Improving the Professional Skills of Engineering Undergraduates

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Kathleen Mancuso is a Secondary Education Major with a concentration in Chemistry at Manhattan College located in Riverdale, NY. As a senior, Kathleen will be graduating in February 2017 with a teaching certification for grades 5-12 in New York State and a B.S. in Education and Chemistry. Her passion for teaching began in her high school chemistry class with Mrs. Merante, after seeing just how valuable a talented and determined teacher was to future STEM fields. Kathleen enjoys teaching tennis over the summer to students ages 8-16 and is looking forward to her graduation to begin her career.

Mr. Anthony Scotti, Manhattan College

Anthony Scotti is a Secondary Education Major with a concentration in Mathematics at Manhattan College in Riverdale, NY. As a senior, Anthony will be graduating in February 2017 with a Bachelor of Science in Education and Mathematics for teaching grades 4-12. Anthony is currently the Office Manager for the Higher Achievement Program at Fordham Preparatory School in the Bronx, NY, a program that prepares seventh grade boys for the Test for Admissions into Catholic High Schools. As a future STEM educator, Anthony looks forward to teaching students the amazing opportunities Mathematics can offer them.

Engineering Ambassadors: Improving the Professional Skills of Engineering Undergraduates

Abstract:
When engineers enter the workforce they are expected to have professional skills and the technical background. However, beside some isolated presentation and writing trainings incorporated in courses such as senior design, usually there is no official training for such professional skills in engineering curriculum. With the support from National Science Foundation, we have developed a program where students have the opportunity to receive training on professional skills and practice them in a non-threatening environment. In this program students prepare engineering related lesson plans and present them to local middle and high school students. The program offers special workshops on leadership, teamwork, presentation, personality types and learning styles. Students not only receive professional trainings on these topics they also have the opportunity to practice and reinforce these skills through the program. They work in a team of diverse students and prepare the lesson plan, practice their presentation and receive peer and faculty feedback and present to local middle and high school students and receive their feedback as well.

In this paper, different aspect of the Engineering Ambassadors Program from the Engineering STAR Center, and the professional development workshops are discussed. The effectiveness of the program is evaluated. Results of the students self-assessment shows that students' teamwork, presentation and communication skills have improved. These skills in leadership, teamwork, presentation and communication skills can be assembled in a series of professional development workshops to prepare engineering students for their profession.

Introduction

When engineers enter the workforce, they are expected to have professional skills and the technical background. According to the ASME vision 2030 necessary professional skills of mechanical engineers include electronic communication, interpersonal/teamwork, oral communication, written communication, and leadership among others [1]. ASCE also has a list of necessary skills on which is communication, leadership, teamwork, and attitude to name a few [2]. IEEE lists professional skills like interpersonal, teamwork, written communication, verbal communication, and leadership in their professional guideline series [3]. In AIChE's body of knowledge, it lists necessary psychomotor skills of listening and interpreting, speaking and presenting, communication, leadership, presentation, and teamwork [4]. In general, every engineering disciple these professional skills for a successful engineer.

Despite the standards set by these societies, usually in an engineering curriculum there is no formal course on professional skills. Typically, during the capstone senior design course undergraduate engineering students are exposed to some of these skills such as presentation and team work. Occasionally the center of career development at an institution will offer sessions on professional skills usually focusing on interviews and presenting yourself to a potential boss. Overall most engineers are graduating with little of the professional skills that will make them successful in the workplace.

Engineering Ambassador's Club at Manhattan College

At Manhattan College, a program was created called engineering ambassadors club. The club runs on a semester long loop spending the first half of the semester preparing lesson plans on engineering topics including a hands-on activity while attending workshops to enhance members' professional skills. The second half is then spent on perfecting, practicing, and teaching the lessons to local middle and high school students. The club is comprised of engineering and education undergraduates. One of the goals of the engineering ambassadors' club is to provide the necessary professional skills for engineers to be successful. The professional skills which this program primarily targets are presentation, communication, leadership and teamwork skills. The ambassadors are learning and improving these skills through workshops in the first half of the semester. The skills they learned are then reinforced through developing lesson plans in interdisciplinary groups, practicing the lessons with peers and faculty, and finally presenting them to middle and high school students. All of these aspects include self, peer, faculty, and in the case of the school visits student feedback.

The Ambassadors

The defining feature of this engineering ambassador program is the collaboration between the School of Engineering and the School of Education at Manhattan College. Within the student body of the club there is not only a diversity of engineering major but also diversity with the education majors as shown in figure 1.

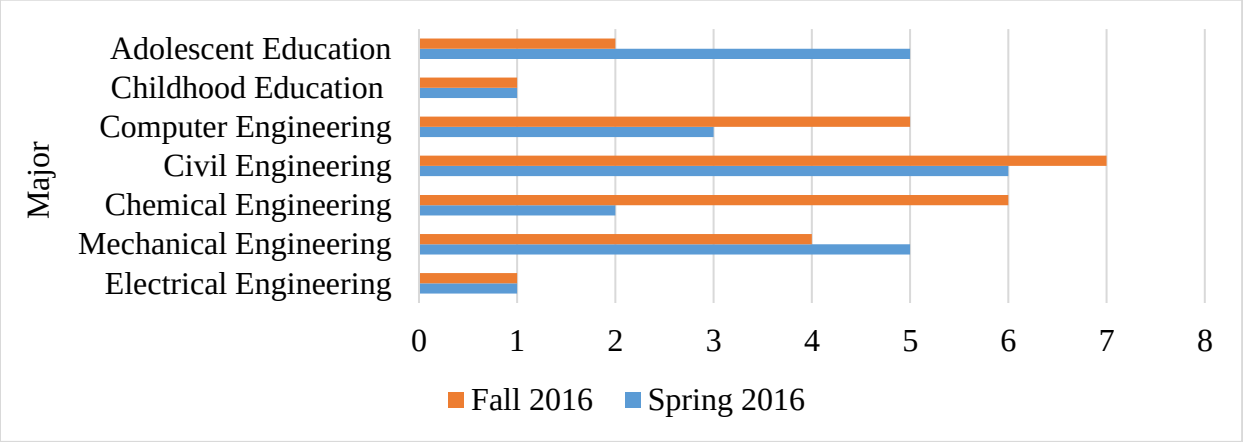

Figure 1: Course of Study for Engineering Ambassadors

One of the goals of the program is to encourage women to enter the engineering field. The demographics of the engineering ambassadors allows for each visit to include about half of the ambassadors to be female. In the spring of 2016 the club comprised of thirty-nine percent (9 students) females which increased in the fall of 2016 to forty-six percent (13 students) females as shown in figure 2. Comparing with the engineering school diversity of only nineteen percent female the program was successful in recruiting female students and providing female role models to middle and high school students [5].

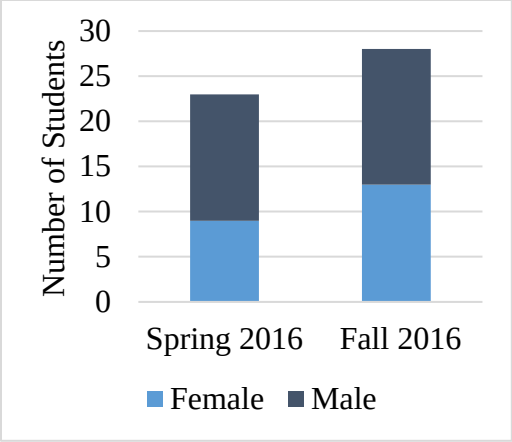

Figure 2: Gender Diversity of Engineering Ambassadors

The other demographic the program wanted to encourage considering engineering is the underrepresented minorities. In each school visit the ambassadors also represent underrepresented minorities. In the spring of 2016 thirty percent of the ambassadors (7 students) were underrepresented minorities which increased in the fall of 2016 to forty-six percent (13 students) as shown in figure 3. Comparing with the engineering school diversity of thirty-four percent non-Caucasian, the diversity of the ambassadors is an accomplishment.

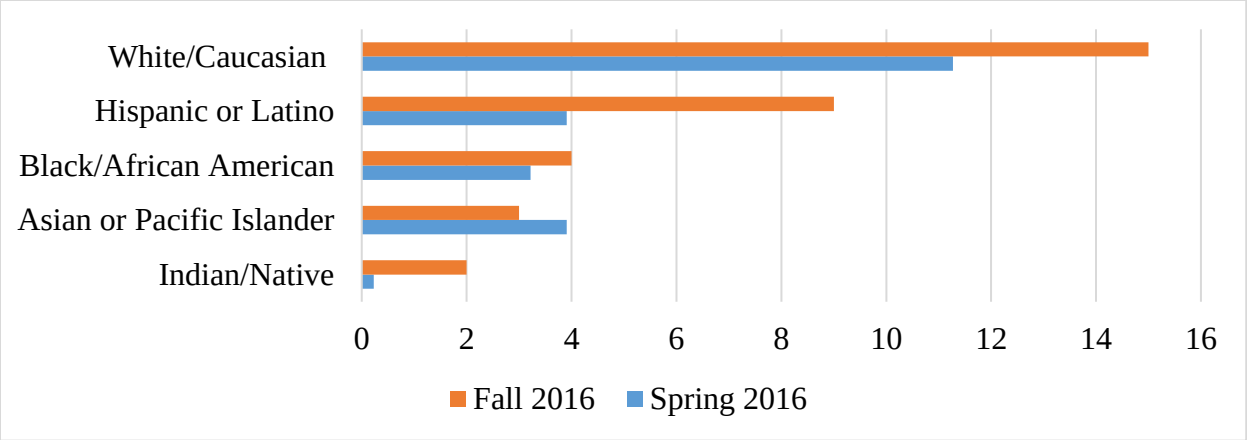

Figure 3: Ethnic Diversity of Engineering Ambassadors

Another diverse demographic of the ambassadors club is the range of academic year and experience as an engineering ambassador as shown in figures 4a and 4b, respectively. The upperclassmen are acting as mentors. The more experienced ambassadors are also able to help those new to the club with preparing workshops and presenting them.

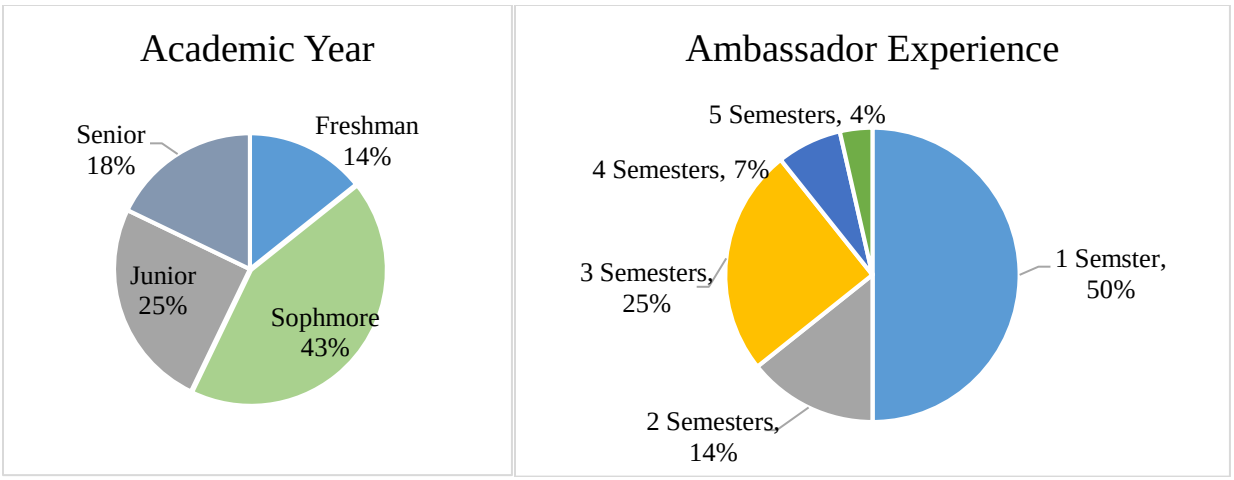

Figure 4: Academic and Ambassador Experience Diversity

Activities

The engineering ambassador's club at Manhattan College is student run with the assistance of the faculty advisors. The club activities start with recruitment in the first two weeks of the semester leading up to an information meeting open to all students interested in the club. The students that are interested in joining the club are then split into groups of 4 or 5 to develop the engineering-based lesson plans with a hands-on activity. The remainder of the semester is then dedicated to workshops, continuing developing and practicing the lesson plans, and visiting middle and high schools. The table below visually shows this process through the fourteen-week semester.

Table 1: General Schedule of Events

	Week													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Recruitment														
Information Meeting														
Split into Groups														
Lesson Plan Development														
Workshops														
Presentation Practice														
School Visits														
Wrap Up Meeting														

Lesson Plan Development

One of the most unique aspects of the engineering ambassador's club is the interdisciplinary groups that the students form. Within the club there are students from each of the engineering disciplines and students from the school of education. Due to this diversity the individual groups have engineering students of different grade level and discipline in addition to education students. The students are enhancing their ability to communicate with people of different

background knowledge. This is then further enriched by creating and teaching lessons for students in middle and high schools. The skill to introduce a technical concept to a person without that technical background is necessary in the engineering industry but is neglected in most engineering undergraduate education programs.

School Visits

One of the goals of Manhattan College's Engineering Ambassador Program besides improving the professional skills of the current engineering undergraduates is to introduce engineering to middle and high school students. The engineering ambassadors go to local middle and high school and present the engineering lessons that they have developed. A typical visit consists of the ambassadors introducing themselves and the main engineering disciplines briefly. Then they dive into the lesson plan and respective hands-on activity with the students. Below table 2 lists the schools the ambassadors have visited the past two years along with the number of students, number of ambassadors, and the lesson presented. In the past two semesters there has been an increase in the number of school visits which implies an increase in the number of students the engineering ambassadors have a chance to introduce engineering to.

Table 2: Engineering Ambassador School Trips

	Visiting School	*Student*	*Ambassadors*	*Lesson Plan*
Fall 2016	Boy Scouts*	30	2	Engineering Day (Ooblec)
	Riverside High School	18	2	Lemon Battery
	Riverside High School	13	6	Spaghetti Bridge
	Lincoln High School	31	7	Ooblec
	St. John and Paul School	50	4	Egg Drop and Water Filter
	St. John and Paul School	53	5	Egg Drop and Water Filter
Spring 2016	Riverside High School	14	5	Water Filter
	Riverside High School	20	7	Egg Drop
	Lincoln High School	28	3	Water Filter
	Tech International*	200	5	Science Fair (Ooblec, LemonBattery, WaterFilter)
	St. Catherine Academy High School	8	3	Lemon Battery/Viscosity
Fall 2015	Tech International	71	11	Fun Day (Pickle, Electromagnetic Motor, Water Filter, Engineering)
	Riverside High School	14	2	Biomechanics
Spring 2015	Riverside High School	18	8	Lemon Battery/Viscosity/Egg Drop
	InTech	15	12	Egg Drop

***** The Boy Scouts' Engineering Day and Tech International's Science Fair were not run as a typical lesson plan but instead as a station.

After the lesson and hands-on activity, the ambassadors distribute an evaluation to collect feedback from the middle and high school visits. In figure 5 below, the collected results from the fall 2016 visit to Lincoln High School and both visits to Riverside High School. It is clear that the students learned something about engineering in a fun, non-threatening, and interactive way

which was the goal. The students consistently express that the ambassadors are well prepared and are able to introduce concepts that are beyond the student's current knowledge in an effective way. The only comment that was not mostly strongly agree and agree pertained to them becoming engineers. The goal of the program is to introduce engineering so that students have a chance to examine their appeal, not to convince every student to become an engineer.

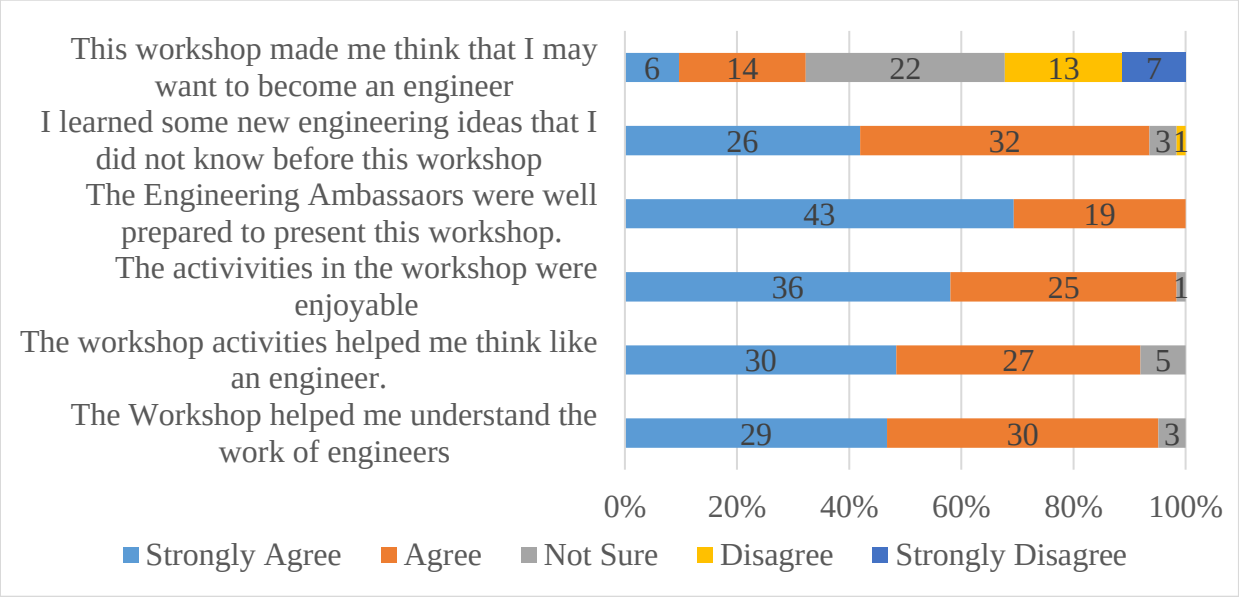

Figure 5: Combined Results from Fall 2016 Riverside and Lincoln High School Visits

Professional Development Workshops

The workshops are designed to introduce and improve specific professional skills of the engineering ambassadors. To further enhance the value of the workshops they occur in two separate one-hour sessions. Typically, the first session is geared to introduction and self-awareness while the second focuses on implementation.

Leadership/Teamwork: The first session of this workshop was geared toward leadership skills and primarily the practice of exemplary leadership. It started with a self-refection where each student was given a list of behaviors and actions to reflect if in leadership positions, they preform them or not. The workshop then went into the five practices of exemplary leadership and how to use them. At the end of the presentation the ambassadors split into groups to create a skit based on a given scenario and the material covered. The second workshop focused on team building. The workshop started with defining a team and the difference between a group of people and a team. Then the ambassadors were divided into groups and given a task. After the task was completed and presented the group thought back to the first workshop on leadership. Each group discussed if there was a team leader and if he/she showed the exemplary leadership characteristics. Figure 6 shows the feedback results from the ambassadors who participated in the workshop. It is clear from these results that the workshop was useful to the ambassadors.

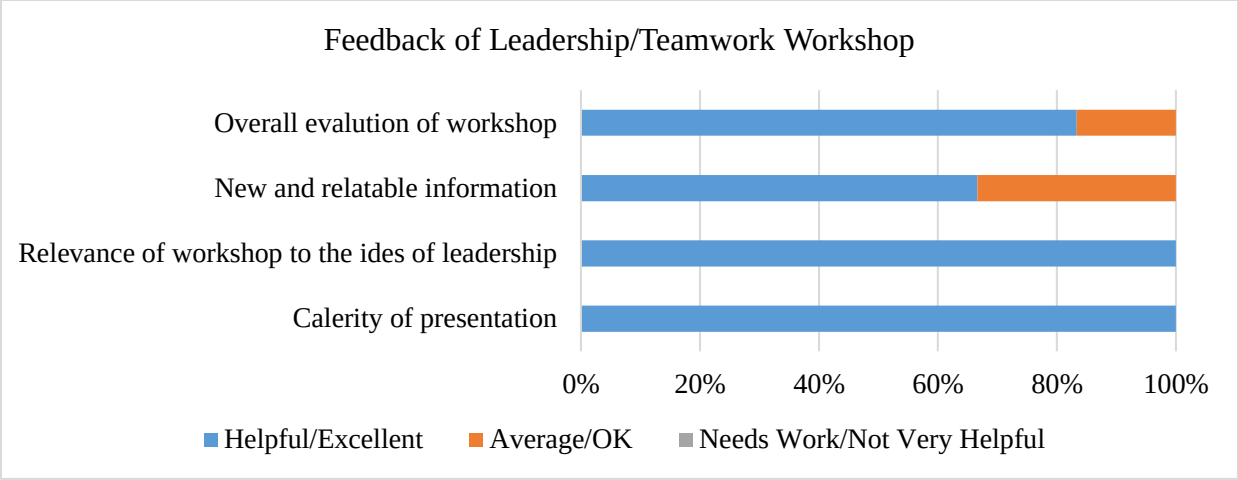

Figure 6: Feedback Results of Leadership/Teamwork Workshop

Presentation Skills: The first session of the workshop was focused on bad presentation practices. It started with the ambassadors listing bad practices that they have experienced or are guilty of having. Then a video of the worst presentation was played for all the ambassadors to view. The video was stopped occasionally to add more bad practices to the list as they appeared. At the end of the workshop the ambassadors were split into groups of two to design a presentation pointing out six bad presentation practices and a way to correct the bad practice. During the second workshop the ambassadors presented their bad presentation practice corrections. Then the workshop turned into a discussion on ways to prevent bad practices for future presentations.

Communication-Learning styles Skills*:* This workshop was focused on communication skills through understanding learning styles. The first workshop introduced the main learning styles of visual, oral, and kinesthetic. In the introduction the ambassadors took a self-evaluation to determine their personal learning style which lead into a discussion on learning and overall communication preferences. Once their own preferences were determined, the professor explained the three learning styles and common teaching and communicating techniques for each learning type. In the second workshop the ambassadors went through their lessons and confirmed that it appealed to all learning types. They then discussed how to integrate all of the styles in typical presentations and conversations. The results of the feedback surveys in figure 7 show that the most students agree or strongly agreed that the workshop offered them a useful tool to improve their communication skill.

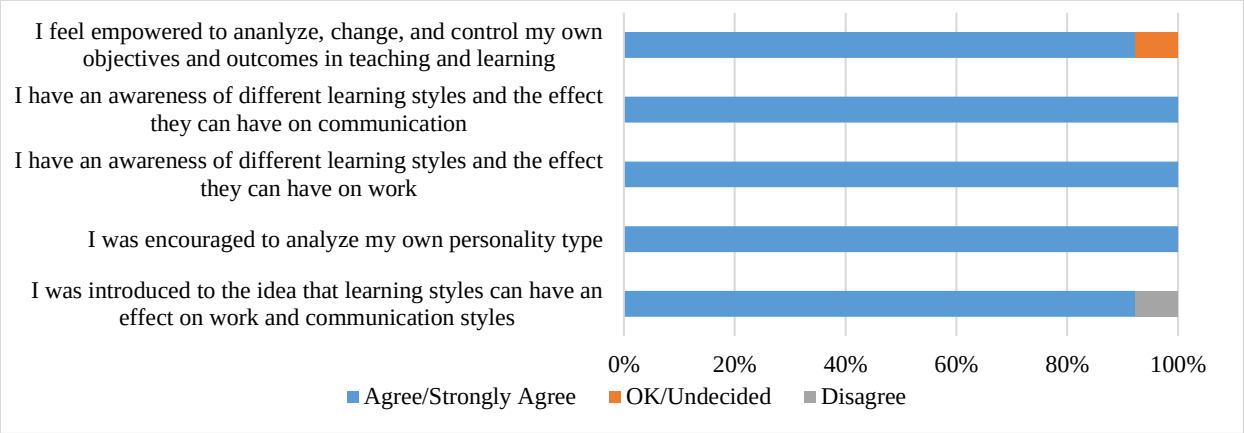

Figure 7: Feedback from Learning Styles Workshop

Communication/Personality Skills: This workshop focused on working with people with various personalities. The first workshop was used to introduce various types of personalities and the ambassadors self-examined their own personalities. The ambassadors were then split into groups of two to discuss their own personality type which integrated into a conversation with all participants. The second workshop focused on ways to effectively communicate and work with people with different personalities. These concepts were then taken to real-life scenarios in school project, at work, and in teaching.

Peer-Presentation Review

To specifically enhance the presentation skills of the engineering ambassadors, the students practice the presentation portion of the lesson their group designed to their fellow ambassadors and faculty. During the presentation, the audience took note on the presentation skills such as posture, filler words, body language verbal tone, volume, and eye contact are ranked on an excellent to needs improvement scale. This provided the ambassadors with a list of required improvements in their presentations. The presenting ambassadors received a similar sheet with the combined results as shown in table 3.

Table 3: Sample of Ambassador Peer Evaluations

Name:	Student A			
Skill	Excellent	Good	Average	Needs Improvement
Posture	6	5		
Filler Words	2	7	2	
Body Language	7	4		
Verbal tone and volume	4	5	2	
Eye contact	7	3	1	

Self-Evaluation

The ambassadors have also competed self-evaluations on their profession skills. In a survey, they ranked the skills of design/creativity, leadership, project management, written communication, and oral communication from not important to emphasized strong. The results can be seen in the Figure 8. It is clear to see that all of the ambassadors know these skills are important and most

would consider their skills sufficient. The category with the most room for improvement seems to be design/creativity. Although the ambassador's program indirectly requires design and creativity in the lesson planning process and determining the hands-on activity, we will put more emphasis on this skill in future.

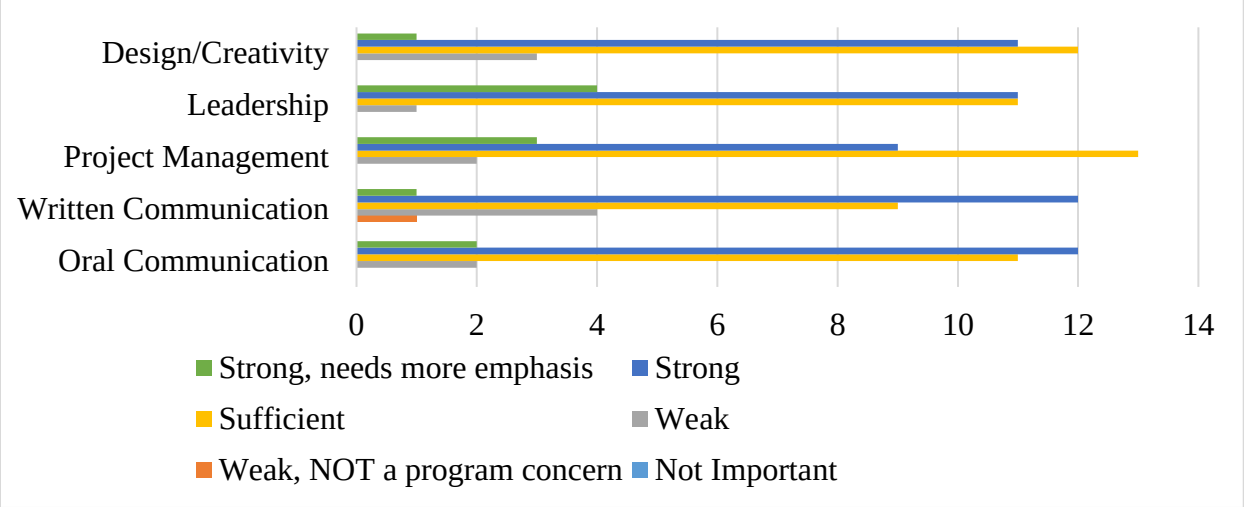

Figure 8: Self-Skill Evaluation of Ambassadors

The ambassadors were also given a list of tasks and asked to determine if they had the necessary skills to perform the task. These tasks incorporated profession skills that have been determined necessary in engineering. Figure 9 shows a few questions and the responses of 26 ambassadors. The two most responsive tasks were interdisciplinary team work and communication both of which have been emphasized in the program through workshops and the group work.

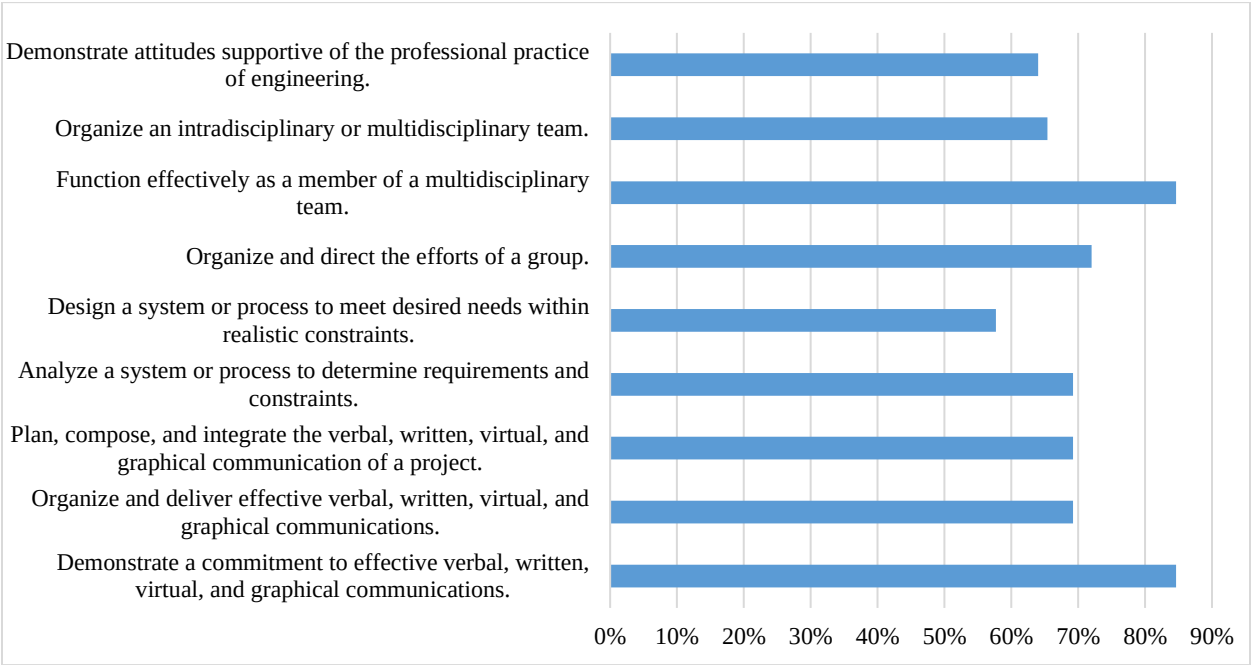

Figure 9: Professional Practice Self-Evaluation of Ambassadors

Conclusion

In this paper, the purpose, goals, and implementation of the professional development aspect of the engineering ambassador's club at Manhattan College was explained. The professional skills emphasized by national engineering associations are directly targeted in workshops and incorporated in the club activities. Specifically, the multidisciplinary teamwork, multiple team leaders, and presenting engineering topics to middle and high school students. These exercises contribute to the development of highly effective engineers who know the technical background and are groomed in professional practices.

Acknowledgement

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