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Practitioners' Reflections on Developing and Implementing Virtual Educational Programming During COVID-19

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Abstract

Developing and implementing programming for pre-college and undergraduate racially and ethnically diverse (RED) students and faculty is an integral part of higher education, as it provides experiences and educational enrichment not often found in classrooms. For many practitioners, developing such programs includes tasks such as contacting speakers, securing classrooms, and arranging interactive activities to ensure a great student experience. Not on the task list: "hosting a virtual program in case of a global pandemic." As news circulated regarding the COVID-19 pandemic, schools and universities around the world took drastic measures to curtail the spread of the virus. Nearly 1,100 colleges and universities in the United States closed their campuses with only days' notice to faculty, staff, and students. COVID-19 caused the cancellation of in-person events and programs, while others quickly transitioned online. The transition online was not only a challenge to the program participants, but also to the practitioners implementing virtual educational programs. Many variables had to be considered to deliver impactful virtual instruction, such as applicable technology, accessibility, and the use of live or pre-recorded content. Moreover, creating equitable and impactful virtual programming that served racial, ethnic, and linguistically diverse individuals required the use of unique programming methods and techniques.

The current paper reflects the lessons learned by practitioners as they transitioned from in-person programming to online instruction in response to the COVID-19 pandemic. Researchers selected the qualitative approach of virtual ethnography to detail the experiences of four practitioners as they planned and implemented virtual educational programming. Each of the four practitioners work as staff members in the University of Cincinnati College of Engineering and Applied Science. The University of Cincinnati is a historically white tier 1 research institution in the Midwest. The reflections of the practitioners were documented as they transitioned programs intended for face-to-face engagement to virtual programming for faculty, staff, middle school, high school, and college students. Programming was designed for populations that are historically underrepresented in engineering and science.

To uncover the practitioners' individual experiences, the practitioners participated in a 25-minute interview and were asked to respond to open-ended questions related to the delivery of virtual programming: online platform selection, device accessibility, screen time and etiquette/decorum,

learning objectives, program assessment and general program insight. All interviews were recorded and transcribed to allow comparison and contrast of experiences. Researchers thematically analyzed the qualitative data generated from the recorded interviews to identify common themes, and ideas.

The findings indicated a pattern of creativity, resourcefulness, and equitable educational practices utilized in the planning and delivery of virtual programming. Additionally, the interviews revealed numerous methods and tactics employed by practitioners to adapt to the virtual learning environment. Practitioners utilized several methods to determine middle school and high school students' access to devices and broad-band internet to support online platforms. In contrast, accessibility to devices and access to online platforms were not major concerns when hosting virtual programs with faculty, staff, and college students. In such instances, faculty, staff, and students, were required by their university to maintain access to devices and on-line platforms in response to the pandemic.

Practitioners disclosed tools and metrics designed to evaluate participants' screen time and compliance with virtual etiquette/decorum. They used various methods to ensure participants were fully engaged while monitoring the possibility of online fatigue. Measures to minimize online fatigue were especially critical for programs that serve middle school students. To enhance the quality of virtual programming and improve user accessibility, practitioners created specific learning objectives. Additionally, practitioners developed several metrics to evaluate program impact, including surveys, engagement benchmarks, observation tactics, and progress reports.

In addition to the immense challenge of engaging with participants in a virtual environment, practitioners shared negative effects, such as the exclusion of students without device or internet access, internet transmission issues, and in some cases, a decrease in event attendance. While practitioners shared unfavorable factors, practitioners noted several advantages, such as the ability to impact a broader population of middle school and high school students and industry experts residing across the country.

The current paper offers an insight into the experiences of the educators who developed and implemented virtual educational programming during COVID-19 in a historically white institution in the Midwest. While it is hopeful that it will be years before the next global pandemic, COVID-19 has shifted perception and normalized digital learning and virtual programming. The narratives shared by participating practitioners may shed light on best practices to deliver effective and equitable educational content when virtual implementation is needed or desired as a method of delivery.

Introduction

For the past half century, the U.S. has been regarded as the scientific and technological powerhouse in the pre-eminent market economy [1]. However, economic indicators predict a need for approximately one million additional STEM professionals than the U.S. will produce at the current rate over the next 10 years if the country is to retain its historical influence and remain competitive [2]. The nation' mandate to fortify the STEM pipeline, is not limited to increasing the number of engineers; the task is coupled with the directive to increase the number of women and racially and ethnically diverse (RED) engineers [3]. As a result, there is heightened awareness of the impact and value of out-of-school, pre-college STEM programs to enhance student interest and understanding of STEM concepts, disciplines and careers [4]. This paper revisits the impact of STEM programs and shares best practices of university practitioners who transitioned traditional face-to-face STEM programs to effective, inclusive, and engaging virtual events due to COVID-19 pandemic.

Since, the 1950s universities have been instrumental in developing STEM programs and initiatives to cultivate STEM interests, with an aim towards enlarging and diversifying the engineering graduate pool [5]. Evidence indicates that students who participate in a high school STEM summer program are likely to experience positive gains in their views of science as well as their interests in science and science coursework during high school [5] Moreover, academic preparation prior to college, such as physics and chemistry courses, are essential in preparing students for STEM careers. Scholars have also noted that STEM Summer Bridge programs help students persist in college STEM programs [6]. Similarly, institutional programs that create a campus climate where women and faculty of color feel valued are essential to retention [7].

Recognizing the immense impact of STEM related events and activities, the Office of Inclusive Excellence and Community Engagement staff at the University of Cincinnati transitioned programs, originally intended as in-person events, to virtual events due to the pandemic. This paper details the reflections and experiences of four practitioners, employed at a historically white tier-1 research institution, as they reconfigured and hosted virtual programs designed for women and RED students, faculty and staff during the pandemic. Each practitioner carefully designed each element of their programs to provide meaningful engagement in a virtual environment. Practitioners utilized specialized methods and procedures to ensure on-line programming was effective for racially, ethnically, and linguistically diverse students. Through virtual ethnography, the experiences of each practitioner were uncovered after reviewing their responses to six open ended questions related to the delivery of virtual programming: online platform selection, device accessibility, screen time and etiquette/decorum, learning objectives, program assessment and general program insight. Researchers utilized a coding theory to organize and access the practitioners' responses in a structured method.

Practitioners' experiences may provide best practices to utilize inclusive and effective practices when hosting instructional activities and programming in a virtual environment.

Theoretical Framework

Educational programming has a significant impact on recruitment and retention of individuals historically underrepresented in STEM [8]. Therefore, shifting to virtual learning due to the pandemic was a call to action. It was paramount that such programming continued. Understanding the implications of virtual environments on programming, this paper is grounded in technology-mediated learning environment theory. Technology-mediated virtual learning environment (TVLE) allows for interactions and knowledge sharing between participants and facilitators, providing access to a wide range of resources all while in a computer-based environment [9].

One of the goals of the programs described in this paper is to create safe spaces for the underrepresented in engineering and science, such as women and people of color, while eliminating barriers. TVLE aims to eliminate such barriers while providing convenience, content, individualized learning, flexibility and aiding in retention [9]. TVLE addresses the relationship between learner control and effectiveness within four categories, learning achievement, self-efficacy, satisfaction, and climate. Compared to traditional TVLE where the participants are all students; our participants range from pre-college to college students, faculty, and staff. Although TVLE was created with students' learning in mind, the framework applies to all educational virtual environments where learning is an integral outcome part of programming.

Participants

The research reflects the experiences of four practitioners at the University of Cincinnati College of Engineering and Applied Science (CEAS), a historically white tier-1 research institution. The practitioners voluntarily agreed to participate in this research study and to have their recorded experiences included as part of this paper. Each practitioner works as a staff member in the CEAS Office of Inclusive Excellence and Community Engagement established to empower and support women and RED students, faculty, and staff. Additionally, the office host outreach activities to expose women and RED middle school and high school students to engineering curriculum and careers.

Practitioner A is an African American woman responsible for hosting an annual seven-week residential Summer Bridge Program (Summer Bridge) designed to assist incoming historically excluded students as they transition as first year students to the University of Cincinnati College of Engineering and Applied Science.

Practitioner B is a white man responsible for hosting a summer Family Engineering Academy for families to learn and explore engineering through videos, live demonstrations, experiments, and home challenges. Additionally, Practitioner B hosted a six-week summer Physics Course for high school students, who attend a local public school, that does not offer physics during the school year.

Practitioner C is a LatinX woman responsible for hosting a series of women in engineering social, instructional, and professional development programs for college students, faculty, and staff to assist with creating an inclusive supportive climate and retention.

Practitioner D is an African American woman responsible for hosting Women of Color Summer Engineering Camp (WOCSEC), a one-week summer engineering exploratory camp for high school women of color with the purpose of increasing interest in becoming an engineer.

After preparing to host the events in a traditional face-to-face format, the practitioners made the decision to host the activities virtually, after the onset of the Covid-19 pandemic.

Methods

The goal of this paper is to compare and contrast the experiences of four practitioners who implemented virtual programming as a response to the global pandemic. Using virtual ethnography as a qualitative approach, four practitioners were interviewed regarding 6 themes related to the implementation of virtual educational programming: platforms, accessibility, screen time/etiquette, program outcome, program assessment and insight/lessons learned (Table 1). All open-ended interviews were conducted one at a time, recorded, transcribed, and coded based on the six themes. Data collected and analyzed using descriptive and semi-structured coding [10]. Each theme has corresponding open-ended questions (Table 1).

Virtual Programming Themes and Corresponding Interview Questions

Themes	Interview Questions
Platforms and Communication	What platforms did you use? How were on-line platforms selected and why? How did you maintain communication with your participants?
Accessibility	What process was utilized to determine students' device and internet access and students' ability to navigate online learning platforms? How did you manage distractions or interruptions in the home environment?
Screen Time and Screen Etiquette	What guidelines and procedures were established to monitor screen time and online engagement? Describe tools and metrics designed to evaluate participants' screen time and compliance with virtual etiquette/decorum.
Program Outcome	How were activities or lessons configured to support virtual engagement and instruction? What were those learning objectives?
Program Assessment	What practices were utilized to measure student success? What metrics did you use to evaluate program impact, such as surveys, engagement benchmarks, observation tactics, or progress reports?
Program Insight/Lessons Learned	Describe advantages and disadvantages experienced while developing and implementing virtual programming? How did you incorporate equitable educational practices in the planning and delivery of virtual programming? Did you notice the positive advantages of hosting your program during the pandemic, if so, what were they?

Table 1. Virtual Programming Themes and Corresponding Interview Questions

Findings

1.Platforms and *Communications* - Connectivity and engagement are significant factors when creating effective virtual programming. Practitioners were asked to disclose the platforms and methods of communication used to implement their respective virtual programs, which are set forth in Table 2. Practitioners all utilized email as the preferred method of communication. In addition to email, Practitioner B utilized texting and phone calls to contact participants.

> "I used a combination of phone calls, emails and texts. I would typically send an email first and if students did not respond, or I noticed that the email was unopened, then I proceeded with a text and phone call."

Platforms and Methods of Communication Utilized by Practitioners

Practitioner	Platform Selections and Methods of Communication
Practitioner A	Email Microsoft Teams Canvas
Practitioner B	Email Text Phone WebEx Google Meet
Practitioner C	Email WebEx Flipgrid Canvas
Practitioner D	Email WebEx

Table 2 Platforms and Methods of Communication Utilized by Practitioners

Platform selection varied depending on the type of program, the intended audience, and the expected program outcome. For example, Practitioners A and D, both used Canvas, an on-line course management system, for instruction and posting assignments. Practitioners chose different delivery platforms due to their intended audience. Practitioner A, responsible for hosting Summer Bridge for incoming first year college students, utilized Microsoft Teams, for daily instruction. Practitioners C and D, responsible for programming for high school students, college students, faculty, and staff, utilized WebEx. WebEx provided polling and other interactive functions which were fun and engaging for participants.

Practitioner B initially utilized WebEx, but later switched to Google Meet, which better supported the devices used by the high school students participating in the Physics Course and Family Science Academy. Practitioner C indicated platform choices were guided by those platforms authorized by the University.

2. *Accessibility* - To establish equitable and inclusive practices in virtual programming, it is imperative that all participants have access to the prescribed technological resources and the ability to utilize the resources. Several weeks before the start of programs, each practitioner surveyed participants to determine device and internet accessibility. Specifically, the survey asked if participants had access to a desktop or laptop computer, and internet for the duration of the event or class. Additionally, Practitioner A asked participants if they had access to a webcam.

Students without webcams were permitted to borrow a webcam from the University for the duration of the camp. In addition to device access, Practitioner B shared specific information regarding the type of device needed for engagement.

> "During the pandemic, I learned that it was critical to specify the type of device needed to access the specific virtual program. For example, Chromebook users have limited access and support when accessing WebEx, which requires an extensive bandwidth. Chromebooks, commonly issued to high school students, are more suitable for web browsing and word processing. All devices do not have the same capability to access all content. It was important to determine access and usage capabilities before the start of the program."

Accessibility goes well beyond having the required device and internet access. The ability to fully engage and utilize technology may be compromised by a student's home learning environment. For example, students sharing their home learning space with siblings and parents may be easily distracted. Recognizing that students do not have control over their learning environment during the pandemic, practitioners learned to value the students' interest and willingness to participate in the event, thereby embracing distractions and remaining flexible. For example, Practitioner B shared the following:

> "I embraced the experience. Recognizing that students needed to watch their siblings and were often sharing a home learning space with others, I made it acceptable to include siblings in the class. I think learning to incorporate all aspects of the virtual environment into the learning experience was helpful and necessary."

3.Screen Time and Screen Etiquette -The amount of screen time and conduct while on screen, also known as screen etiquette, are key elements of effective virtual programming. Regarding screen time, Practitioner D incorporated 5-to-10-minute daily breaks and an extended lunch period to allow students to step away from the screen during camp. Practitioner D shared:

> "During the scheduled breaks we encouraged students to turn off their computers. We also scheduled a two-hour lunch break and encouraged the students to eliminate the use of devices during this time. It was important to incorporate designated time each day for students to pause and shift away from the computer screen."

The practitioners were asked to share the tools and metrics that were utilized to monitor participants' screen etiquette. All practitioners permitted students to utilize the online "chat function" for questions and comments for instructors and event organizers. Additionally, practitioners encouraged students to use the "reaction button" to show applause or to signal the need to ask a question. While both functions are helpful tools during virtual programming, practitioners shared the importance of constant monitoring to ensure appropriate use. Practitioner B instructed students to refrain from using the "chat function" to talk with other camps students to reduce the risk of inappropriate communication between students. Practitioner A asked a teaching assistant to monitor the chats and participants interactions, whereas Practitioner B monitored the chat himself. Practitioner A shared the following:

> "The TA (teaching assistant) helped a lot by monitoring students' use of the chat and reaction functions. The TA also ensured that students had cameras on during instruction. Additionally, the TA was instrumental in determining if students were logged on, fully engaged, and completing tasks and assignments."."

Practitioners C and D were more structured when addressing virtual etiquette expectations. Both practitioners instructed students to mute their mics unless speaking, operate with cameras on, and to use the chat only when needed. Both practitioners felt it was necessary to create virtual and etiquette rules for the participants. Practitioner D shared:

> "Every day we reminded the students to have their mics muted, and to make sure they had their cameras on. We also asked the students to be respectful and use appropriate language in the virtual space. We let the students know that it is helpful for event speakers to see their faces during session discussions."

Practitioner C shared "I did not provide the same screen instructions regarding mics and cameras when hosting events for faculty and staff. I felt faculty and staff would utilize the mics, cameras and the chat function appropriately."

4. Program Outcome - Creating learning outcomes designed specifically for virtual instruction is key to delivering impactful online events. Practitioner B shared the following strategy that was utilized for the Physics Course and Family Engineering Academy.

> "I definitely designed learning outcomes according to the subject matter. For the Physics Course, learning objectives were focused narrowly on a particular concept like motion, then the next class would focus on force. I found this approach to be very effective rather than teaching the entire theory of Newton's Law during one session. Without the ability to engage the students face-to-face, at times it was difficult to evaluate body language to determine if the student fully understood the material. Teaching smaller topics with regular check-ins with students was an effective method of meeting our learning objectives for the course."

Another aspect in creating effective virtual programming is understanding the parameters of virtual delivery. In preparing virtual lessons, practitioners must be prepared for the possibility of technical challenges and determine the best way to help students experiencing platform connection issues. Practitioner D shared the following:

> "We scheduled an orientation. We wanted the parents to know about the on-line platforms we chose and that they would be free of charge. We asked students to become familiar with accessing WebEx and the various functions associated with the platform.

5. Program Assessment - Program evaluations serve as an accountability measure to determine effective program implementation and to gather information to enhance future programming. Practitioners were asked to share specific measures used to determine success and impact of their respective virtual programs. Each practitioner utilized surveys to collect information on a broad range of topics, including student satisfaction and program engagement. In addition to surveys, Practitioner A utilized focus groups. Below are Practitioner A's experiences using surveys:

> "We have an exit survey that students complete at the end of their first semester. We also felt it was important to spend time talking with the students. We conducted a focus group with the students to determine if the program was beneficial, and if students had suggestions to improve the program."

6. Program Insight - The ability of practitioners to review and reflect upon their experiences is critical to improving and enhancing future virtual programs. While practitioners shared disadvantages to hosting virtual events, such as technical challenges and inability to engage with students and faculty face-to-face, practitioners noted several advantages. Practitioner D shared that hosting virtual camps allows students and invited speakers to attend without incurring travel costs. Practitioners noted that in some instances, virtual programs yielded greater attendance for both students, faculty, and staff. All practitioners shared that offering virtual programs created a measure of inclusivity, thereby permitting participants to attend from locations outside the regional area, as well as outside the country. To that end, Practitioner D stated:

> "One thing that virtual programming allowed was reaching individuals farther than face to face would have permitted. We had students participate from locations 200 miles to 500 miles away from our campus. The virtual camp allowed us to serve a broader population. "

As practitioners reflected on their experiences, they shared various lessons learned as they implemented virtual programming during the pandemic. First, unlike a traditional classroom, all home learning environments are different. As a result of different participants' experiences and engagement may not be similar. Practitioner C shared that that it is incumbent upon the practitioner to create numerous opportunities and options for engagement in virtual programming. In addition to learner diversity, adaptability to the participants' environment and their access to resources is important. Practitioner B stated:

> "In a classroom setting, I typically provide all the materials needed for a structure challenge. In preparing for the virtual structural challenge, I gave the students a lot of options for the challenge. I made sure that all project materials needed could be easily found in the home. For example, for our structure challenge, I suggested students use items like empty cereal boxes in home recycling bins."

Key Learnings

The paper offers recommendations related to the experiences of the practitioners who developed and implemented virtual educational programming as a response to COVID-19 in a historically white institution in the Midwest. Practitioners described their experiences related to six distinct aspects of effective virtual programming: platforms, accessibility, screentime/screen etiquette, program outcome, assessment and lessons learned (program insight).

1. An analysis of the practitioners' experiences led to the emergence of the following themes which are offered as best practices for delivering virtual, inclusive STEM programming. Platforms and Communications – In the preliminary stages of planning, it

is essential to select the right online platform. Online platform selection is typically guided by the goal of the program, course content and whether the platform is sanctioned by the institution. As expected, email, text and phone are all effective methods of communication with students and parents.

2. Accessibility – To ensure equitable participation among students, it is crucial to determine participants' access to specific devices and access to the internet for the duration of the program. Remaining flexible is helpful as technical challenges may arise and students may experience interruptions in their home during instruction.
3. Screen Time/ Screen Etiquette – Regulating screen time and ensuring proper manners and behavior online are key components for successful virtual instruction. Establishing a formal break period during the activity improves students' focus and concentration for the remainder of the day. Sharing online rules and expectations encourages students to practice appropriate and courteous behavior. Utilizing a Teaching Assistant to monitor students' compliance with etiquette expectations is helpful.
4. Program Outcome – Without face-to-face interactions with students, it is often difficult to assess students' comprehension of material. To create an effective program, it is important to establish specific learning outcomes, tailored for online instruction. Every program cannot be created equally. Determining the goal of the program and the participants' accessibility is key in creating a successful and inclusive program.
5. Assessment - Different tools and metrics may be utilized to access program success, such as surveys and focus groups. Focus groups are particularly helpful to gather the participants' opinions and allow participants to openly discuss their program experiences. A survey is a key tool for measuring program impact. Surveys will continually be used to access the needs of participants prior to the program and serve as feedback after the programs have been implemented, even when practitioners pivot back to face-to-face instruction.
6. Lessons Learned (Program Insight) - Virtual programming creates a measure of inclusivity by reaching a broader audience and eliminating transportation barriers often experienced by students attempting to attend face-to-face programs, thereby increasing event attendance. The ability to expand programming to a larger segment of the population and reduce barriers were definite advantages. As a result of the positive impact observed by implementing virtual programming, our findings suggest the continued use of virtual or a hybrid model for educational program implication. Online instruction provides expanded access thereby creating equitable programming in the future.

The narratives shared by the four practitioners may provide insight on best practices to deliver effective, inclusive, and equitable educational content when virtual implementation is used as the method of delivery in STEM programming for the historically excluded.

Limitations

The practices and methods discussed in this paper are subject to some limitations. The virtual programs hosted by the practitioners were specifically designed for women students, faculty, and staff, as well as racially and ethnically diverse middle school, high school and entering first year college students. The paper reflects the experiences of four practitioners employed at the same historically White, tier 1 research institution in the Midwest during a single program year. Moreover, the methods and metrics utilized by the practitioners were developed for virtual programs with 6 to 45 participants, which may be considered a small group of attendees.

The focus of the practitioners' programming was to increase STEM interest, diversify the STEM pipeline and retain women faculty and staff. The best practices shared in this paper are valuable as universities adopt strategies and procedures to host virtual programming devoted to STEM related initiatives. Of special note, several of the best practices may be applicable to face-to-face and non-STEM instruction as well.

Future Work and Impact

The 2020-2021 program year ushered in a new paradigm for delivering much needed programming to expose young students to STEM disciplines, as well as increase the number and diversity of STEM professionals, including faculty and staff. As a result of the pandemic, universities were forced to accelerate their strategies and procedures for on-line class instruction, including STEM related events and programs. Virtual programming opens new instructional pathways and allows participants to engage from around the world, eliminating travel time and cost associated with attending events on campus. Hosting virtual events for students removes financial barriers thereby creating a measure of inclusion and equity for participants, provided students have access to a device or the internet. For future student programming, our office plans to partner with local libraries, school systems and agencies working collaboratively to provide needed support to close the home connectivity gap by providing needed digital access. To that end, the University of Cincinnati Office of Inclusive Excellence and Community Engagement will host a combination of virtual, in-person, and hybrid events to determine if offering multiple viewing options generates wider impact.

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