

## **The Impact of Healthcare-Related Workshops on Student Motivation and Retention in Engineering**

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# The Impact of Healthcare-Related Workshops on Student Motivation and Retention in Engineering

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## Abstract

This paper discusses the steps taken to design and implement a set of workshops focused on healthcare engineering with the aim to increase the motivation and retention of engineering students, *especially women*. During the workshops, students had an opportunity to interact with a panel of experts working in the healthcare field. The panelists, all professional engineers and mainly females (5:2) shared their inspirations, obstacles, and achievements, and performed an interactive case study session based on their fields of work. Two workshops were designed: Workshop 1 was only attended by students with prior interest in the topic of healthcare engineering; whereas Workshop 2 welcomed students with some or no previous interest related to the topic. To measure the effectiveness of the activities, a survey was designed and administered at the end of each workshop. Statistical analysis was performed to determine students' perceptions towards the workshops' content and implementation as well as to compare responses from students based on gender. The feedback from students was found to be very positive in both instances. The response from 100% of the female students who participated in Workshop 1 not only indicated that they were more aware of the opportunities, but also, more *motivated* to pursue a healthcare-related engineering job. In addition, 90% of students who participated in Workshop 1 and 87% of those in Workshop 2, positively responded that after the workshop, they were more interested in pursuing engineering as a career (*impacting both motivation and retention*). The encouraging results support this intervention as an effective tool to showcase the connection between engineering and healthcare, and to increase student motivation in engineering- irrespective of gender.

## Keywords:

Diversity, engineering education, healthcare, active learning, workshop.

## 1. Introduction

Undergraduate education statistics show that in 2015 women earned 57% of all bachelor's degrees completed. However, only 19.9% of women earned a bachelor's degree in engineering [1]. Conversely, the bachelor's degrees awarded to women in health professions surpassed 85% [2]. Evidently, women are more inclined to pursue degrees related to health. Although the percentage of women majoring in various science fields has reached parity with the male population, there is a big discrepancy when it comes to representation of women in the sciences and engineering labor force (after graduation). Specifically, data from the U.S. Department of Commerce, Economics and Statistics Administration, [3] show that women constitute almost 50% of the U.S. workforce but less than 20% are in science and engineering fields. Moreover, almost 40% of women with engineering degrees quit the workforce or never enter the field [4].

To address this disparity and motivate female students to pursue academic degrees and careers in the engineering field, different approaches have been proposed. These approaches include: in-class interventions such as case-based, project-based and problem-based approaches in engineering courses; and out-of-class interventions such as workshops, seminars, field trips and demonstrations to undergraduate and high school students [5-9]. The literature review has shown that out-of-class activities are effective in encouraging women to remain and succeed in engineering while increasing their self-confidence [10, 11]. Examples of these activities include small group leading discussion in STEM disciplines [12], and mentoring of female students [13]. Given the effectiveness of out-of-class interventions as well as the evident tendency of women to pursue health-related degrees and careers, the initiatives of our project focus on topics related to health services and operations.

The work presented in this paper is part of the ongoing work of an NSF-TUES funded project titled Increasing Diversity in Engineering and the Labor force (IDEAL). The mission of the IDEAL project is to develop and incorporate into the educational curriculum innovative pedagogical in-class and out-of-class interventions motivated by ongoing challenges in the healthcare field. It aims to create awareness of the critical role that engineering plays within the complexities of health systems. The activities are purposely designed to train students and equip them to tackle relevant problems in that field. In addition, given that many women are attracted to professions associated to health, the IDEAL project aims to encourage female engineering students to seek job opportunities within healthcare. In [14], we presented our related previous work on the design and implementation of in-class interventions based on healthcare applications. These in-class interventions consisted of case-studies and the implementation of a new healthcare systems engineering course, which were shown to positively impact students' motivation and retention.

In this paper, we present our work on the design and implementation of a set of workshops focused on healthcare engineering with the aim to increase the motivation and retention of engineering students, *especially women*. Two workshops were designed as part of the out-of-class interventions developed through the IDEAL project. In these workshops, students interacted with professional engineers working in the healthcare field. Each workshop was presented to a different student audience: Workshop 1 targeted students who had previously expressed interest in the topic of healthcare engineering whereas the students who attended Workshop 2 had some or no previous interest in that field. The workshops, although gender inclusive, were focused on especially inspiring female engineers. Surveys were designed and administered at the end of each workshop. Data was collected and analyzed to assess the impact of the proposed workshops on student motivation and retention in engineering.

## **2. Description of the Workshops**

In this section, we describe the targeted audience for each workshop as well as the content and process delivery format.

### **2.1 Participants**

Workshop 1 took place during the 2015 fall semester. The workshop was promoted via email, flyers and screen postings across the College of Engineering and the university's student center. To account for attendance and effectively design the various interactive activities, interested students were required to complete an application form. Given the diversity component of our

project, information regarding gender, academic rank and current major was collected. That allowed the team to focus on motivating a certain sector to participate if underrepresented in the applications process. Applicants were also required to articulate why they were interested in attending the workshop. That provided great insight to the panelist and allowed them to better prepare to answer questions and meet students expectations. A total of 62 applications were received, 26 were females and 36 were males. Their rank composition was: 4 freshmen, 3 sophomore, 19 juniors, 29 seniors, 4 M.S. students, and 3 Ph.D. students. Most of the students were from Industrial Engineering but there were also some applicants from Chemical Engineering, Mechanical Engineering, and Computer Engineering.

Workshop 2, took place during the 2016 spring semester and it was embedded into the program of the Regional Conference for the Institute of Industrial and Systems Engineers hosted at the University of South Florida (USF) Tampa campus. All the students who attended the workshop were from Industrial Engineering and came from external institutions. No screening process was performed for attendees of Workshop 2.

## **2.2 Format**

The process for designing the workshops was focused on the panelists, the attendees, and the topics to be covered. The panelists were all engineering professionals working in healthcare environments. They were invited to share about their journey in the non-traditional field of healthcare engineering. They narrated some of their motivations, challenges and accomplishments. This type of dialogue that allows students to network first-hand with professionals in the field was eye-opening and greatly appreciated by the students. To make the workshop interactive, a set of case studies were presented and discussed with the students. Exposing students to real-life applications increases their motivation and rekindle their interest in performing well while in school and eventually in their careers, particularly for female students. The following sections describe the two workshops developed and implemented.

### *Format of Workshop 1*

For Workshop 1, five panelists were invited. Two of them had over 10 years of experience and held senior positions in the workforce. The experience of the other three panelists ranged from 2 to 6 years. The panelists hold positions such as Data and Simulation Engineer, Performance Improvement Consultant, Data Scientist, and Director of Process Improvement. Four out of the five panelists were female engineers to showcase the existing opportunities in the field as well as their experiences working in healthcare.

The workshop consisted of welcoming remarks, an ice-breaker exercise, panelists' presentations and Q&A session, and a case study. The ice-breaker exercise allowed participants to get to know each other while learning about the healthcare industry and statistics associated with the project (e.g., the low percentage of bachelor's degree in Engineering earned by women in the U.S., the high percentage of women in the health sciences, and the high incidence of female engineers who quit their jobs within 3 years or never enter the field).

The panelists then presented their experiences, challenges, and accomplishments while also addressing the following questions:

- “How did you become interested in healthcare?”
- “What skills did you learn during your Industrial Engineering (IE) courses and projects that have been the most beneficial in your work?”

- “In what capacity does your company utilize IEs and what skills are they looking for in an entry level position?”
- “What are your observations/experiences relative to female IEs? If gender is a factor, how?”
- “What challenges have you faced as a young, entry-level professional?”
- “Biggest surprise as an IE in healthcare”
- “Top three pieces of advice for IEs looking for a career in healthcare”

One of the most interactive segments of the workshop was a case study provided by the panelists for the students to address in teams. The audience was split into four teams to work on a small case study related to a real healthcare challenge. First, a video was displayed, then specific questions were raised, and the students worked in teams to address the problem. The following case studies were provided and discussed:

#### 1) ED wait times

*Hospitals are making available to the public the average time a patient spends in the Emergency Department before they see a healthcare provider. Also, the time that patients wait for a bed after being admitted is publicly available. However, despite of all efforts to maintain low average wait time, the numbers across all hospitals nationwide continuously increases. Students were asked to provide ideas for decreasing average wait times and improving patient experience in the Emergency Department at hospitals.*

#### 2) Falls prevention

*Patient fall prevention is very important for patient safety and healthcare institutions. A case scenario was provided and students were asked to provide ideas for decreasing patients’ falls and reducing related injuries. They were also asked to provide the variables involved and the measurement approaches for assessing the effectiveness of the proposed ideas.*

#### Format of Workshop 2

For the second workshop, there were two guest panelists and a moderator. One panelist was a male with over 10 years of experience and held a Senior Manager position in the healthcare field. The second panelist was a female that had recently graduate and joined the field in the area of emergency services.

Similar to Workshop 1, Workshop 2 consisted of an ice-breaker, panelists’ presentations and Q&A session, and a case study. For the ice-breaker, students familiarized with each other while learning about hospitals operational challenges. Examples include number of patients who suffer some form of preventable harm during their hospital stay, the mean wait time in U.S. emergency departments (EDs), and the percentage of Americans that think healthcare systems need a fundamental change or needs to be completely rebuilt.

The panelists then presented information regarding their experiences, challenges, and accomplishments in their fields in a similar approach as in workshop 1. The case study for Workshop 2 consisted of a PACU (Post-Anesthesia Care Unit) that was being utilized inefficiently, both care-wise and revenue-wise. Students received the following preliminary information:

- The hospital has 300 beds
- There are over 40 cases per day

- The hospital has 16 Operating Rooms
- The hospital has 39 PACU Bays
- It costs \$100 to have the PACU functioning 1 minute
- Patients have been recovering in the Operating Rooms
- The current process is requiring overtime

The students were asked to creatively re-design the process in the PACU using different approaches. The workshop attendees were very engaged in the activity and participated enthusiastically in finding potential solutions to the problem presented. They were also very receptive to the measures proposed by the panelists. The activity was instrumental in making attendees aware of the use and relevance of engineering methods to improve processes in the healthcare field.

### **3. Evaluation**

In collaboration with an external evaluator, a comprehensive evaluation was performed to assess the perceived effectiveness of the developed workshops. To gain insight on students' perception on the workshops, the following questions were asked in the survey provided after each workshop:

- Q1. I am more aware of the opportunities for students in the healthcare-engineering field.
- Q2. I am more interested in learning about healthcare-related engineering opportunities.
- Q3. I am more likely to pursue an engineering job or internship in the healthcare field.
- Q4. I am more interested in pursuing healthcare-related engineering as a career path.
- Q5. I am more interested in pursuing engineering, in general, as a career.

The survey was designed utilizing a five-point Likert scale where one (1) through five (5) represent: “Strongly Disagree”, “Disagree”, “Neither Agree/Disagree”, “Agree” and “Strongly Agree” respectively. For the evaluation, a response of 4 or 5 was regarded as a positive perception (“yes”); a response of 3 depicted a neutral position; and a response of 1 or 2 was regarded as a negative perception (“no”).

To examine students' response, the output from survey questionnaires was analyzed following a non-parametric data analysis approach. Non-parametric methods do not assume that the data are approximately normally distributed. Therefore, they provide an advantage when data are drawn from a skewed or peaked distribution, which is the case for the output from the surveys as very few students indicated having negative perceptions of the interventions. Specifically, Wilcoxon Signed Rank test was performed to verify if the students had favorable perceptions regarding the in-class and out-of-class interventions. In addition, Mann-Whitney U-Test was used to test if there was a significant difference between responses from students based on gender. Both, Wilcoxon Signed Rank test and Mann-Whitney U-Test are non-parametric statistical tests suitable for ordinal variables as is the case for the surveys.

#### **3.1. Results for Workshop 1**

A total of 22 students participated in the Workshop 1 survey. Figure1 presents the results from student responses grouped by gender.

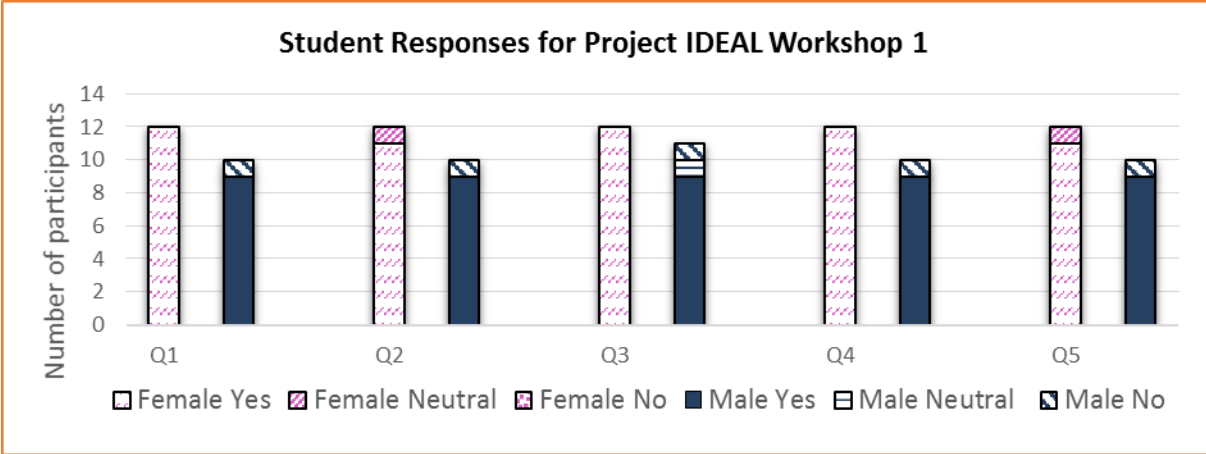


Figure 1: Student responses based on gender for Workshop 1.

Table 1 shows the percentage of positive responses from students to the questions for Workshop 1. A median score of 4 or greater was regarded as a positive response. As noted from Table 1, students' positive perceptions of the utility of the workshop met or exceeded 90%.

Gender	Q1	Q2	Q3	Q4	Q5
Female	100	92	100	100	92
Male	90	90	90	90	90
All	95	91	95	95	91

Table 1: Percent of positive responses for Workshop 1.

Interestingly, 100% of the female students indicated they were more aware of the opportunities, more interested in learning more and more motivated to pursue healthcare-related engineering opportunities/jobs after participating in the workshops.

To statistically test the impact of the workshop the Wilcoxon Signed Rank test was performed. The null hypothesis tested whether the median answer to each questions is positive ( $\geq 4$ ). To accept or reject the null hypothesis an  $\alpha = 0.1$  was used. The results for the statistical tests are shown in Table 2.

Question	Median	One-sided P-value ( $\mu=4$ )	One-sided Hypo.	One-sided Decision
Q1	5	0.0009**	1	Median significantly larger than 4
Q2	5	0.0039*	1	Median significantly larger than 4
Q3	5	0.0063*	1	Median significantly larger than 4
Q4	4.5	0.0723*	1	Median significantly larger than 4
Q5	5	0.0025*	1	Median significantly larger than 4

Table 2. Wilcoxon Sign Rank Test for testing students' perception of Workshop 1.

A Mann-Whitney U-Test was conducted to test if there was a significant difference based on gender. The results for the statistical tests are shown in Table 3. Question 4 was the only question that showed a significant difference in genders and it indicated females had a higher median.

Question	Female Median	Male Median	One-sided P-value	One-sided Hypothesis	One-sided Decision
Q1	5	5	0.1197	0	No significant difference
Q2	5	5	0.1776	0	No significant difference
Q3	5	5	0.2805	0	No significant difference
Q4	5	4	0.0960*	1	Significantly higher for females
Q5	5	5	0.1363	0	No significant difference

Table 3. Mann-Whitney U-Test for rank difference in gender for Workshop 1.

Based on the student responses and comments for Workshop 1, students appeared to appreciate the activities provided, the real world examples, and the opportunity to ask panelists questions. The students expressed their interest in participating in more workshops related to healthcare engineering, and they suggested allocating more time to future workshops. Below are some comments from students:

- “I really enjoyed the panel discussing their individual experiences and what kind of jobs they do. “
- “I was never interested in healthcare and had a wrong idea about what the health care field for industrial involved. Today’s workshop really informed me about the other opportunities.”
- “I enjoyed speaking with and hearing first hand from current IE healthcare professionals. It was very informative and educational.”
- “The workshop was an excellent tool and resource for me at USF. I would love if they have more of these seminars. I would enjoy a networking event where we can interact on a more personal level with people currently in the Healthcare field as engineers.”

### 3.2. Results for Workshop 2:

A total of 30 students completed the survey for Workshop 2, which was the same as the survey for Workshop 1. Most of the responses were positive irrespective of gender (Figure 2). However, there was a mix in the percentage of positive responses across the questions (Table 4).



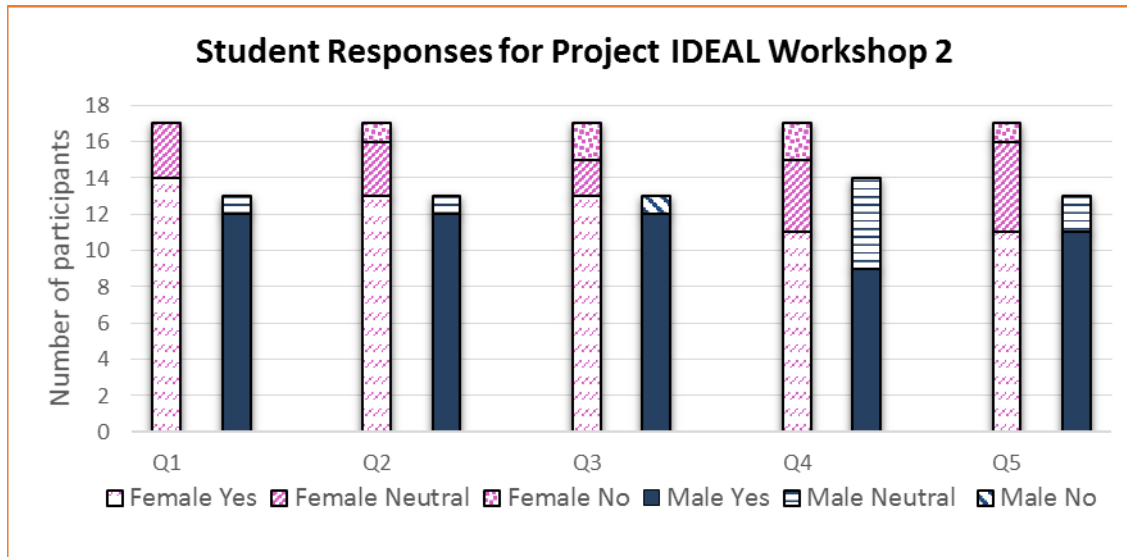


Figure 2. Student responses based on gender for Workshop 2.

Gender	Q1	Q2	Q3	Q4	Q5
Female	93	77	65	65	82
Male	92	92	64	77	92
All	93	83	65	70	87

Table 4: Percent of positive responses for Workshop 2.

To statistically test whether there was a positive impact on students, the Wilcoxon Signed Rank test was performed and as before,  $\alpha = 0.1$  was used to determine statistical significance. The results for the statistical test are shown in Table 5. Missing values were replaced with a neutral answer. Responses were statistically larger than 4 for questions one and two.

Question	Median	One-sided P-value ( $\mu=4$ )	One-sided Hypo	One-sided Decision
Q1	4	0.0317*	1	Median significantly Larger than 4
Q2	5	0.0650*	1	Median significantly Larger than 4
Q3	4	0.6534	0	Median significantly not Larger than 4
Q4	4	0.7385	0	Median significantly not Larger than 4
Q5	4	0.1631	0	Median significantly not Larger than 4

Table 5. Wilcoxon Sign Rank Test for testing students' perception of Workshop 2.

A Mann-Whitney U-Test was conducted to test if there was a significant difference based on gender. The results for the statistical tests are shown in Table 6 and indicated no gender differences with the exception of question 5 where males answered more positively.

Question	Female Median	Male Median	One-sided P-value	One-sided Hypothesis	One-sided Decision
Q1	5	4	0.5000	0	No significant difference
Q2	5	5	0.2984	0	No significant difference
Q3	4	4	0.4089	0	No significant difference
Q4	4	4	0.2135	0	No significant difference
Q5	4	5	0.0082*	1	Significant higher for males

Table 6. Mann-Whitney U-Test for rank difference in gender for Workshop 2.

Based on the written comments for the second IDEAL Workshop students appeared to appreciate the activities and the real-life examples. They expressed their interest in having more workshops in the future. It stimulated their interest in pursuing a career in an engineering-healthcare related field.

In addition, the following questions were asked to the students through the survey:

- What did you like most about the workshop?
- What would have improved the workshop?
- Other general comments

Following is a list of sample comments provided by the participants regarding the above questions:

- “It was very hands-on which helped me understand the facts more.”
- “The workshop kept students engaged with a mixture of activities and presentations.”
- “Panelists were well informed and knew how to convey their info to the audience appropriately.”
- “The game at the beginning was a fun and memorable way to learn about how broken the healthcare system is.”
- “The interactive games put us in a situation and made us think about what we would do.”

#### 4. Conclusion

In this paper, a set of workshops focused on healthcare applications were designed and implemented to engage and motivate students, particularly females, to complete their degree in engineering and pursue careers in engineering after graduation. Two workshops were designed where students interacted with a panel of professional engineers working in the healthcare field. The targeted audience for each workshop was different where Workshop 1 was attended by students with prior interest in healthcare engineering whereas Workshop 2 was attended by students with some or no previous interest related to the topic. Evaluation results indicate that the students had very positive perceptions regarding the workshops. Specifically, 100% of the female participants of Workshop 1 were more aware of the opportunities and more motivated to pursue healthcare-related engineering opportunities/jobs after participating in the workshop. In addition, 87% of female participants of Workshop 2 were more interested in pursuing engineering as a career. Although no statistically significant difference was found between students responses based on gender, results indicate that the workshops positively motivated students in engineering irrespective of gender. The overall results indicate that the workshops brought positive impacts on the audience and made them interested to further pursue a career in healthcare engineering. As a

result, we will continue to promote the use and adoption of this type of interventions as it effectively motivates students and reinforces the value of the profession in settings that might be perceived as non-traditional but are rich in opportunities and growth.

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