candidate's day events were pivotal |
| Why did you choose to stay at Villanova University? | |
| <ul style="list-style-type: none"> • The faculty care and want to see the students succeed • Villanova offers civil engineering trips/community work • Opportunities for research • Study Abroad opportunities • Laboratory facilities • Education is good • Advisors are good | <ul style="list-style-type: none"> • The faculty care and want to see the students succeed • Villanova offers civil engineering trips/community work • Opportunities for research • Study Abroad opportunities • Laboratory facilities • Small class sizes • Friends in other majors |
| What do you think of the faculty/mentors available to you? | |
| <ul style="list-style-type: none"> • Vast majority of faculty are willing to help students • Faculty can help give you confidence • Mentors can be both male and female faculty • Faculty realize that you are students and that you have other things to do and understand | <ul style="list-style-type: none"> • Vast majority of faculty are willing to help students • Large number of women faculty • Faculty is very knowledgeable • Class work is based on real problems • Innovative teaching: problem based learning, active learning, flipped classroom • Not a rigidly defined relationship – more unofficial – students need to seek out a mentor • Faculty encourage you to seek internships |
| What are the strengths of Villanova University? | |
| <ul style="list-style-type: none"> • Sense of community and welcoming atmosphere from department to university • Service opportunities • Faculty | <ul style="list-style-type: none"> • Sense of community and welcoming atmosphere from department to university • Service opportunities • University has Augustinian roots |

Results of Senior Exit Survey

The Senior Survey is administered to all graduating seniors prior to commencement. Various versions of senior surveys have been administered by Villanova University since 1993. This survey is comprised of special issue questions for our university and some standardized questions from national surveys. The types of questions ask students to assess their experiences regarding:

- Levels of satisfaction with academics and campus services and supports (Figure 6); choices were very dissatisfied, generally dissatisfied, generally satisfied, and very satisfied.
- Skills they have attained (Figure 7); choices were not at all, a little, moderately, and greatly.
- Engagement and participation in campus life (Figure 8); choices were yes or no.
- Values (personal importance) (Figure 9); choices were not important, somewhat important, very important, and essential.

The 44 seniors exiting the program were surveyed in 2014. The response rate was 95%, which enables us to explore the differences and draw conclusions on the results. Fifteen women and 27 men completed the survey. The differences between women and men were actually more pronounced at the senior exit survey than with the incoming student survey.

All of the women reported that they were very satisfied to satisfied with campus safety. Both women and men showed similar levels of satisfaction with their interactions with faculty and the sense of community on campus, which is consistent with the focus group discussions. Women were more satisfied with study abroad programs, but less satisfied with the cultural programming (Figure 6). Overall, women reported more enhancement of their skills and abilities with the exception of using technology and understanding others (Figure 7).

As shown in Figure 8, women participated at much greater rates than men in educational experiences, service trips, research, service learning, and volunteerism. This is consistent with the intentions that the incoming students showed. Men and women showed similar rates of participation in internships. As shown in Figure 9, women place a great deal of personal importance on relationships, concern for and accepting of others, their own interpersonal and spiritual growth, and a sense of advocacy and action. This emphasis is most likely related to their opinions on the acceptance of minorities and people with different beliefs (Figure 6).

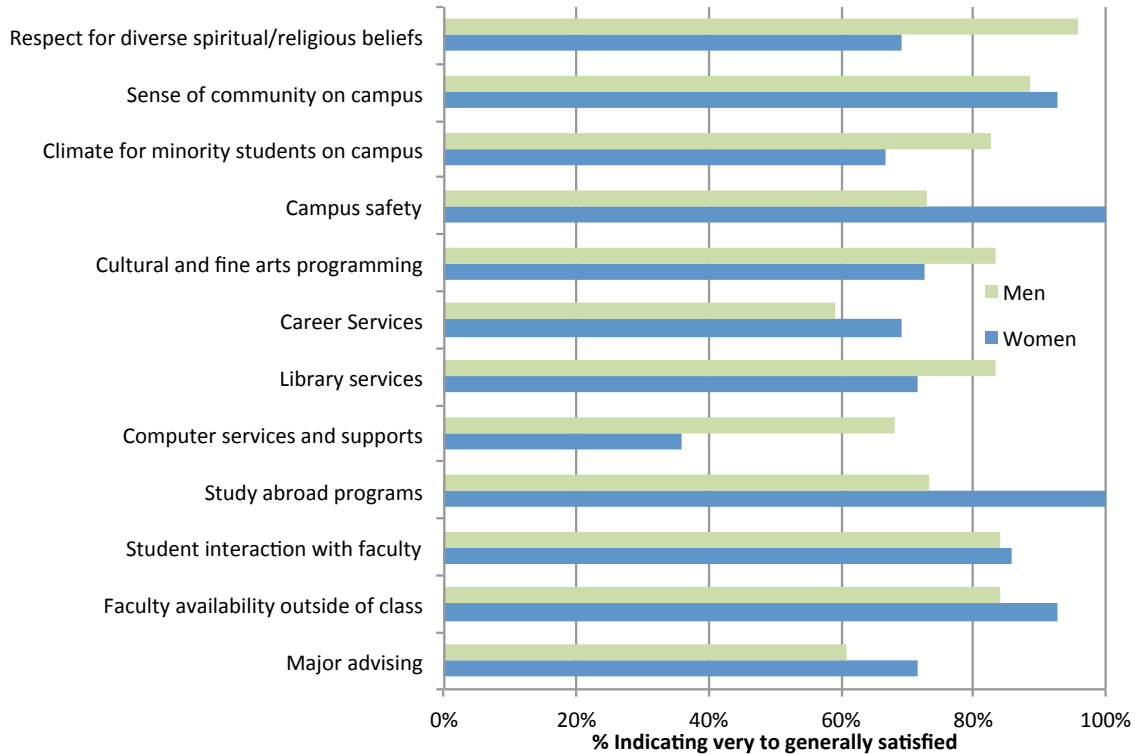


Figure 6. Results of Senior Survey for Levels of Satisfaction – Question was “How satisfied were you with following?”

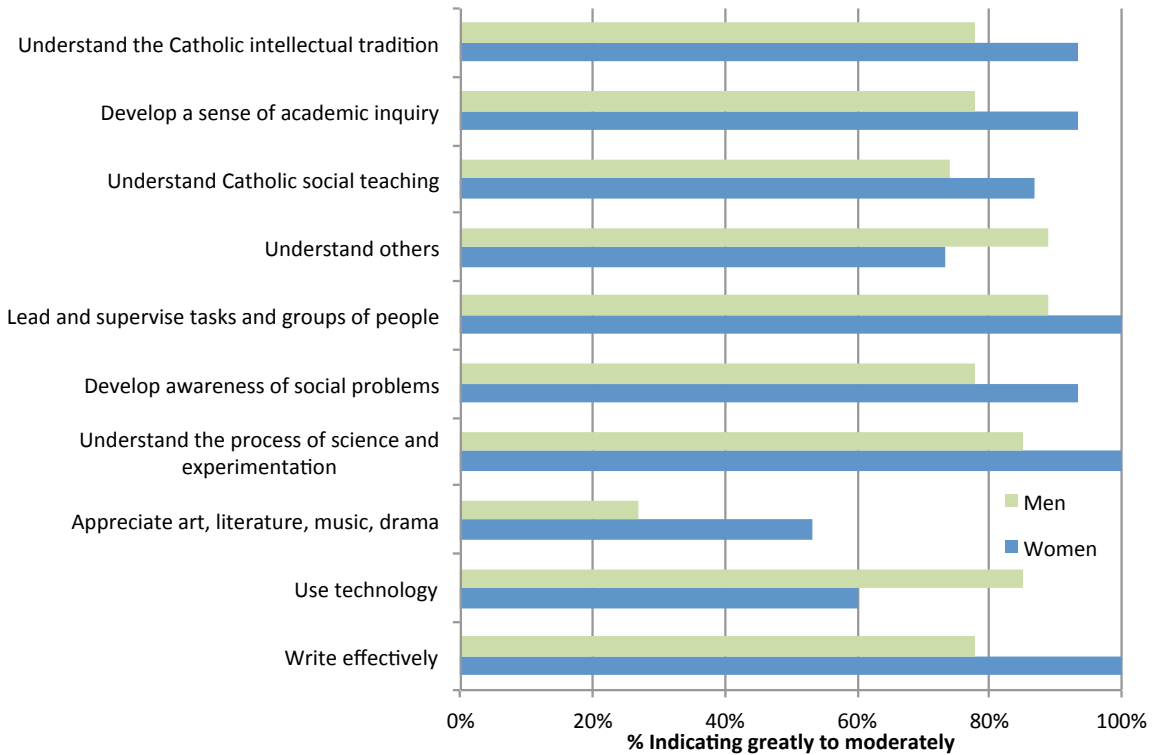


Figure 7. Results of Senior Survey for Enhancement of Skills and Abilities – Question was “Please rate the extent to which each was enhanced by your undergraduate experiences.”

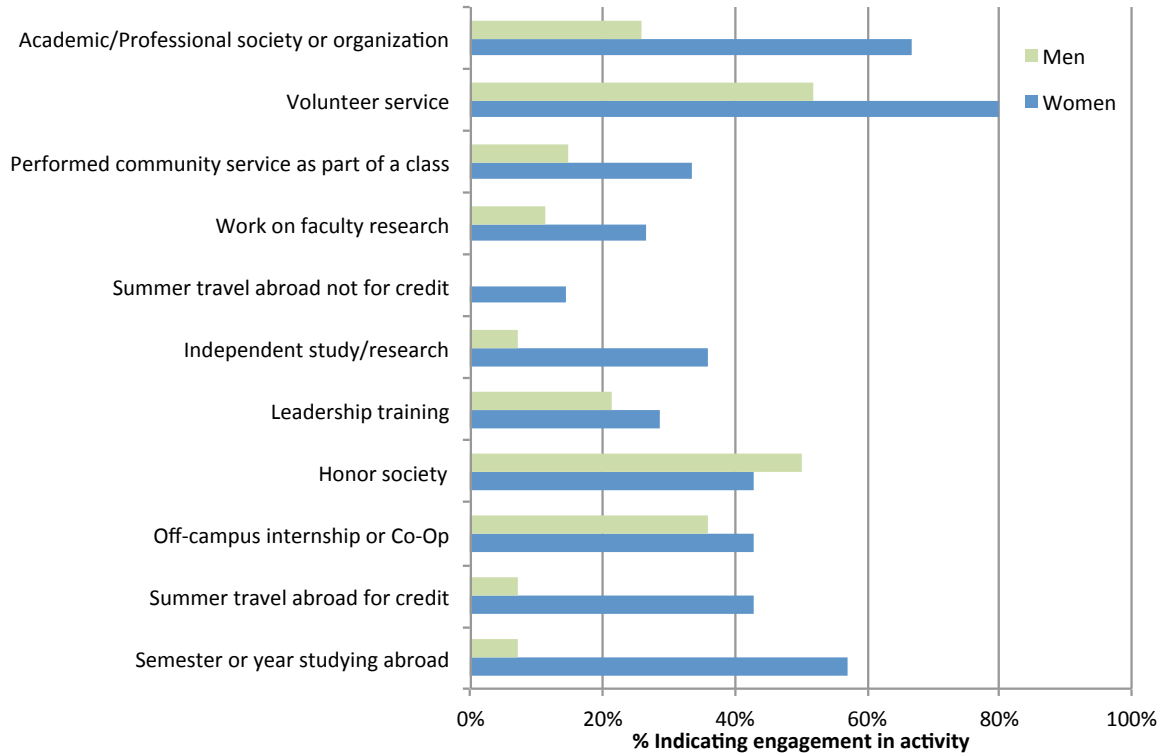


Figure 8. Results from Senior Survey for Participation in Educational Activities and Service – Question was “Did you participate in any of the following activities?”

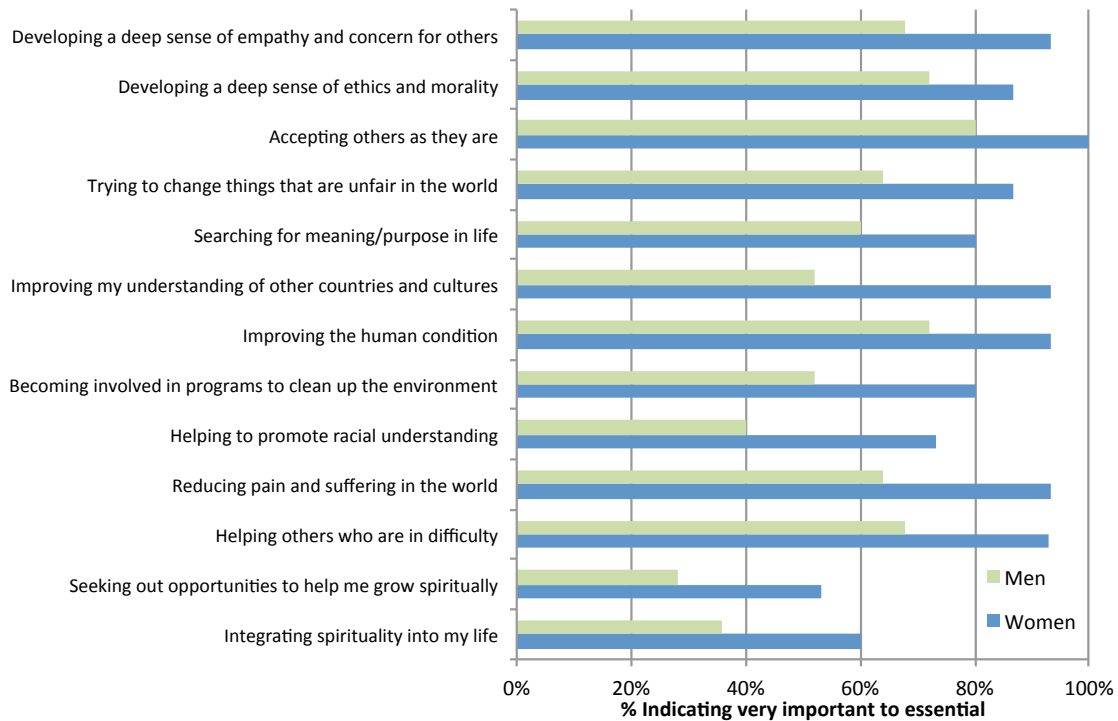


Figure 9. Results from Senior Survey for Personal Values – Question was “Please indicate the importance to you personally for each of the following.”

Discussion of Results

Both men and women are drawn to the academic reputation and the positive employment prospects of obtaining a BSCE from Villanova University. This indicates that while other factors may provide “added value,” the major focus of any program needs to be creating an academically robust degree program that provides students the knowledge, skills, and attitudes they need to succeed after graduation.

Half of the incoming women have expectations and interests in study abroad and study abroad opportunities were a very important consideration for 29% of the women in choosing this university. From the senior survey there is evidence that our most recent women graduates have participated much more so than men in international experiences: 57% semester or year abroad; 43% summer travel for credit; 57% college-sponsored service break trips. All of the women were completely satisfied with study abroad programs. This is indicative of the importance this graduating class of women place on improving their understanding of other countries and cultures (93% essential or very important). It is important to note that knowing this information will allow us to direct resources to fulfilling this high expectation for our incoming classes. Men are also interested in study abroad, thus this effort would have implications for the recruitment of men. During the focus group discussions, one man stated that he investigated each university he was considering attending to be sure he could fit in study abroad with his curriculum. This would suggest that study abroad is an important aspect in recruiting all students, but it may be especially important to advertise these programs when recruiting women. Increasing study abroad opportunities has been a focus of the civil engineering department for the past several years and the program has grown dramatically over the past fifteen years⁷. In 2000 none of the graduating seniors studied abroad, whereas the more than 25% of the last graduating class studied abroad for a semester or summer. The entire university has also placed emphasis on internationalizing the campus and curriculum in recent years. This effort will strengthen the international culture of the department⁸.

The sense of community at the school was mentioned in both focus groups; however, it is an especially important reason for women to choose our university (65% ranking it a very important consideration; while 53% of men did). More than 9 out of 10 students in Class of 2014 strongly agreed or agreed that they feel part of the University community. Unfortunately, fewer women feel valued at the university (80% of women vs 92% of the men). While discussion in the focus groups emphasized their experience of this being a welcoming community; the senior survey revealed that fewer women felt the community was welcoming for persons of all races and cultural backgrounds or all faith traditions. Perhaps this is related to the values of the women towards caring for others, helping others, wanting to promote racial understanding, contributing to improving the human condition, and reducing pain and suffering in the world. These results indicate that a culture of inclusivity is important and must be cultivated. The sense of community can also be related to the satisfaction that the students had with their faculty interactions and the level of comfort the women reported within the department. The significant percentage of women faculty was noted by the women in the focus group discussions. The department’s efforts to recruit women faculty has been successful; in 1999 there was one woman, whereas there will be six in the Fall of 2015. The women students noted that having women faculty as mentors made them feel as though women engineers are “normal.” The large percentage of women

faculty is important because Sonnert, et al.⁴ reported that “the percentages of women among undergraduate science/engineering majors and degree recipients are associated with the percentages of women among the faculty in these fields.”

Service is related to the first two items: understanding others and a sense of community. Many of the service opportunities are international⁹ and the participation in these trips adds to the sense of community. Eight of ten incoming women (82%) say there is a very good chance they will participate in volunteer or community service while in college in comparison to 54% of the men. The University’s commitment to community service was a very important consideration for more than half of the incoming women. Eighty percent of the women in the Class of 2014 said they participated in volunteer service during their college years; 57% participated in college service break trip; 36% participated in service learning and another one-third performed community service as part of a class. Service to others is part of the departmental culture. The department provides student many opportunities for service including a Civil Engineering specific service learning course, service-related capstone design projects, and service extracurricular groups. Again, the values of these women most likely play a very strong role in their participation, and this department affords these women many opportunities to do so.

Conclusions and Applicability to Other Programs

The analyses of the incoming student survey, focus group discussions, and senior exit survey indicate that the overall culture of a program is critical to women entering and successfully completing an engineering program. This is consistent with prior research⁴, which found that the departmental culture was more important to successfully recruit and retain women than the overall institution. However, it is important to note that academic quality and reputation are critically important to attracting and retaining well-qualified men and women.

These results indicate that the cultural shift can be directed at the departmental level, which is a more focused effort, rather than at the entire institution. Three major themes emerged that were important to women in this civil engineering program:

- Understanding other cultures/study abroad
- Sense of community/large percentages of women students and faculty
- Service opportunities

The civil engineering department has a culture of providing and valuing a sense of community that is influenced by the large numbers of women students and faculty, service opportunities, and opportunities for international experiences. While these three themes may not be present for women studying civil engineering at every university, the methodology used to uncover these themes could be broadly applied, especially since many of the questions used in the incoming student and exit surveys are used nationally by many universities.

Acknowledgements

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