Targeted Communication Trainings to Foster Minority Students' Presentation Skills

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Abstract

Education in the 20th century is not perceived as an objective for a restricted few, rather, it is the pillar of success that forms the primary backbone of our economy. Due to the rapid growth in economic structures and the globalized competitiveness of the market, the job industry is expected to raise the bar on our future workforce. Therefore, STEM students will require an academic career that develops and nurtures their professional skills far beyond technical skills, thus ensuring success in such competitive work environments. This is especially true for international, women, first-generation STEM students, and underrepresented minorities in STEM education, who must overcome additional barriers to succeed. To understand the current status, priorities and deficiencies in presentation skills, a benchmark survey was administered to 320 STEM students to understand their understandings of presentation skills. Afterward, a pilot study measured students' communication skills development in two construction management courses, by implementing a lecture-based communication skills training and analyzing students' improvement. Box plots with line plots were used to graphically represent the changes in descriptive statistics of pre and post-peer evaluation ratings for specific presentation evaluation criteria. Finally, to understand the influence of students' socio-demographic profiles, an ordered probit regression was conducted. Female and first-generation students expressed a deficiency of communication skills and may benefit greatly from innovative communication skills activities that can successfully foster students' growth. The results of this research emphasize the significance of developing minority students' presentation skills. The findings of this study also provide insights into a sustainable implementation of alternative learning pedagogies such as in-class training that integrate students' development skills in addition to technical contents.

Background and Motivation

From providing access to clean water to managing large-scale infrastructure projects, the grand challenges that engineers face in the modern world are equally technical and social. To overcome these challenges, engineers must not only become experts on the technical aspects of their specific field but also develop their soft skills, such as communication and presentation skills, to enable leveraging their technical knowledge in an evolving, increasingly complex and globalized work environment. In today's world, where multicultural teams are encouraged and considered the norm rather than an exception, technical professionals must be able to communicate effectively in order to realize their full potential [1]. Although these intangible qualities are often referred to as "soft skills", they are tightly coupled with professional performance and play a hard role in a professionals' success, including those in STEM careers [2]. However, these skills have become stifled, as the typical engineering graduate spends approximately five years building her/his technical expertise, with little to no time devoted to communication training [3]. Evidence suggests that in the industry, engineers lack the basic required communication skill sets to "hit the ground running" [4]. A recent study indicated a high percentage of professional engineers reported that ineffective communication skills caused problems in their place of work [5]. For instance, reports by the Society of Manufacturing Engineers stated that a significant percentage of their professionals could not communicate their ideas well in writing [6]. Moreover, 38% of new engineering graduates across all engineering specialties report that

while communication skills are of the most important factors impacting their advancement and success in industry, this area is often the most undeveloped during their academic preparation [7]. Overall, Engineering and STEM, possibly more than most professions, require accurate and efficient communication skills—professionals must be capable of understanding what the user/client is saying and vice versa for the design to function [11]. This lack of skills can have serious cost implications for industries, as there is an increasing pressure to cut costs and improve efficiency; thus, STEM professionals are constantly pressured to overcome soft skill deficiency. This is especially true for international, female, first-generation students and underrepresented minorities in STEM education, who often face additional barriers in the form of language, culture, and overall adjustments [8]. Numerous industry assessments confirm this fact, not to mention that minority students themselves attest that formal communication skills are one of their primary shortcomings [10].

As the demographics in the United States diversify and as STEM student enrollment continues to grow, higher education institutions have struggled to adapt to the diversity of their student bodies, especially minority students' needs [9]. Even though literature indicates that oral communication has been identified as a learnable skill, and some institutions attempt to provide extracurricular communication skills training sessions, such training remains separate from the technical curriculum. Moreover, most of the STEM coursework is heavily skewed towards writing, which ultimately hinders active engagement [10]. Due to this recent increase attention on changing expectations from practicing STEM professionals, there is an urgent need to successfully develop new skills sets throughout students' academic careers [12]. Although communications have recently been incorporated into engineering schools (motivated by ABET and other accreditations), many higher educational degrees still lack this validation [13]. Thus, many STEM institutions are still not required to incorporate communication development trainings into their curricula. That said, many international students, including women and first-generation students, still lack the necessary professional skills, particularly communication and presentation skills, which are vital to convey technical information to audiences. Engineering curricula could integrate objective communication activities that make up for this gap [14], and/or explore new pedagogies that encourage the development of minority students' professional skills [15][16]. Thus, the purpose of this study is to (1) identify the major deficiencies in STEM students' communication skills at Florida International University, a minority-serving institution; (2) analyze the relationship between students' presentation skills and factors such as academic level, gender, first-generation and international status; and (3) assess the outcomes of a lecture-style communication skills training on Construction Management students' presentation skills.

Methodology

This study encompassed understanding STEM students' baseline communication skills, as well as helping underrepresented minorities in STEM to further develop these skill sets. The study is divided into two phases. Phase one involved a benchmark survey, distributed to 320 STEM students at Florida International University. In this survey, the students self-evaluated their strengths and weaknesses, as well as provided their knowledge on the fundamentals of presenting. The evaluations were conducted through Qualtrics, a web-based tool to conduct survey research, evaluations, and other data collection activities.

Phase two consisted of a pilot study, where a lecture-style communication skills training was conducted on two construction management courses. This phase consists of an ongoing study and should impact around 150 international, women and/or first-generation university

students over an academic year. The two courses that implemented this pilot study are Sustainable Approach to Construction and Sustainable Construction, which are offered at the College of Engineering and Computing with a total of 34 students. The courses include both undergraduate and graduate students.

The lecture-style communication skills training offered students the opportunity to enhance their presentation performance, improve their confidence and overcome common presentation issues, such as glossophobia, unpreparedness, ineffective visuals, inappropriate content use, distracting body language (i.e., inappropriate eye contact, inappropriate postures and movements, etc.), and lack of dynamism. For this task, each student was required to conduct an in-class presentation related to the coursework where they also received peer-evaluations pertaining to her/his presentation skills, based on performance, delivery, body language, and other criteria, as shown in Figure 1. The initial evaluation results were utilized as a reference for each student, as these presentation skills results would later be compared to the results from each students' second in-class presentation. Peer-evaluations were chosen as a measure, as it is an effective quality assurance measure in many contexts, including science, business, and education and is considered more extensive than other common evaluation mediums [17][18]. Peer-evaluations have been shown to provide many advantages in STEM, including prompting students to think about the exercise more deeply and seriously, and recognizing others' viewpoints and criticism [1].

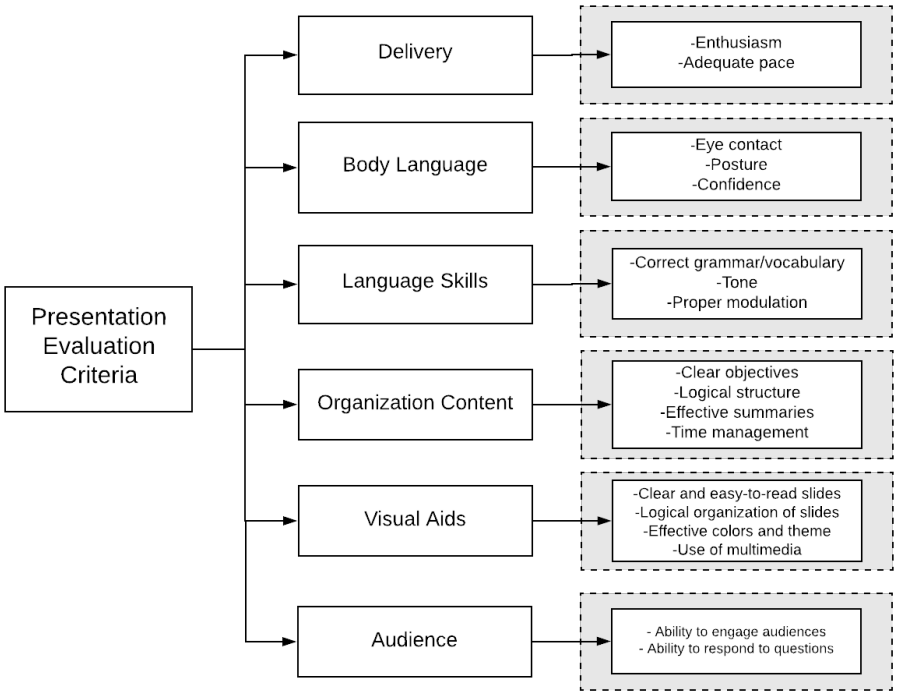

Figure 1. Presentation Evaluation Criteria

Following the students' initial in-class presentations, the instructors introduced the Lecture-Style Communication Skills Training, which was conducted by a professional communication skills expert. The training was conducted in class and included, but was not limited to, various topics such as (1) the elevator pitch - a type of presentation that entails describing an idea, topic or product in a short period of time; (2) complex information presentations - how to properly communicate information to diverse audiences (i.e., body language, language skills, etc.); (3) emotion control (i.e. nervousness, anxiety, etc.); (4)

storytelling - how to engage, motivate and inspire audiences through stories; and (5) visualization in presentation - how to effectively use visualization techniques. Since such training are usually part of extracurricular activities, one of the main goals of this approach was to integrate the training into the course work; therefore, each student was obliged to attend the training as it was embedded into the course schedule.

After carrying out the training, students were required to conduct their second in-class presentation to evaluate their communication and presentation skills learning. For the post-training presentations, each student again received peer-evaluations. Both peer-evaluations were compared. The data collected in phase two was analyzed through boxplots with line plots in RStudio, to assess the success of the targeted training on minority students' skills development.

Finally, to understand the relationship between students' socio-demographics and their presentation skills, an ordinal probit regression model was developed. An ordered probit regression analysis is the selected method for the collected data, as this analysis is fit for the generalization of cases of more than two outcomes of an ordinal dependent variable (a variable with potential values such as poor, fair, good, excellent) [19] . Through this analysis, the authors determined which independent variable had a statistically significant effect on the dependent variable, as well to determine how well the model predicts it. For this model, the dependent variable was defined as Students' Current Skills, while the independent variables are Gender, Academic Level, International Status, Previous Communication Skills Training, Public Speaking Experience, First Generations, and Interest on Communication Training. The ordinal probit regression model utilizes these parameters through the following equation:

$$y_i^* = X_i\beta + \varepsilon \tag{2}$$

Where y_i^* is a latent variable measuring the professional development of the ith participant; X_i is a (k x 1) vector of observed nonrandom explanatory variables; β is a (k x 1) vector of unknown parameters, and; error factor (ε) captures the reality that the Student Skills is not perfectly predicted by the regression equation. Therefore, Student Skills, y_i is determined from the model as follows:

$$y_i = \begin{cases} 1\ if\ -\infty \leq\ y_i^* \leq \mu_1\ (Poor\ presentation\ skills) \\ 2\ if\ \mu_1 \leq\ y_i^* \leq \mu_2 \quad (Good\ presentation\ skills) \\ 3\ if\ \mu_2 \leq\ y_i^* \leq \mu_3\ (Excellent\ presentation\ skills) \end{cases} \tag{3}$$

In equation 2, the partial change in y^* with respect to X_i is β_i units. This implies that for a unit change in X_i, y^* is expected to change by β_i units, holding all variables constant. Furthermore, the significance test uses the t-score to describe how the mean of the data sample with a certain number of observations is expected to behave. On the other hand, the P-value indicates the confidence level, in terms of correlation, of each variable to the dependent variable. The confidence interval in the analysis is assumed to be 90% for this study; thus, the area under the curve (z) is obtained as 1.645.

Analysis and Results

The proposed activity is expected to create an engaging educational environment that seeks to enhance minority students' communication and presentation skills, thus honing their professional development. Their participation in the training increased their confidence, improved their performance and engagement, and allowed them to develop sufficient skills to convey technical information to diverse audiences. The data obtained from the survey and peer and self-evaluations allowed the authors to evaluate the activity's impact and acceptance, identify the students' strengths and weaknesses, and evaluate their professional development and growth.

Through the self-assessment survey, 320 STEM students at Florida International University self-evaluated their presentation skills, of which 36% of respondents were female, 62% first-generation students, and 90% non-native English speakers, as shown in Figure 2.

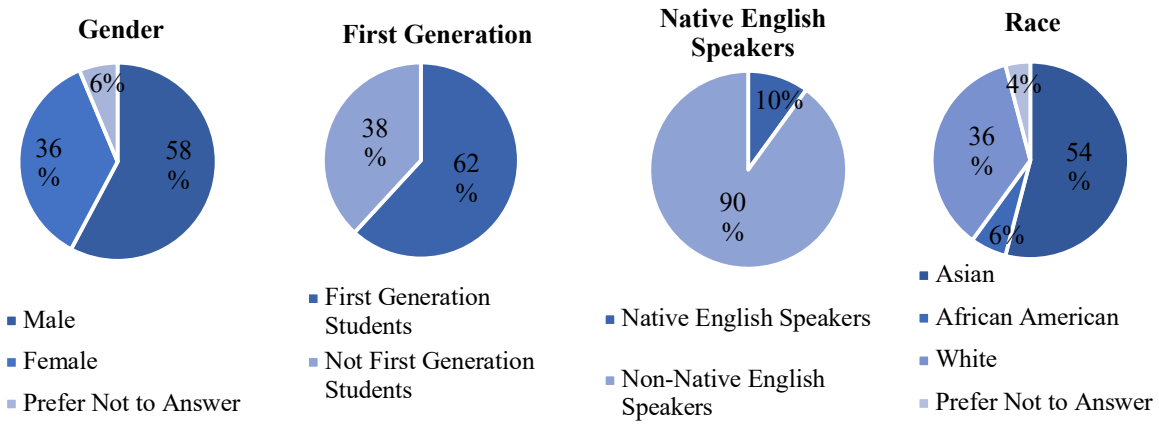

Figure 2. Socio-Demographics profile of the Respondents - Benchmark Survey

The results of the students' self-ratings are shown in Figure 3. These results indicate that the majority of the students lack common presentation skills, as the average score for body language (BL) was 3.49, language skills (LS) was 3.49, content preparation and organization (CP) was 3.88, ability to engage audiences (EA) was 3.38, time management (TM) was 3.67, use of script support (SS) was 3.21, use of storytelling (S) was 3.29 and ability to control emotions (CE) was 3.57. Based on the student self-assessment responses (Figure 3), the areas that received the lowest average ratings were the inability to include storytelling techniques (S), effectiveness to use script support (SS), as well as incompetence to engage audiences (EA). Students expressed that their strengths were content preparation, organization and time management, yet these skills received a rating of approximately 3, indicating that their strengths are still considered as underdeveloped. Therefore, results indicated that there is an opportunity for improvement and mastering all the different presentation criteria.

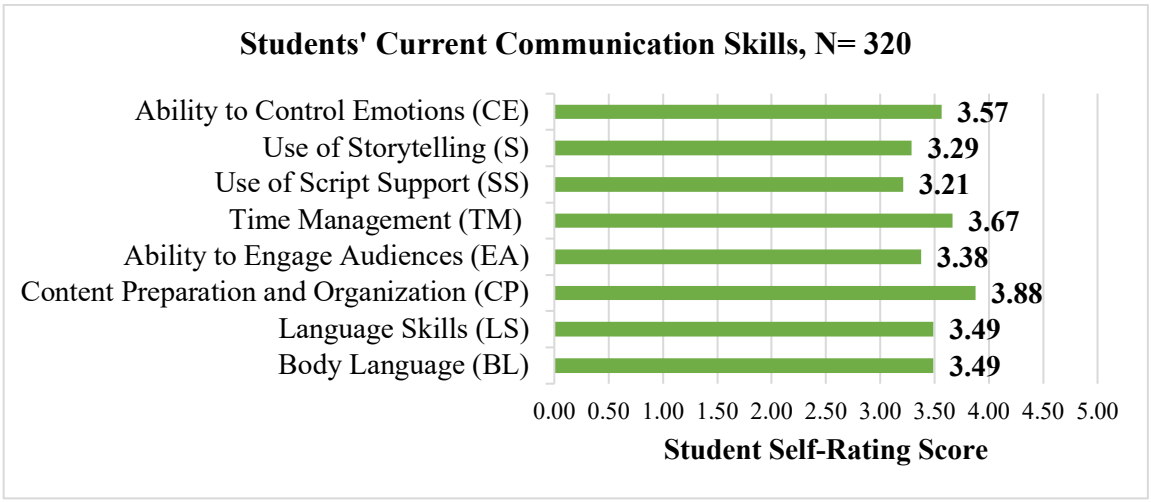

Figure 3. STEM Students' Presentation Skill Self-Assessment

Additionally, the students were surveyed on their perception of the importance of the different skills required to deliver a successful presentation. As shown in Figure 4, students rated BL, LS, CP, EA, TM, SS, S, and CE, an average of 4.36, 4.43, 4.50, 4.31, 4.25, 3.51, 3.93 and 4.19, respectively. Considering these results, the study inferred that while most STEM students acknowledge the required skills for a successful presentation, the vast majority expressed their own lack of presentation skills in these same areas. This indicates that the reason that STEM students lack presentation skills are not due to their knowledge of presentations, but rather lack of availability and structured trainings offered in higher education.

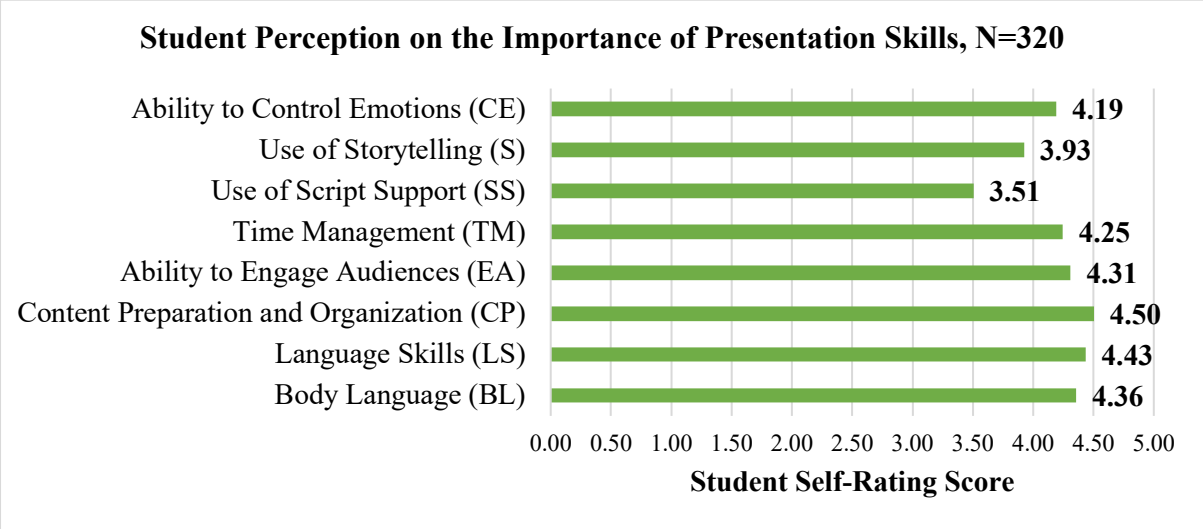

Figure 4. STEM Student Perception on Presentation Skill Importance

To analyze the relationship between students' presentation skills and socio-demographic profiles, an ordered probit analysis was conducted. This method was selected as it provides an appropriate fit to the data obtained. Table 1 provides the estimated results of the student skills with a Pseudo R^2 value of 0.55. The regression coefficient values of Gender, Academic Level, International Status, Previous Communication Skills Training, Public Speaking Experience, First Generations, and Interest on Communication Training are 0.003, 0.038, 0.044, 0.002, 0.027, 0.006, and 0.062, respectively. Based on these results, it can be inferred

that students' presentation skills are highly influenced by their socio-demographic profile. Therefore, the statistical analysis results in Table 1 suggests:

- STEM students interested in communication skills training are more likely to achieve higher presentation skills than those who are not interested in training, as they are more motivated to participate in the activities and place more effort in ameliorating their presentation performance.

- International STEM students are more likely to possess higher presentation skills. This could be since internationals must overcome multiple barriers when studying abroad; thus, they tend to put more effort into improving their overall skills, especially their communication skills.

- Regarding gender, male STEM students tend to possess higher presentation skills. This could be since STEM is a male-dominated industry; thus, male individuals could be more pressured to stand out and be more competitive.

- First-generation STEM students are less likely to have their presentation skills developed. This could be since first-generation students potentially face additional barriers than their counterparts, when in higher education programs. Additionally, these students have been shown to have less family influence to develop these soft skills outside their academic settings [20]. That said, and since first-generation students need more training, higher education should focus on fostering such trainings to this student body to support their success in STEM.

- STEM graduate students are more likely to possess higher communication skills, possibly since graduate students maintain more academic knowledge, experience, and different exposures than undergraduates. Thus, this could indicate that undergraduate programs require reinforcement through additional training specifically in the communication/presentation areas.

- Students who have had previous communication skill training or public speaking experience are more likely to have better presentation skills. This could indicate that offering students different training activities and opportunities to practice their skills can, in fact, help further develop their presentation and communication abilities.

Regardless of their current skills, all STEM students, specifically women and first-generation students, benefit greatly from innovative communication skills activities that can successfully foster students' growth. This study not only focused on integrating a communication and presentation training into courses' syllabi to ensure all minority students are exposed to such trainings, but also provided practicing these skills during in-class presentations.

Table 1. Coefficients and P-Value from Ordered Probit Analysis

Variables	Coeff (β)	Std. Error	Z	P-Value
Indicator variable for Interest on Communication Training *(1 if respondents are interested, 0 otherwise)*	1.537	0.82	1.87	0.062
Indicator variable for International Status *(1 if respondents are International, 0 otherwise)*	2.36	1.17	2.01	0.044
Indicator variable for Gender *(1 if respondents are female, 0 otherwise)*	-2.95	0.9	-2.98	0.003
Indicator variable for First-Generation *(1 if respondents are first generation students, 0 otherwise)*	-4.48	1.62	-2.76	0.006
Indicator variable for Degree *(1 if respondents are undergraduate, 0 otherwise)*	-1.55	0.74	-2.08	0.038
Indicator variable for Previous Communication Training *(1 if respondents are not previously trained, 0 otherwise)*	-4.18	1.33	-3.13	0.002
Indicator variable for Public Speaking Experience *(1 if respondents are not experienced, 0 otherwise)*	-1.75	0.79	-2.21	0.027
$\boldsymbol{\mu}_1$	-6.8	1.82		
$\boldsymbol{\mu}_2$	-3.8	1.24		
$\boldsymbol{\mu}_3$	1.7	1.17		

To assess the results of the communication skills, the students were asked to evaluate their peers' first presentation during their second presentation. Through a 5-point Likert Scale, where 1 indicated extremely poor skills and 5 indicated excellent skills, the students rated their classmates on their presentation's delivery, body language, language skills, organization and content, visual aids and ability to engage audiences. To compare and analyze the results, boxplots were developed through RStudio to graphically represent the respondents' development based on the training provided. As shown in Figure 5, the students experienced significant growth in their ability to: (1) engage audiences; (2) use visual aids; and (3) organization and content skills. This indicated that the in-class communication training successfully improved students' presentation skills. It is also worth noting that some skills such as presentation delivery, body language and overall language skills did not seem to significantly benefit from the training, represented by the downward slope of the line plots in Figure 5 and thus, possibly require additional innovative training methods to observe a significant change in students' performances.

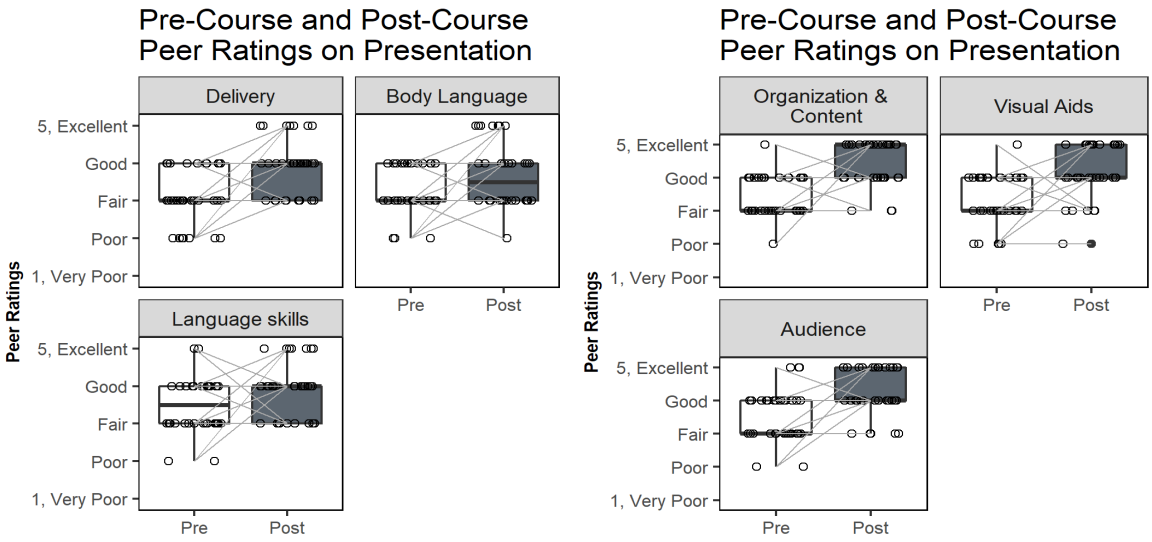

Figure 5. STEM Students' Professional Skills Development, N=34

Limitations and Future Work

The study assessed the effects of a formal presentation skills training on STEM students' presentation performance. However, there were some limitations when conducting the research. Some specific limitations include: (1) the peer and self-evaluations conducted within this research may be subjective due to personal opinions and self-judgments; (2) the students' peer-assessments could be influenced by the students' previous communication skills knowledge. Regardless, the authors believe this knowledge was sufficient to appropriately evaluate their peers; (3) students' skills improvement throughout the course could be influenced by external factors besides the training implemented; nevertheless, the authors believe the results reflect the influence of the training on the students professional growth; and (4) the survey target was limited to two Construction Management courses. The future stage of this study will conduct the activity on three additional courses at the minority-serving institution of Florida International University, as well as incorporate and analyze the effectiveness of additional informal learning pedagogies, such as VR-based presentation simulations and social media activities, that will further engage and nurture these minority students' presentation skills.

Conclusion

To succeed as professionals in the United States and globally, minority STEM students must not only focus on their technical knowledge but also invest in developing their soft skills and specifically communication skills. From this research, the main weaknesses that minority STEM students depicted were the inability to engage audiences, to use script support, and to implement storytelling techniques during their presentation delivery. Nevertheless, all STEM students, including women, international, and first-generation students, expressed a deficiency of skills across all the specified criteria. Additionally, an ordered probit analysis indicated that female, first-generation and undergraduate students are less likely to possess adequate presentation skills; thus, innovative training programs must be tailored to address this issue. Finally, participation in the lecture-style presentation skills training allowed students to improve their organization and content skills, their use of visual aids, and their ability to engage audiences. Additional skills, such as delivery, body language and language

skills, did not seem to improve significantly through the lecture-style presentation skills training, thus indicating that additional training activities are required to obtain significant professional growth.

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