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SPECIAL TOPIC

The University of Pennsylvania Flap Course Enters Virtual Reality: The Global Impact

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Background: The purpose of this study was to evaluate participants from the in-person Penn Flap Course (PFC) and virtual PFC to determine if the virtual PFC increased diversity in culture, sex, education, and surgical specialties internationally and within the United States. Our hypothesis is that the virtual PFC increases diversity internationally and within the United States.

Methods: A retrospective descriptive comparison was performed between participants from the in-person PFC from the years 2017 to 2019 and virtual PFC in 2020. Frequency maps were generated to determine differences in participation of cultures, sexes, education, and specialties internationally and within the United States. Net Promoter Scores (NPSs) were used to assess participant satisfaction with the virtual course.

Results: The in-person PFC included 124 participants from the years 2017 to 2019, whereas the virtual PFC included 770 participants in the year 2020. Compared to the in-person course, the virtual course included more cultures (countries: 60 versus 11; states: 35 versus 22), women (countries: 38 versus 7; states: 23 versus 9), students/researchers (countries: 24 versus 0; states: 9 versus 0), residents (countries: 44 versus 5; states: 26 versus 15), fellows (countries: 21 versus 2; states: 21 versus 9), attendings (countries: 34 versus 8; states: 16 versus 11), plastic surgery (countries: 54 versus 9; states: 31 versus 18), orthopedic surgery (countries: 12 versus 5; states: 11 versus 9), and other specialties (countries: 19 versus 1; states: 8 versus 2). Our overall NPS for the virtual PFC totaled 75%, categorized as "world class" based on global NPS.

Conclusion: A virtual interface for a flap course increased participation and diversity of culture, sex, education, and specialties internationally and within the United States with "world class" participant satisfaction. *(Plast Reconstr Surg Glob Open 2021;9:e3495; doi: 10.1097/GOX.0000000000003495; Published online 18 March 2021.)*

INTRODUCTION

In 2017, the University of Pennsylvania formed the annual weekend Penn Flap Course (PFC) with a focus on education and techniques of dissections pertinent to flap-based reconstruction.[1] This on-site education included didactic lectures, case presentations, and latex-injected cadaveric flap dissections in real time with residents, fellows, and attending surgeons who were willing to attend from around the world. Following the clinical examples from international leaders in microsurgical reconstruction, participants would then practice flap dissections on latex-injected cadavers with or without expert guidance. Cadaveric learning has demonstrated increased participant self-reported confidence and preparedness for cases across surgical specialties, including plastic surgery.[2–5]

With the spread of coronavirus disease (COVID-19) caused by the virus SARS-CoV-2, new challenges in surgical education emerged in the face of a pandemic. The effect of the worldwide pandemic accelerated the use of technology for education and collaboration as a result of social distancing and limitations in travel.[6,7] Since their creation, flap courses have included in-person teaching, mentorship, and participation to meet educational needs for all levels of surgical training.[1] In 2020, the PFC adopted a virtual interface to maintain participant safety while still providing microsurgical education free of charge.[8] By waiving course fees and increasing access to all participants interested in attending the PFC, anyone from around the world could attend as long as they had an electronic device. The goal of the virtual course was to not only increase the number of participants but also

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increase the diversity of participants exposed to microsurgical education. Different cultures, sexes, education levels of surgical training, and/or surgical specialties all contribute to diversity.

The purpose of this study was to evaluate participants from the in-person PFC and virtual PFC to determine if the virtual PFC increased diversity in culture, sex, education, and specialties internationally and within the United States. Our hypothesis is that the virtual PFC increases diversity internationally and within the United States compared to the in-person PFC.

MATERIALS AND METHODS

Study Design

We performed an institutional review board-approved retrospective descriptive comparison of 2 cohorts of participants from a single institution's annual flap course from the years 2017 through 2020. The first cohort included participants who attended the in-person PFC from the years 2017 to 2019. The second cohort included participants who attended the virtual PFC in the year 2020. Strengthening The Reporting of Observational Studies in Epidemiology (STROBE) guidelines were followed throughout the synthesis of the article.[9]

Participants were included if they registered and attended the course either in-person or virtually. All participants completed a demographic form that included contact information, first and last names, country, state and city of origin, institution affiliation, education level of training (student/researcher, resident, fellow, attending), and surgical specialties (plastic surgery, orthopedic surgery, other). Culture was determined by country of origin, state, and institution affiliation. Sex was categorized as man or woman based on registration data. Education levels of training and surgical specialties were self-reported by participants. Computer and/or mobile phone devices used to view the virtual flap course were recorded by the virtual interface. Only participants who logged onto the virtual interface were considered for the study. Those who registered, but did not attend in-person and/or virtual PFC were excluded. Remote Internet Protocol addresses of devices were used to confirm countries and states of origin for each participant.

Diversity Assessments

Descriptive comparisons were made between in-person and virtual cohorts. Frequency maps were generated for in-person and virtual cohorts to determine differences in participation of cultures, sexes, education levels, and surgical specialties internationally depicted by continents and countries and within the United States depicted by states.

Virtual Course Satisfaction

Participants using a computer device to view the virtual flap course were prompted to complete a Net Promoter Score (NPS). The NPS is a marketing industry index that assesses the likelihood a customer will recommend a brand or product to others. Scores were rated from "0" to "10" on an 11-point Likert-scale to assess overall satisfaction with the virtual interface (0–6: distractors, 7–8: passives, 9–10: promoters; NPS = %promoters − %distractors).[10] Global NPS standards define any score above 0 as "good," scores 50 and above as "excellent," and scores 70 and above as "world class."[11]

RESULTS

Culture

One hundred twenty-four participants attended the in-person PFC from 2017 to 2019, whereas 770 participants attended the virtual PFC in 2020. Compared to the in-person course, international cultural diversity changed with the virtual course in North America from 80% to 42%, Europe from 9% to 10%, Asia 5% to 24%, South America 4% to 15%, Africa 0% to 7%, and Oceana remained constant at 2%. The in-person course included participation from 11 countries, compared to 60 countries included in the virtual course (Fig. 1). Within the United States, the in-person course included 22 states, compared to 35 states included in the virtual course (Fig. 2). Cultural participant diversity increased internationally and within the United States with the virtual course (Figs. 1 and 2).

Sex

From 2017 to 2019, 80 male (64.5%) and 44 female (35.5%) participants attended the in-person course, whereas 516 male (67%) and 254 female (33%) participants attended the virtual course. The in-person course included participation of men from 8 countries, compared with men from 51 countries included in the virtual course (Fig. 3). Within the United States, the in-person course included men from 22 states, compared with men from 30 states included in the virtual course (Fig. 4). The in-person course included participation of women from 7 countries, compared with women from 38 countries included in the virtual course (Fig. 5). Within the United States, the in-person course included women from 9 states, compared to women from 23 states included in the virtual course (Fig. 6A and B). Male and female participant diversity increased internationally and within the United States with the virtual course (Figs. 3–6).

Education

No students/researchers attended the in-person course, whereas 85 students/researchers (11%) attended the virtual course. Compared with the in-person course, student/researcher diversity changed with the virtual course in North America from 0% to 29%, Europe from 0% to 8%, Asia 0% to 27%, South America 0% to 31%, Africa 0% to 4%, and Oceana 0% to 1%. The virtual course included students/researchers from 24 countries. Within the United States, the in-person course included no students/researchers, whereas the virtual course included students/researchers from 9 states. Seventy-nine residents (63.7%) attended the in-person course, whereas 379 residents (49.2%) attended the virtual course. The in-person course included

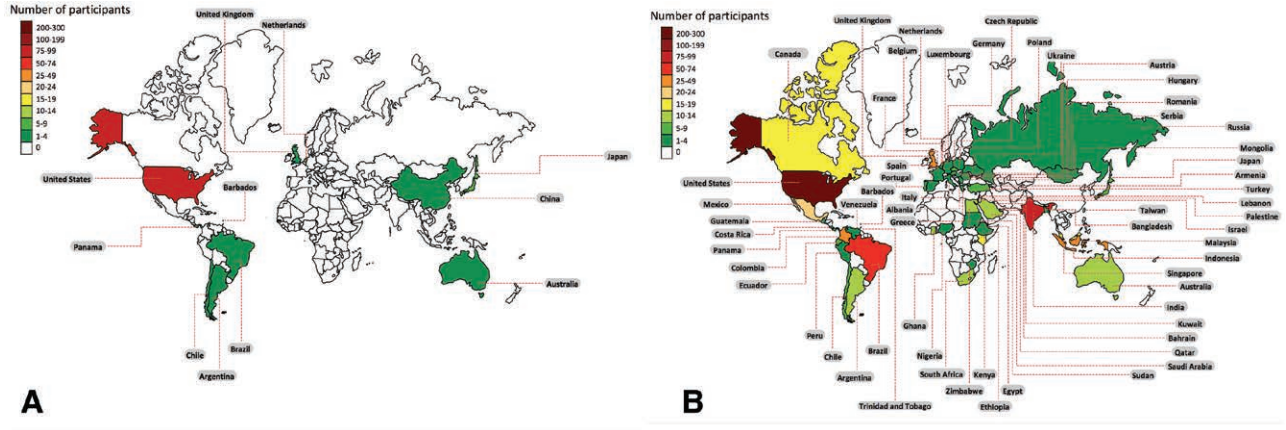

Fig. 1. International frequency maps of cultures. A, Cultures that participated at the in-person PFC 2017–2019. B, Cultures that participated at the virtual PFC 2020.

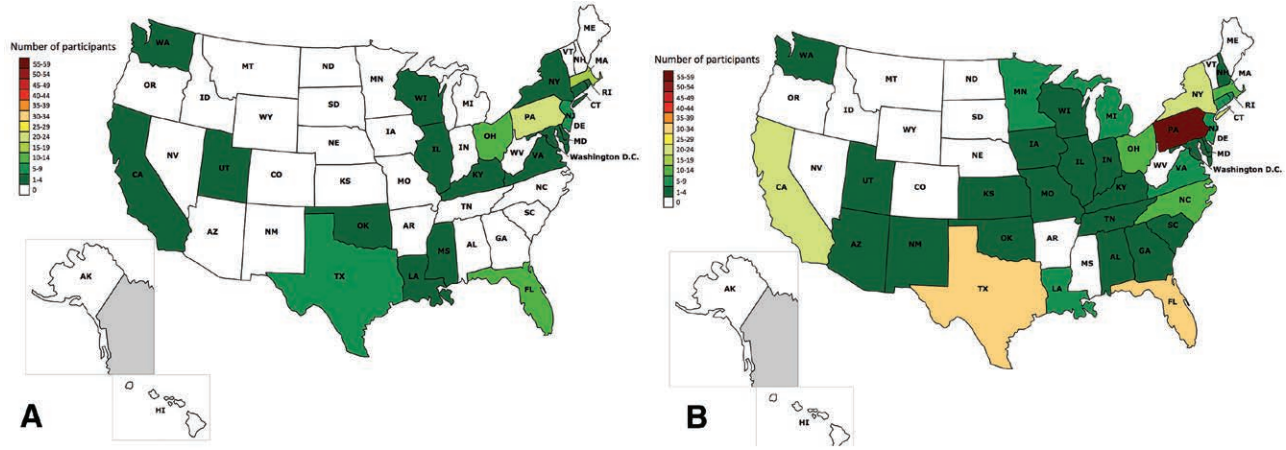

Fig. 2. The US frequency maps of states. A, States that participated at the in-person PFC 2017–2019. B, States that participated at the virtual PFC 2020.

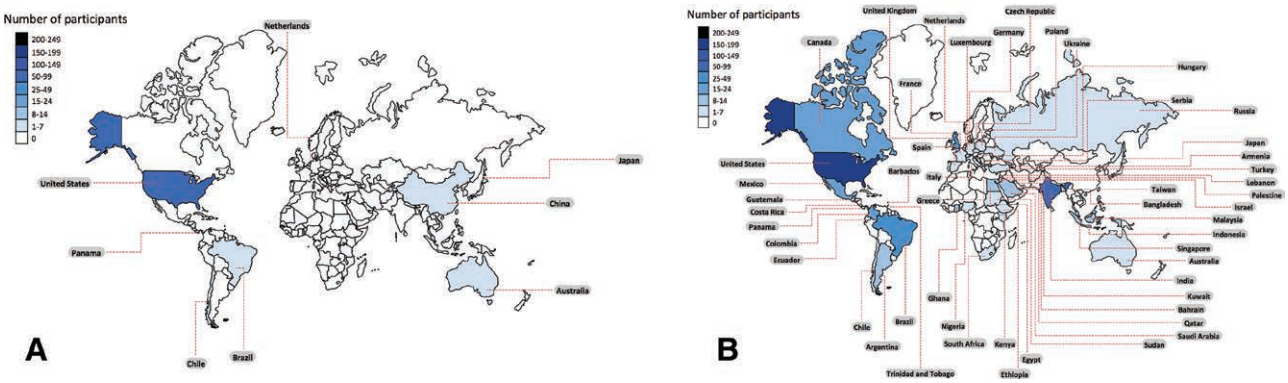

Fig. 3. International frequency maps of male sexes. A, Male sexes that participated at the in-person PFC 2017–2019. B, Male sexes that participated at the virtual PFC 2020.

residents from 5 countries, compared with residents from 44 countries included in the virtual course. Within the United States, the in-person course included residents from 15 states, compared with 26 states included in the virtual course. Twenty-three fellows (18.5%) attended the in-person course, whereas 128 fellows (16.6%) attended the virtual course. The in-person course included fellows from 2 countries, compared with 21 countries included in the virtual course. Within the United States, the in-person course included fellows from 9 states, compared with 21 states included in the virtual course. Twenty-two attending physicians (17.7%)

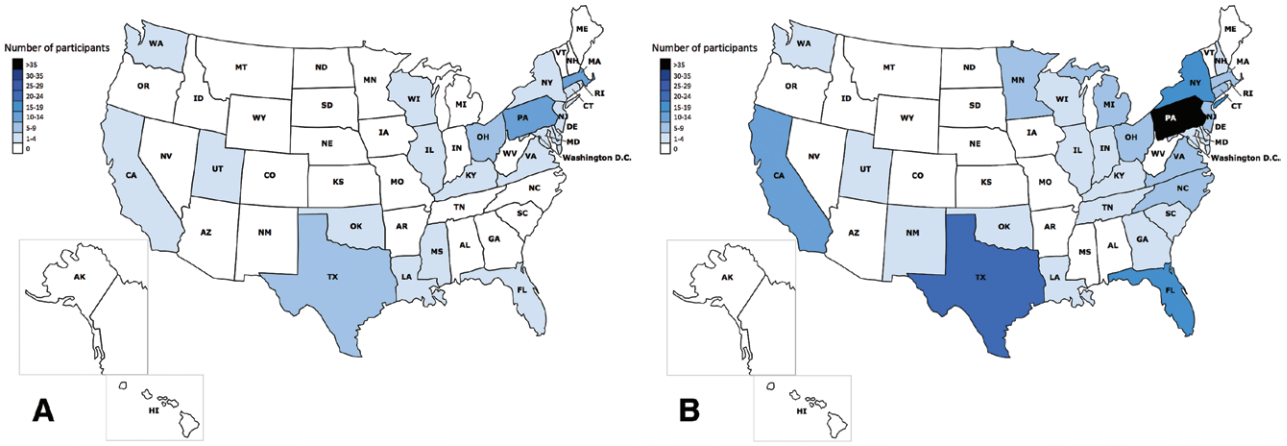

Fig. 4. The US frequency maps of male sexes from states. A, Male sexes from states that participated at the in-person PFC 2017–2019. B, Male sexes from states that participated at the virtual PFC 2020.

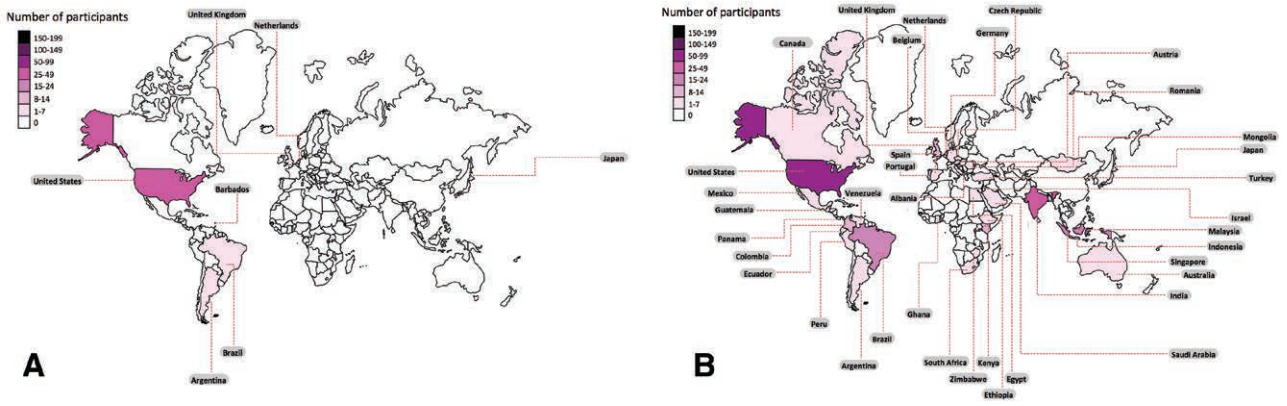

Fig. 5. International frequency maps of female sexes. A, Female sexes that participated at the in-person PFC 2017–2019. B, Female sexes that participated at the virtual PFC 2020.

Fig. 6. The US frequency maps of female sexes from states. A, Female sexes from states that participated at the in-person PFC 2017–2019. B, Female sexes from states that participated at the virtual PFC 2020.

attended the in-person course, whereas 160 attending physicians (20.7%) attended the virtual course. The in-person course included attending physicians from 8 countries, compared with 34 countries included in the virtual course. Within the United States, the in-person course included attending physicians from 11 states, compared with 16 states included in the virtual course. Student/researcher, resident, fellow, and attending physician diversity increased internationally and within the United States with the virtual course.

Surgical Specialty

Of the surgical specialties that were represented at the in-person course, 94 participants (76%) were affiliated with plastic surgery, 28 participants (22%) were affiliated with orthopedic surgery, and 2 participants (2%) were affiliated with other specialties. Other specialties consisted of 1 participant affiliated with otolaryngology and 1 participant affiliated with general surgery. The virtual course included 627 participants (81%) affiliated with plastic surgery, 61 participants (8%) affiliated with orthopedic surgery, and 82 participants (11%) affiliated with other specialties. Other specialties consisted of 57 participants affiliated with otolaryngology and 25 participants affiliated with general surgery. The in-person course included plastic surgery from 9 countries, compared with plastic surgery from 54 countries included in the virtual course. Within the United States, the in-person course included plastic surgery from 18 states, compared with 31 states included in the virtual course. The in-person course included orthopedic surgery from 5 countries, compared with orthopedic surgery from 12 countries included in the virtual course. Within the United States, the in-person course included orthopedic surgery from 9 states, compared with 11 states included in the virtual course. The in-person course included other specialties from 1 country, compared with other specialties from 19 countries included in the virtual course. Within the United States, the in-person course included other specialties from 2 states, compared with 8 states included in the virtual course. Plastic surgery, orthopedic surgery, and other specialty diversity increased internationally and within the United States with the virtual course.

Virtual Course Satisfaction

Of the 770 participants who viewed the virtual course, 452 (59%) viewed the course with a computer device alone, 242 (31%) viewed the course with a mobile phone device alone, and 76 (10%) viewed the course with both a computer and mobile phone device. Of the 513 participants who were able to report an NPS, 108 participants responded (21%), from 31 countries. Scores ranged from 9 to 10 (n = 86), 7 to 8 (n = 17), and 0 to 6 (n = 5) for course satisfaction and loyalty to the virtual interface. Our overall NPS for the virtual flap course totaled 75%, a "world class" score, indicating 75% of the participants were likely to recommend the virtual flap course to a friend or colleague. Education levels for the 5 distractors included 3 residents (Israel, Japan, and Singapore), 1 student/researcher (United States), and 1 attending physician (Armenia).

DISCUSSION

The virtual interface of the PFC increased the diversity of culture, sex, education, and surgical specialties internationally and within the United States while achieving a "world class" NPS of 75% and 21% response rate. The virtual interface allowed more than 6 times the number of participants in a single year compared with the in-person PFC in 3 years. In addition, the virtual interface provided new education and exposure to 1 continent, 49 countries, and 13 US states. The unforeseen international outreach of the PFC proved to be more extensive than we could have imagined. With the success of the virtual PFC, we weighed the positive and negative characteristics of the virtual and in-person PFC.

A major deterrent of in-person PFC participation is cost. Even without the cost of the course registration itself ($1225 USD per resident/fellow and $1750 USD per attending physician), participants need to fund domestic and international travel, discounted lodging, and meals. This may deter international participation for a weekend course if participants lack finances. Additionally, the cost of time committed to a weekend course may be a factor for in-person participation. Travel times may be longer than the course itself. We waived participant costs and spent approximately $11,000 USD for 2 latex-injected cadavers and $8000 USD for Plexus Surgical Video with aid from sponsors, in an effort to promote diversity and provide greater international access to microsurgical education. This is likely why students and researchers were able to attend the PFC for the first time, along with many low-income countries.[12,13] It may be difficult to determine if an increase in virtual PFC participation was due more to the virtual interface or the waived costs.

Africa is a continent that lacked PFC participation until the introduction of the virtual interface in 2020. African countries included 57 participants from Ghana, Nigeria, South Africa, Zimbabwe, Kenya, Ethiopia, Egypt, and Sudan. Similarly, India included 90 participants never before able to attend the in-person PFC. Previous studies have demonstrated average flap success rates of 87.1% in low-income countries and 95% in high-income countries.[14–17] The virtual interface may provide an affordable way to provide surgical education to low-income countries without the need for physicians to be physically present. Educating physicians within these communities can facilitate the formation of a self-sustaining medical community without the need for continual physical presence.[18] Funding may be allocated to other resources for self-sustainability within low-income countries.[19]

Female participation increased with the virtual PFC internationally and within the United States. Providing an inclusive environment for female engagement available worldwide allows women access and exposure to plastic surgery and microsurgical education. By reaching students and researchers before they have determined their training pathways, this may help reduce the known sex and gender disparities in plastic surgery.[20,21] Also, microsurgical educational access allows the opportunity for more women to pursue microsurgical careers.[22] A diverse workforce is vital to patient-centered care and creating role models for future female microsurgeons.[20,21,23]

In addition to sex diversity, technologic diversity was observed with the PFC. Participants had options to view the virtual PFC using a computer device or mobile phone device. Seventy-six participants alternated between both devices. Viewing the course by phone allows for continuous remote access even if the participate needs to change locations for any reason. This offers flexibility to a participant who may have other responsibilities or tasks during

the course. Participants were able to enter and exit the virtual PFC whenever they liked. If they were not interested in a particular dissection, they did not need to participate. If participants had conflicting obligations, they could attend the virtual PFC while still fulfilling obligations.[24]

The virtual PFC relied entirely on technology. Participant experiences varied depending on resolution of devices, sound quality, and internet connections. Some comments included "buffering problems," "interruption of video," and "can't appreciate much detail of the dissection as resolution quality is not the best." These can lower participant satisfaction and even cause patient harm if a critical portion of a flap dissection is interrupted or poorly visualized due to technological difficulties.[24]

Limitations include retrospective study design, lack of statistical comparisons and assessments of surgical competency, and a 21% response rate for virtual PFC satisfaction. Due to the retrospective nature of our study, we were unable to account for participant satisfaction responses that were only available through computer devices. Descriptive statistics were performed over statistical analyses to avoid overstratifying and underestimating the involvement of participants from different continents, countries, and states. As expected, significant statistical differences existed with larger comparisons (culture, male sex, female sex, students/researchers, residents, fellows, attending physicians, plastic surgery, orthopedic surgery, and other specialties); however, smaller comparisons lacked the appropriate power for statistical comparisons (countries and states). Participants were not assessed for surgical competency following the virtual course. The participant that stated the camera resolution limited details of dissection may not have adequately learned how to perform the microsurgical dissection. Although the majority of participants rated the virtual course highly, a negative characteristic may be the inability to perform these surgeries in clinical practice. Virtual PFC dissections were prerecorded and edited by Plexus Surgical Video using high-definition resolution (1920 × 1080/59.94i, 29.97p, 23.98p) cameras. Prerecorded dissections may limit real time surgical variability and over-estimate the ease of a procedure. The in-person PFC incorporates the "see one, do one" method in surgical training. Following a teaching session by the instructor, participants have the opportunity to perform flap dissections with other learners. In the past, nearly all participants of the in-person PFC agreed that the course improved their overall comfort with microsurgical skills and understanding.[1] Assessing competency following the in-person and virtual PFC would require in-person evaluations, which we were unable to perform. We observed a 21% survey response rate following the virtual PFC. Response rates for survey studies are historically low and increase participation bias. As a result, responses accumulate primarily from promoters and distracters. We attempted to overcome participation bias by incorporating the NPS. Due to the novelty of the virtual interface and flap course, we were unable to compare our NPS to preexisting standards. Last, the PFC did not fund advertising. By providing funds for advertising, we speculate an even greater international outreach would have further increased diversity of the PFC.

Future implications from our observations of the virtual PFC should include a virtual component to the PFC. Participants who prefer the in-person experience may practice flap dissections on latex-injected cadavers with or without expert guidance, whereas participants who prefer the virtual interface may learn flap-based reconstruction remotely at a reduced cost. By providing both the in-person and virtual PFC options, a greater variety of participant educational needs may be met. Comparisons should be made between the combined course and virtual course NPS to evaluate growth and participant satisfaction. Our goal of the PFC is to provide the highest level of education with an inclusive learning environment for all interested in flap-based surgery.

CONCLUSIONS

The major barriers to in-person flap course participation are the limited number of spaces for learners and cost. A virtual model for a flap course increased participation and diversity of culture, sex, education, and specialties internationally and within the United States. Our overall NPS for the virtual flap course totaled 75%, categorized as "world class" based on global NPS standards. By providing both in-person and virtual course options, a greater variety of participant educational needs may be met.

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