

Benefits of the virtual platform for K-12 STEM Outreach

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Abstract

The number of students enrolling and graduating with STEM degrees in the United States must increase exponentially in order to meet the predicted job shortages in STEM. Perkins Peer Advisement is a grant funded program at NYC College of Technology (City Tech) committed to increasing enrollment and retention of female and nontraditional undergraduate students in engineering technology programs. Program activities include professional development, mentoring, faculty development, and community outreach. Community outreach is a critical component of the program as it benefits the undergraduate students hosting the events as well as the K-12 students participating in them. Studies indicate that greater exposure to STEM at early levels contributes to narrowing the STEM gap. The COVID 19 pandemic has forced all aspects of society to transition to a virtual platform. The pandemic has forced children to stay home and has limited their physical ability to participate in field trips and lab experiments; however, today's technology allows for students to expand the opportunities accessible to them through a virtual world. This paper will focus on the transition of the program to a virtual platform and the successful expansion of the community outreach component as a result of this transition. The program offers monthly family STEM workshops at the local elementary school and hosts an annual Girl Day event in celebration of National Engineers Week. The 2020-2021 academic year was the first time these outreach events were held virtually. Although the transition presented challenges, in the end there are benefits to the virtual platform. This paper will provide a summary of the STEM Outreach activities and provide conference participants with a tool kit that can be applied at their home institutions and local communities.

Keywords

STEM, Online Learning, K-12 Outreach

Background

According to the National Science Board's Science and Engineering Indicators 2018, while basic STEM skills have improved over the past two decades, America still lags behind many other countries. Women and underrepresented minorities comprise less than 30% and 11% , respectively of the STEM workforce [1]. In order to keep up with the predicted STEM job needs for the nation, we need to increase interest and diversity in STEM. Students in K-12 need to be exposed, encouraged, and motivated to pursue careers in STEM. Exposing all children as early as possible to STEM, especially women and underrepresented minorities is critical to narrowing the gap [2, 3,4]. Significant efforts have been made to improve science in K-12 education by incorporating the Next Generation Science Standards (NGSS). The NGSS are science standards developed with the intent of standardizing the curriculum across the nation and incorporating scientific and engineering practices in the curriculum. The adoption of the NGSS in the curriculum is one step towards narrowing the STEM gap by promoting better preparedness of our students; however not all states have adopted the standards and the teacher workforce delivering the curriculum often does not have the relevant background in Science [5,6,7]. Academia, government, and school districts have a duty to provide coherent and focused professional learning experiences for STEM educators [8,9,10]. Teachers delivering NGSS curriculum without being trained appropriately provide missed opportunities for motivating

students. The inclusion of NGSS must go beyond the classroom to make the practical connections to everyday engineering. Local programs have been successful in increasing interest in STEM and technical disciplines among elementary school children by exposing them to STEM-focused, hands-on collaborative activities at an early age [11, 12]. Short term interventions at the high school level have also been proven to help provide increased STEM exposure to high school students, in particular programs targeting underserved populations [13]-[18]. The outreach programs hosted by Perkins Peer Advisement aims to increase exposure of STEM careers to the K-12 population, especially underrepresented groups in STEM. The programs target underserved populations and provide participants with role models in STEM representing diverse backgrounds. These supplemental experiences are designed to motivate and spark curiosity in STEM among the participants.

Perkins Peer Advisement

City Tech's Perkins Peer Advisement (PPA) is a grant funded program committed to increasing enrollment and retention of female and nontraditional students in engineering technology programs. Program activities include professional development, mentoring, faculty development, and community outreach. PPA was piloted in 2015 in the civil engineering technology department, and later expanded to include five other departments, mechanical engineering, computer engineering, computer systems, electrical engineering and architectural technology.

Community outreach is a critical component of the program as it benefits the undergraduate students hosting the events as well as the K-12 students participating in them. Engaging the undergraduate students in the outreach events increases their social and civic engagement which contributes to their personal growth as a STEM student [19, 20, 21]. As part of the outreach component, PPA provides monthly family STEM workshops at the local elementary school and hosts an annual Girl Day event in recognition of National Engineers Week.

Family STEM Workshops

The program offers interactive STEM workshops for families and students to increase their knowledge and awareness of STEM-related careers. Partnering with a Daniel Hale Williams Elementary school (P.S. 307) in Brooklyn, the program delivers monthly family STEM workshops via the zoom platform. The reported demographics of P.S. 307 for the 2019-2020 academic year was 49% Black, 31% Hispanic, 15% White, 3% Asian, and 4% Other; 73% of the students qualify for free or reduced price lunch [22].

The workshop format consists of a guest speaker, presentation and activity. The guest speakers are content experts on the workshop topic and can be college students, alumni or industry professionals. The presentation highlights related career opportunities and information on middle schools and high schools with a STEM focus. The activity is designed to engage the participants' in a hands on project aligned with the workshop topic. Table 1 lists the topics and activities for the workshops in the 2020-2021 academic year. The presentation also include information on college majors of study to inspire the participants to think about long term college plans. During the activity the students are divided into breakout rooms to allow for smaller groups and greater engagement. The activity is followed by a discussion about challenges and successes of the activity.

Table 1. Family STEM workshop topics and activities

Topic	Activity
Weather/Natural Disasters	Rainbow Rain [23]
Chemical Engineering	Lava Lamp [24]
Sound of the Physics	Musical Straws [25]
Computer Engineering	Flappy Bird Game [26]
Structural Engineering	Jelly Bean Tower [27]

Planning for Virtual Workshops

The virtual platform allows for greater flexibility and a broader reach; however there are critical elements that contribute to the success of the program. The first critical component is a dedicated liaison at the elementary school. The school liaison promotes the workshops and acts as a familiar face to the families attending the workshops. Monthly planning meetings are held with the liaison to run through logistics and zoom links are provided to the elementary school families using a secure platform. The second critical component is selecting an activity appropriate to the grade level with a basic list of supplies. The topics are designed to align with the NGSS subjects being covered in the classes. The activities were selected such that the materials could be found in a typical household, or easily purchased. The posters used for promoting the workshops include date, time, topic and list of materials needed. Providing the list of materials is important so that parents can prepare for the workshop ahead of time. The last critical component is the preparation of the facilitator for the activity. The facilitator tests all the activities beforehand, this provides an example of the final product as well as identifies potential difficulties that could occur during the workshop. The facilitator prepares a demonstration video illustrating the steps of the activity so that participants get an idea of what they will be doing before attempting the activity. At the elementary school level, the video is shown twice before the workshop facilitator leads them through the activity. These components were identified through lessons learned after each workshops, we continue to adapt and improve as necessary.

Surveys

The workshop participants are provided a survey at the completion of the workshop to gauge their interest and satisfaction. The survey questions are shown below:

1. Which workshops have you attended this school year? (check all that apply)
2. How content were you with the workshop? (Likert Scale)
3. The most important thing I learned today was... (Fill in the blank)
4. The presentation and workshop increased my understanding of the topic. (Likert Scale)

The link to the exit surveys are distributed at the end of the workshop. Families are also invited to share photos and videos of their projects. Attendance at the workshops ranges from 5 to 10 families. The results of the survey are shown in Figures 1 through 4.

Figure 1. Which workshops have you attended this school year?

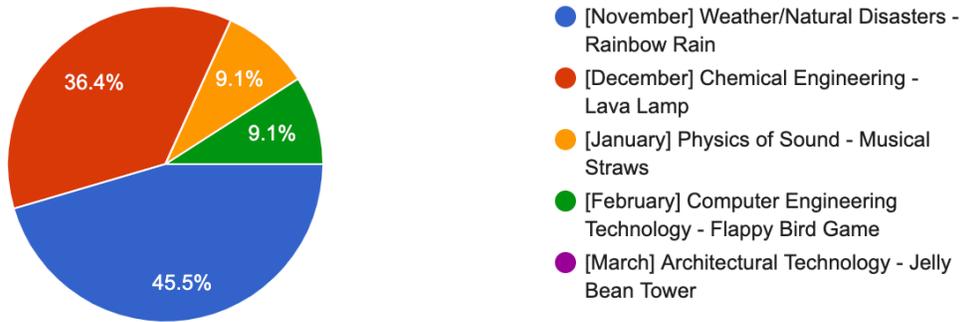


Figure 2. How content were you with the workshop? (5-Very Content)

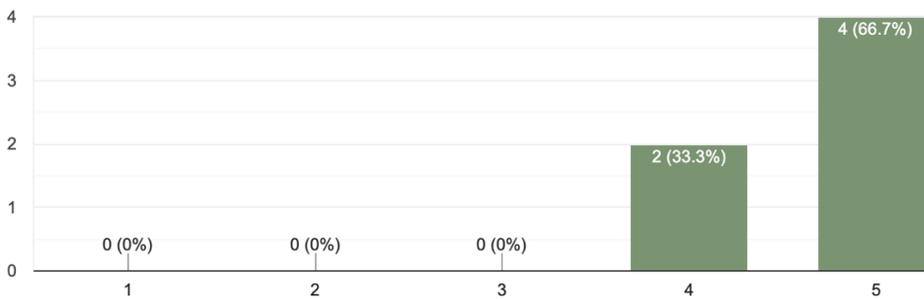
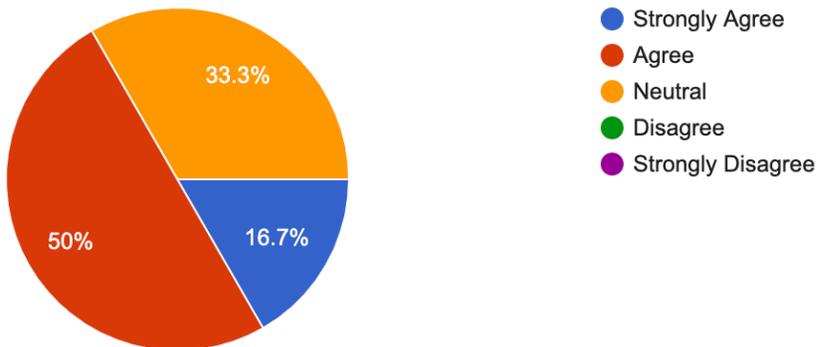


Figure 3. The most important thing I learned today was...

- How to make a lava lamp.
- why the vinegar want up to the top
- How the experiment worked. Love the Periodic Table of Discovered Elements.
- To keep trying and trying till I get it right , and learning about vibrations! 🤔😓😓
- that flappy bird exists
- I can build a jelly bean tower

Figure 4. The presentation and workshop increased my understanding of the topic.



The results of the survey indicate that most of the families are regular participants and are satisfied with the workshop topic and the outcome of the activity.

Girl Day

Girl Day is an annual celebration part of National Engineers Week. The purpose of Girl Day is to promote STEM engagement among female students. The PPA program is focused on increasing retention and enrollment of females in the engineering technology majors. A 2019 report by DiscoverE identified opportunities to encourage females to choose and persist in engineering, these include providing engineer role models, sending effective messaging campaigns, engaging in hands-on engineering activities, and promote student-centered learning. These opportunities can spark an interest in STEM, build confidence and help them to see themselves as engineers [28]. Our annual Girl Day event was launched in 2015 and has brought high school students on campus to participate in a day-long event each year.

The high school students visit the college campus, hear presentations from successful females in STEM and complete hands-on activities. Recruitment for the event targets two local high schools, Manhattan Bridges High School (Bridges) in Manhattan and High School for Construction Trades, Engineering and Architecture (CTEA) in Queens. The reported demographics of Bridges for the 2019-2020 academic year was 99% Hispanic; 85% of the students qualify for free or reduced price lunch [29]. The reported demographics of CTEA for the 2019-2020 academic year was 75% Hispanic, 33% Asian, 8% Black, 11% White, and 11% Other; 85% of the students qualify for free or reduced price lunch [30].

This year the annual event took place on a virtual platform, the event was condensed to two-hours and divided into two segments: presentations and activity. The first segment consisted of a keynote speaker and a presentation by current STEM students. The purpose of these presentations is to highlight role models in STEM and inspire the participants to consider pursuing careers in STEM. The second segment consisted of the hands on activity, or engineering challenge. Breakout rooms were used to break the participants into smaller groups to promote engagement. The activity was selected from a list of recommendations by DiscoverE [31], which provides a variety of resources for Engineers Week targeted to different education levels. The activity chosen was, “Build an Earthquake Resistant Structure”, students built a structure with the materials listed and devised their own version of a shake table to test their structure. After the activity the participants shared their projects with the group and discussed their experiences and lessons learned.

Planning for Virtual Workshops

Similar to the elementary school workshop, there are critical elements that contribute to the success of the event. The program has established partnerships with teachers at local high schools which participate in the event each year. The teachers promote the event among their students and their administrators. The second critical component is selecting an activity appropriate to the grade level, for this event grades 7-10. The posters distributed to promote the event included date, time, registration link and list of materials. The third component was using Google Forms to track registration, this was instrumental in providing the same information to all registrants regardless of which school they came from. In addition, google forms adds a layer

of security to provide zoom links and provides a database of registrants email addresses that we were able to use to send reminders.

Surveys

The workshop participants are provided a survey at the completion of the workshop to gauge their interest and satisfaction. The survey questions are shown below:

1. How engaging did you find the activity? (Likert Scale)
2. Of the 5 engineering and technology majors that you were introduced to today, which did you like the most? (Multiple Choice)
3. Are you interested in pursuing a career in STEM? (Multiple Choice)
4. Would you recommend a friend to attend this workshop? (Multiple Choice)

There were 10 participants in virtual Girl Day. The results of the survey are shown in Figures 5 through 8.

Figure 5. How engaging did you find the activity?

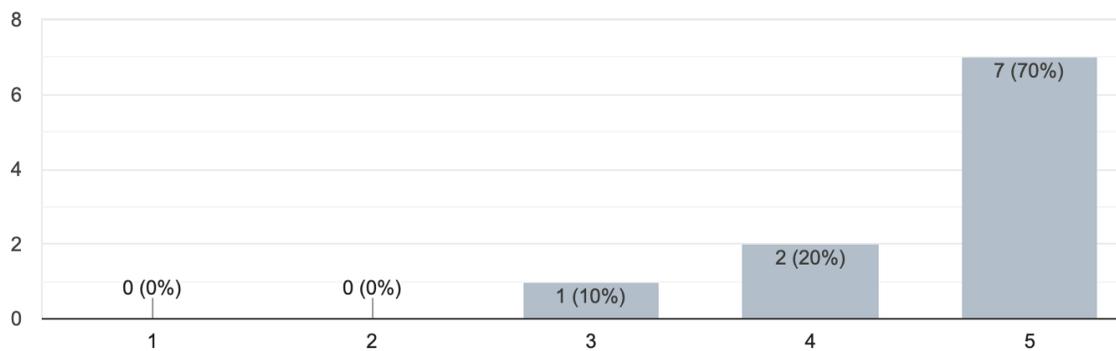


Figure 6. Of the 5 engineering and technology majors that you were introduced to today, which did you like the most?

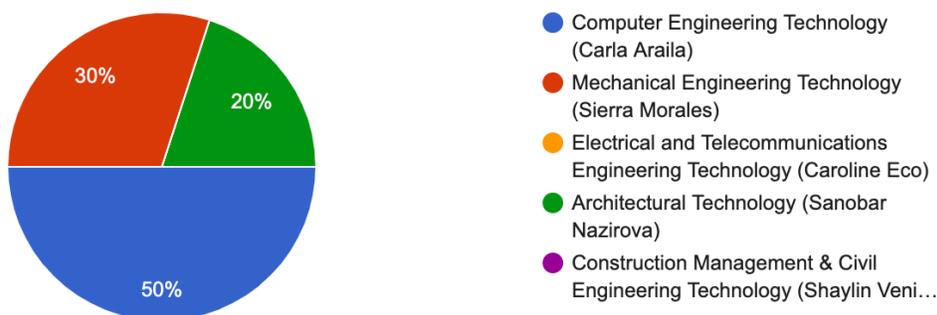


Figure 7. Are you interested in pursuing a career in STEM?

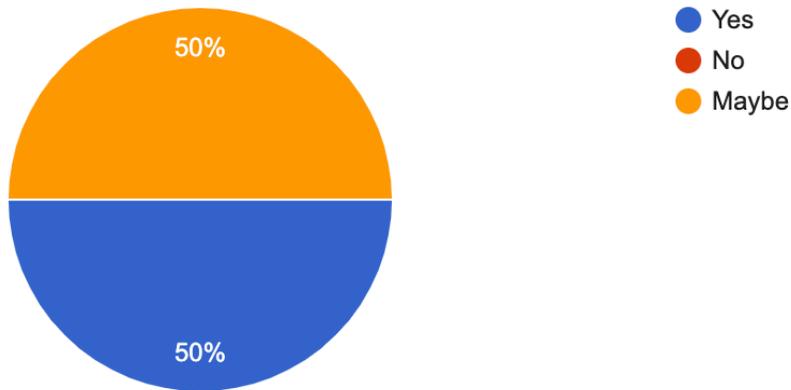
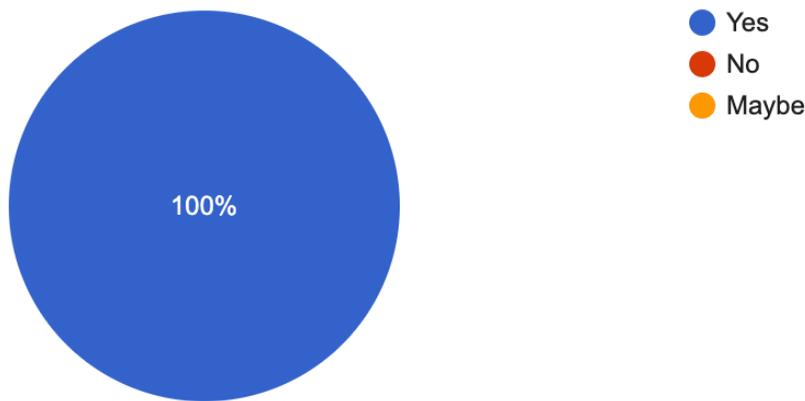


Figure 8. Would you recommend a friend to attend this workshop?



The survey results indicate that participants were engaged and interested in learning more about STEM career options. The comments from the participants are shown below:

- *This really sparked my interest especially since I like science and art at the same time.*
- *I really liked the activity that we did in the breakout rooms!*
- *Thank you for this opportunity it was very informative and fun!*
- *It was very interesting and engaging. I enjoyed making my own shake box to simulate an earthquake. Thank you very much I enjoyed it.*
- *I feel like this was such an amazing experience, it definitely was fun when we got to do the project and learning new things.*
- *It was very engaging and interesting.*
- *Thank you for this opportunity it was very informative and fun*

Discussion

The COVID 19 pandemic forced all aspects of society to transition to a virtual platform. The pandemic has forced children to stay home and has limited their physical ability to participate in field trips and lab experiments; however, today's technology allows for students to expand the opportunities accessible to them through a virtual world. The 2020-2021 academic year was the first time these outreach events were held virtually. Although the transition presented a challenge at first, in the end there are many benefits to the virtual platform. Mobile learning enriches students' learning experience, makes learning occur outside of schools and supports spontaneous learning [32]. The biggest challenge is planning logistics and making the workshops accessible. The critical elements we discovered for a successful event were: (1) having designated liaisons within the partner institution; (2) selecting the appropriate level and accessibility of activity; (3) using a range of teaching styles; and (4) appropriate technology. A 2015 guide to achieving broader impacts in K-12 identified similar critical elements for K-12 STEM outreach; use technology to enrich the experience within time limitations; develop a partnership with open communication; make it personal; and know the audience [21]. The benefits of the virtual platform include a larger pool of speaker availability and broader accessibility. Aligning a guest speaker for a virtual platform is easier since they do not have to plan in the commute time to the event. The workshops can be accessed from any location using the zoom link therefore the students can be home or with a caregiver, all they need to participate is a personal electronic device to connect and the supplies for the activity. The advantage of zoom is that students do not need a tablet or computer, a phone is adequate, therefore accessible to most. Specific to the Girl Day event, the audience is typically limited by space and time constraints. The virtual platform increased the target audience to include middle school students as well as high school students. Although attendance for the virtual programs was less than in person events, the potential for reaching a larger audience exists in the virtual platform. These activities could be used as a tool of expanding access to STEM activities to typically underserved populations and promoting equity. There are many benefits to the virtual platform and outreach efforts can be expanded using this delivery method. The recommendation would be to use a combination of virtual as well as in person delivery for STEM outreach as soon as we return to the new normal.

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