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BRAINterns 2.0: Durability of Webinar-Based Education and Social Media Beyond the Coronavirus Disease 2019 Pandemic

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■ **BACKGROUND:** Webinars offer novel educational opportunities beyond those of traditional, in-person experiences. BRAINterns is an open-access webinar-based education platform created to replace opportunities lost during the coronavirus disease 2019 pandemic. This program previously showed the efficacy of webinars to expand access to careers in medicine, and in particular, neurosurgery. BRAINterns 2.0 was established to assess the durability of Web-based learning.

■ **METHODS:** A modified 4-week webinar series was held during July 2021. A retrospective exit survey was distributed to participants and responses analyzed.

■ **RESULTS:** A total of 16,045 people registered for BRAINterns 2.0, representing 103 countries. Survey responses were received from 3765 participants (23% response rate). New, first-time registrants comprised 66% of participants, with the rest being returning participants. A total of 342 students participated in a dedicated module delivered entirely in Spanish. Females represented 81% of respondents. Participants identified that desirable elements of the program were opportunities to hear from women (53%) and people of color (44%) in health care. Participants heard about the series through TikTok ($n = 1251$; 33%), Instagram ($n = 1109$; 29%), Facebook ($n = 637$; 17%), and word of mouth ($n = 708$; 19%) with assistance from an ambassador program.

■ **CONCLUSIONS:** Webinar-based education programs continue to be of interest to students in an increasingly digital world. Social media, and specifically the use of educational ambassadors, are effective to improve visibility of educational programs across a diverse population of students. Understanding the desires of participants is critical to building a successful online education platform.

INTRODUCTION

The coronavirus disease 2019 (COVID-19) pandemic served as a catalyst for the expansion of alternative educational modalities, particularly within medical education. Medical education has traditionally relied on in-person shadowing and mentorship as an integral component of career development. In response to the disruption of traditional in-person educational methods created by the pandemic, several Web-based educational initiatives were created, particularly within neurosurgery.¹⁻³ These Web-based programs offered a unique opportunity for programs to expand access and recruitment to historically underrepresented populations in medicine and neurosurgery.

The Lenox Hill Hospital Department of Neurosurgery created the BRAINterns webinar series in 2020, capitalizing on the accelerated improvements in Web-based multimedia platforms. The initial program was met with widespread enthusiasm and garnered the attention of 16,484 registrants from 87 countries.⁴ Analyses of survey participants showed that Web-based education expanded access to medical education to a traditionally

Key words

- BRAINterns
- Diversity
- Education
- Medical education
- Recruitment
- Social media
- Webinar
- Women in neurosurgery

Abbreviations and Acronyms

COVID-19: Coronavirus disease 2019

OR: Operating room

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underrepresented cohort of students, including women and underrepresented minorities.

Given the success of the first online series, a second series of webinars was created and dubbed BRAINterns 2.0. BRAINterns 2.0 sought to streamline the open-access webinar platform in an environment that had largely returned to in-person learning through an expanded set of lecture topics focusing on the importance of women and diversity in medicine, an updated centralized Web site, and a week of curated content delivered entirely in Spanish in response to participant requests. BRAINterns also experimented with novel promotional techniques and appointed a cohort of 433 student ambassadors worldwide and promoted widely on common social media platforms.

We analyzed survey responses from participants in BRAINterns 2.0 to confirm the durability of virtual education and to better

understand its ability to expand access to careers in medicine and specifically, neurosurgery, through high-quality, multimedia webinars that respond to the real-time needs of students entering health care. We evaluated the usefulness of modern tools such as webcasting technology, electronic anonymized exit surveys, and social media promotion to maximize reach and deliver educational content. These data can be extrapolated and serve as a guide to the development of future Web-based educational programs in an increasingly digital world.

METHODS

This project was granted human subjects research exemption by the Feinstein Institute of Medical Research institutional review board.

A					
	Monday	Tuesday	Wednesday	Thursday	Friday
9-10AM EST	Special Summer Seminar	Women in Medicine	ACP Corner	Administration Station	Medical Student Journeys
10-11AM EST	Neurology Case Study	Virtual Cerebrovascular OR	Virtual Spine OR	Neuro-oncology Virtual OR	Chairman's Corner
11-12PM EST	Medical School Preparation	Diversity in Medicine	Introduction to Diagnostic Neuroimaging	Neurosurgical Innovation/Research	
B					
	lunes	martes	miércoles	jueves	viernes
9-10AM EST	Introducción a la Cirugía Neuro-Endovascular	Experiencia y conocimiento del asistente del médico en una sala de operación	Cirugía pediátrica	De la hematología y oncología pediátrica a administrar un hospital	Administración de un departamento de neurocirugía
10-11AM EST	La magia de la Neurología y Neuro-anatomía	Anestesia y la conciencia	Cuidado intensivo pediátrico	Introducción a la neuroradiología	De las granjas a la cima de la neurocirugía
11-12PM EST	La determinación y la excelencia entre medicina y el deporte	Consejos de una neurocirujana cerebrovascular y neuro-endovascular	Neuroradiología intervencional, La creación de un campo nuevo en la medicina	Cómo se llega a ser un cirujano neuro-endovascular	

Figure 1. Sample schedule for BRAINterns 2.0 in (A) English and (B) Spanish.

Webinar

BRAINterns 2.0 was delivered as a series of webinars over Zoom's videoconferencing platform (Zoom Video Communications Inc., San Jose, California, USA). Each week, 15 hours of content were delivered including lectures, pre-recorded live surgical shadowing, and career advising. All content was interactive through the Zoom platform. The program spanned 4 weeks in total. The last week (July 26–30, 2021) was delivered entirely in Spanish and mirrored the English. Sample schedules for a week of lecture series content in both English and Spanish are shown in [Figure 1](#). The webinar series was also recorded and posted to the BRAINterns YouTube channel, where it was available for free asynchronous viewing.

Ambassadors Program

The creators of BRAINterns formed an ambassadors program comprising international participants committed to the goal of marketing and communicating the benefits of this program to students worldwide via multiple media platforms. The opportunity to join the ambassadors program was publicized on all forms of social media and interested BRAINterns participants who wanted an expanded role within the program were invited to contribute. Ambassadors were instructed to produce at least 3 forms of outreach content including e-mails, clubs, and/or flyers. In addition, ambassadors created and managed social accounts under Instagram (@lhbrainterns) and TikTok (@lhbrainterns) to further publicize the program. Ambassadors were volunteers and there was no compensation. Ambassadors could resign at any time and continue to participate in the BRAINterns program as they desired.

Survey

Data were obtained through an anonymous retrospective exit survey distributed to participants at the conclusion of the webinar series. A list of the survey questions is provided in [Supplementary Table 1](#). Although survey completion was voluntary, students who submitted the survey were awarded a certificate of completion for the webinar series. The online questionnaire was distributed through SurveyMonkey Inc. (San Mateo, California, USA), which served as the platform for data acquisition. The survey was created to assess 1) demographics of participants, 2) continued interest in another webinar series among those who previously participated, 3) interest among first-time participants, 4) the impact of webinar-based health care education on participants' career choices (including interest in neurosurgery), 5) the effectiveness of course materials, and 6) goals of students who enrolled.

Data Analysis

Anonymously collected data were exported from the SurveyMonkey platform to Microsoft Excel (Microsoft Corp., Redmond, Washington, USA). SPSS version 26 (IBM Corp., Armonk, New York, USA) was used for all statistical analyses. Mean values for numeric variables were recorded with standard deviations. Two-sided t tests were performed on the self-

reported confidence data and career interest data to ascertain whether the increases were statistically significant. Because of a nonnormal distribution of values, a Kruskal-Wallis test was conducted to evaluate if there was a statistically significant relationship between age and methods by which participants first heard about the webinar series. To analyze the statistical significance in retention rate, χ^2 analysis was conducted. A P value <0.05 was considered statistically significant. Qualitative data and open-ended responses were hand-coded and analyzed manually.

RESULTS

Demographic Data

BRAINterns 2.0 had 16,045 registrants and 3795 survey respondents (23.5% response rate). [Table 1](#) compares demographics from survey responders who participated in BRAINterns 1.0 and 2.0. There was an increase in international participation and the number of countries represented increased from 87 to 102. In addition, 66% of survey responders were new to the BRAINterns program and had not attended the original webinar series. A total of 342 students attended BRAINterns 2.0 in Spanish. The median age of participation in BRAINterns 2.0 did not differ significantly from BRAINterns 1.0 and was 21 years (range, 12–74 years). Female students continued to represent most participants, at 81.1% of all participants. Asian participants were the most well represented, at 39.71%. Hispanic and Latino students made up 16.63% of participants. Black and African American students made up 7.04% of participants. Participants of all socioeconomic backgrounds participated in the webinar series, with self-reported household income levels ranging from less than U.S. \$25,000/year to more than U.S. \$150,000/year ([Table 2](#)).

Self-Rated Competency and Career Interest Scores Increase After the Webinar Series

Participant interest in pursuing various health care tracks before and after the webinar series was evaluated. Overall, average self-reported likelihood of pursuing physician training increased among participants after the webinar series ($P < 0.001$). [Table 3](#) summarizes the participants' average self-reported likelihood scores of pursuing careers as a physician (M.D./D.O.), nurse practitioner, or physician assistant, and within neurosurgery. These values are stratified by sex, race and ethnicity, household income, and if participants have a family member in health care. High-school and college students specifically reported a significant increase in the likelihood of applying to medical school after the webinar series ($P < 0.0001$). Further stratification by household income showed that participants from all 4 income groups included reported a significant increase in likelihood of applying to medical school ([Table 4](#)). Participants from all demographic backgrounds reported statistically significant increases in self-rated knowledge of operating room (OR) procedures ($P < 0.0001$) and technology ($P < 0.0001$) ([Supplementary Table 2](#)).

Table 1. Demographic Data from Original Webinar (1.0) and Second Webinar (2.0)

Characteristics	Values
BRAINterns 1.0 participant demographics	
Number of registrants	16,484
Number of participants	6675
Age (years)	
Median	21
Range	8–68
Sex	
Male	1094 (16.39)
Female	5521 (82.71)
Not specified	60 (0.89)
Race (%)	
Asian	2798 (41.92)
Black or African American	516 (7.73)
Hispanic or Latino	1080 (16.18)
Middle East or North African	335 (5.02)
Multiracial/multiethnic	236 (3.54)
Native American or Alaska Native	9 (0.13)
Native Hawaiian or Pacific Islander	22 (0.33)
White	1514 (22.68)
Level of education	
Middle and high school	945 (14.16)
College	4180 (62.62)
Graduate school	280 (4.19)
Nursing school	55 (0.82)
Medical school	408 (6.11)
Medical fellowship and residency	28 (0.42)
Physician assistant school	34 (0.51)
Not currently enrolled	575 (8.81)
None of the above	170 (2.55)
BRAINterns 2.0	
Number of registrants	16,045
Number of participants	3765
Age (years)	
Median	21
Range	12–74
Sex (%)	
Male	685 (18.19)
Female	3054 (81.12)
Not specified above	26 (0.69)
Continues	

Table 1. Continued

Characteristics	Values
Race	
Asian	1495 (39.71)
Black or African American	265 (7.04)
Hispanic or Latino	626 (16.63)
Middle East or North African	213 (5.66)
Multiracial/multiethnic	143 (3.80)
Native American or Alaska Native	4 (0.11)
Native Hawaiian or Pacific Islander	13 (0.35)
White	894 (23.75)
Level of education	
Middle and high school	977 (35.33)
College	1886 (50.09)
Graduate school	117 (3.11)
Nursing school	28 (0.74)
Medical school	382 (10.15)
Medical fellowship and residency	20 (0.53)
Physician assistant school	9 (0.24)
Not currently enrolled	264 (7.01)
None of the above	82 (2.18)
Values are number (%) except where indicated otherwise.	

Medical student participants reported an overall increase in likelihood of pursuing a career in neurosurgery ($P < 0.001$) (Table 5). When stratified by sex, both female ($n = 279$) and male ($n = 102$) medical students reported a significantly higher likelihood of pursuing a career in neurosurgery after the webinar ($P < 0.0001$). Asian ($n = 139$; $P < 0.0001$), Hispanic/Latino ($n = 61$; $P < 0.01$), Middle Eastern or North African ($n = 25$;

Table 2. Yearly Household Income of U.S. Participants ($N = 2759$)

Income	Number (%)
<USD15,000	181 (6.56)
USD15,000–29,999	262 (9.50)
USD30,000–49,999	273 (9.89)
USD50,000–74,999	276 (10.00)
USD75,000–99,999	234 (8.48)
USD100,000–150,000	371 (13.45)
>USD150,000	363 (13.16)
Do not know	405 (14.68)
Prefer not to answer	394 (14.28)

Table 3. Self-Rated Likelihood (1–10) of Pursuing Various Health Care Tracks by Sex, Yearly Household Income (U.S. \$), Race or Ethnicity, and Family Member in Health Care, Before and After the Webinar Series

	Likelihood of Pursuing a Career in Neurosurgery		Likelihood of Pursuing the Physician (M.D./D.O.) Track		Likelihood of Pursuing the Nurse Practitioner Track		Likelihood of Pursuing the Physician Assistant Track	
	Before	After	Before	After	Before	After	Before	After
	P value		P value		P value		P value	
Overall sex								
Male (n = 675)	5.557	7.201	7.834	8.545	2.637	3.262	3.018	3.801
	<0.0001		<0.0001		<0.0001		<0.0001	
Female (n = 2973)	5.025	6.817	7.622	8.337	2.709	3.368	3.261	4.166
	<0.0001		<0.0001		<0.0001		<0.0001	
Annual household income								
<USD15,000 (n=338)	5.538	7.559	7.515	8.467	2.923	3.950	3.296	4.299
	<0.0001		<0.0001		<0.0001		<0.0001	
USD15,000–29,999 (n = 345)	5.299	7.330	7.501	8.354	2.716	3.528	3.458	4.504
	<0.0001		<0.0001		<0.0001		<0.0001	
USD30,000–49,999 (n = 327)	5.104	7.000	7.884	8.535	3.046	3.560	3.517	4.358
	<0.0001		0.0014		0.0122		0.0002	
USD50,000–74,999 (n = 344)	4.875	6.820	7.666	8.462	2.669	3.445	3.151	4.052
	<0.0001		<0.0001		<0.0001		<0.0001	
USD75,000–99,999 (n = 277)	5.166	6.791	7.989	8.588	2.585	3.173	3.325	4.375
	<0.0001		0.0042		0.0014		<0.0001	
USD100,000–150,000 (n = 417)	4.664	6.302	7.758	8.427	2.329	2.892	3.065	3.899
	<0.0001		0.0002		<0.0001		<0.0001	
>USD150,000 (n = 401)	5.080	6.708	7.920	8.531	2.262	2.576	2.751	3.421
	<0.0001		0.0004		0.0198		<0.0001	
Race								
White (n = 874)	4.944	6.568	7.514	8.135	2.458	2.891	3.168	3.899
	<0.0001		<0.0001		<0.0001		<0.0001	
Asian (n = 1464)	5.051	6.879	7.557	8.292	2.855	3.567	3.268	4.128
	<0.0001		<0.0001		<0.0001		<0.0001	
Black/African American (n = 256)	5.254	6.949	7.836	8.746	2.712	3.523	3.215	4.309
	<0.0001		<0.0001		<0.0001		<0.0001	
Hispanic/Latino (n=611)	5.363	7.241	7.948	8.632	2.804	3.609	3.321	4.391
	<0.0001		<0.0001		<0.0001		<0.0001	
Another race or ethnicity (n=109)	5.440	7.376	7.422	8.220	2.413	3.147	3.101	3.982
	<0.0001		0.0367		0.0172		0.0207	
Middle Eastern or North African (n=203)	5.246	7.241	7.948	8.632	2.804	3.609	3.321	4.391
	<0.0001		0.0022		0.0009		<0.0001	
Continues								

Table 3. Continued

	Likelihood of Pursuing a Career in Neurosurgery		Likelihood of Pursuing the Physician (M.D./D.O.) Track		Likelihood of Pursuing the Nurse Practitioner Track		Likelihood of Pursuing the Physician Assistant Track	
	Before	After	Before	After	Before	After	Before	After
	P value		P value		P value		P value	
Native American or Alaska Native (n=3)	6.000	9.333	7.000	9.000	4.667	6.667	5.000	6.667
	0.0668		0.3349		0.5158		0.5898	
Native Hawaiian or other Pacific Islander (n=12)	5.417	7.167	7.833	8.833	3.667	4.167	4.167	4.500
	0.1423		0.3376		0.7189		0.8263	
Family member in health care								
Yes (n = 1638)	5.102	6.813	7.761	8.415	2.751	3.380	3.292	4.177
	<0.0001		<0.0001		<0.0001		<0.0001	
No (n = 2127)	5.138	6.941	7.571	8.336	2.654	3.328	3.155	4.039
	<0.0001		<0.0001		<0.0001		<0.0001	

$P < 0.05$), and white ($n = 104$; $P < 0.0001$) participants were also significantly more likely to pursue a career in neurosurgery after the webinar. In particular, medical students who identified as Asian and female ($n = 100$; $P < 0.0001$) or male ($n = 39$; $P < 0.0001$); Hispanic/Latina and female ($n = 49$; $P < 0.01$); and white and female ($n = 71$; $P < 0.0001$) or male ($n = 33$; $P < 0.01$) reported that they were more likely to pursue a career in neurosurgery after the webinar.

The Importance of Social Media

Social media continued to be a driver of participation in the webinar series. The Instagram account (@lhbrainterns) had 57 posts, 2130 followers, and 6241 likes as of April 11, 2022. The TikTok account (@lhbrainterns) had 26 posts, 6997 followers, 881,752 views, and 156,700 likes as of April 11, 2022. The Facebook group “Lenox Hill Hospital BRAINterns” has 15,800 members and the YouTube channel, “BRAINterns Webinar Series” has 167 videos and 6150 subscribers. The BRAINterns social media presence is summarized in Table 6. Participants most commonly heard about the series through TikTok ($n = 1251$; 33%), Instagram ($n = 1109$; 29%), Facebook ($n = 637$; 17%), word of mouth ($n = 708$; 19%), and Twitter ($n = 88$; 2%). The distribution of participants' ages and the methods by which participants heard about the webinar are summarized in Figure 2. The median age of participants who found the series through TikTok (20), Instagram (21), Facebook (22), word of mouth (23), and Twitter (21.5) are significantly different ($\chi^2 = 284.701$; $P < 0.00001$).

DISCUSSION

Continued Interest in Web-Based Education

BRAINterns 1.0 was met with enthusiasm, shown by both the number of participants and their global distribution.⁴ As

educational systems returned to in-person instruction, the durability of Web-based educational endeavors became uncertain. BRAINterns 2.0 was evaluated for potential insights into the durability of Web-based medical education.

BRAINterns 2.0 had 16,045 registrants and 3795 survey respondents (23.5% response rate), compared with BRAINterns 1.0, which had 16,484 registrants and 6675 survey respondents (40.5% response rate). There was only a 2.7% decrease in the number of registrants (16,484 to 16,045), despite the widespread shift back to in-person education. BRAINterns 2.0 continued to have representation from all 50 states, with more widespread international representation (102 countries this year vs. 87 countries previously). Interestingly, the majority of participants were new (66%) and did not participate in the initial series. These data likely reflect an intrinsic automatic annual renewal of students interested in pursuing careers in medicine but also confirm a persistent interest in web-based educational series that provide immediate and convenient access to a broad range of interested students. Although survey engagement decreased between BRAINterns 1.0 and 2.0, it is possible that students who had completed the course the previous year and received a certificate were less incentivized to complete the second survey. However, this finding may also reflect the intrinsic anonymity of Web-based education delivered freely, in which individuals can decide their own degree of engagement. Despite a lower survey response rate in the second rendition compared with the first, the racial and ethnic breakdowns as well as sex breakdowns were similar between both years, supporting the validity of survey responses across both years.

Webinar-Based Education Works to Enhance the Student Diversity Pipeline

The use of an open-access, free, Web-based platform for education allows for engagement and recruitment of students who may

Table 4. Self-rated Likelihood (1–10) of Pursuing a Career in Neurosurgery or the Physician Track by Sex, Yearly Household Income (U.S. \$), Race or Ethnicity, and of Having a Family Member in Health Care Before and After the Webinar Series in a Cohort of High-School and College Students

	Likelihood of Pursuing a Career in Neurosurgery		Likelihood of Pursuing the Physician (M.D./D.O.) Track	
	Before	After	Before	After
	P value		P value	
Overall sex				
Male (n = 491)	5.243	6.866	7.751	8.546
	<0.0001		<0.0001	
Female (n = 2332)	4.949	6.711	7.562	8.332
	<0.0001		<0.0001	
Annual household income				
USD15,000 (n = 211)	5.217	7.130	7.232	8.309
	<0.0001		<0.0001	
USD15,000–29,999 (n = 245)	5.055	7.106	7.496	8.500
	<0.0001		<0.0001	
USD30,000–49,999 (n = 237)	4.934	6.843	7.934	8.638
	<0.0001		0.0014	
USD50,000–74,999 (n = 251)	4.874	6.879	7.628	8.530
	<0.0001		<0.0001	
USD75,000–99,999 (n = 230)	5.272	6.790	7.906	8.558
	<0.0001		0.0034	
USD100,000–150,000 (n = 351)	4.702	6.324	7.749	8.486
	<0.0001		<0.0001	
USD>150,000 (n = 355)	5.084	6.686	7.902	8.542
	<0.0001		0.0004	
Race				
White (n = 633)	4.809	6.439	7.469	8.172
	<0.0001		<0.0001	
Asian (n = 1200)	4.978	6.710	7.543	8.297
	<0.0001		<0.0001	
Black/African American (n = 196)	5.063	6.794	7.667	8.672
	<0.0001		<0.0001	
Hispanic/Latino (n = 463)	5.164	7.100	7.783	8.551
	0.0001		0.0001	
Another race or ethnicity (n = 72)	5.478	7.435	7.029	8.072
	<0.0001		0.0294	
Middle Eastern or North African (n = 163)	5.039	6.311	7.651	8.321
	<0.0001		0.0051	
Native Hawaiian or other Pacific Islander (n = 7)	5.429	7.143	8.857	9.714
	0.3031		0.2818	

Continues

Table 4. Continued

	Likelihood of Pursuing a Career in Neurosurgery		Likelihood of Pursuing the Physician (M.D./D.O.) Track	
	Before	After	Before	After
	P value		P value	
Family member in health care				
Yes (n = 1231)	5.022	6.762	7.451	8.274
	<0.0001		<0.0001	
No (n = 1613)	4.969	6.704	7.769	8.485
	<0.0001		<0.0001	

otherwise have limited opportunities for exposure into medical fields. A novel element of BRAINterns 2.0 was the week of specialized medical lectures produced in Spanish. There was a greater retention rate among white (35.1%; $P = 0.002$) and Hispanic/Latino students (38.1%; $P = 0.013$) between BRAINterns 1.0 and 2.0 compared with other racial/ethnic groups, as shown in **Figure 3**. This finding suggests that having content delivered in Spanish may have been a driving factor in retention among the Hispanic/Latino population. Observing demographic trends and responding with more specialized course content tailored to targeted populations may contribute to long-term program retention.

Our demographic data showed that women continue to be well represented (81.12% of all participants identified as female in BRAINterns 2.0, compared with 82.87% in BRAINterns 1.0). A second year of data with robust female participation underscores both webinar education and social media marketing as particularly effective tools in recruiting women into medical fields. These tools should be readily used when organizing recruitment efforts into fields in which women are underrepresented.

Because the medical school application process often begins several months to years before college graduation, the appropriate educational demographic to target would be high-school and college students.^{5,6} Our data show that webinar-based programming is an effective way to reach this particular educational demographic, because high-school and college students comprised most participants ($n = 958$ [25.44%] and $n = 1886$ [50.09%], respectively). Not only were these students well represented in our program but they further reported that their likelihood of pursuing the physician track significantly increased after program participation.

Webinar-Based Education Facilitates Access to Medical Knowledge for Students Lacking Resources

Among high-school and college students with an interest in health care who reported no family members in health care, individuals identifying as Asian, black or African, Hispanic or Latino, Middle Eastern or North African, and white all reported a significantly higher average knowledge of both OR procedures

and technology used in the OR after their participation in BRAINterns (**Supplementary Table 2**). This finding supports the ability of webinar education to mitigate inequities associated with lack of readily available connections to health care. Furthermore, increased self-reported competency scores showed improved confidence among students who completed the webinar series (**Supplementary Table 3**). Thus, BRAINterns 2.0 served as a method to close the confidence gap among women and minorities, which may encourage more diverse applications into medicine and surgical subspecialties such as neurosurgery.

Economic status can also pose a significant barrier to entry into medical fields.⁷ Many educational programs charge tuition fees, and courses with in-person instruction may be impractical to attend for those with summer jobs and household obligations. The option to participate in either the synchronous or asynchronous free course live on Zoom or on YouTube, respectively, mitigates both barriers. When analyzing trends among various self-reported household income levels, the likelihood of applying to medical school significantly increased across all income levels ($P < 0.01$). Although webinar-based educational courses are relatively inexpensive compared with an in-person course, these data may also suggest an opportunity for collaboration with industry for funding to continue the free distribution of information paramount to continuing to expand access to participants of limited financial resources.

Social Media Are an Essential Tool for Webinar Participant Recruitment

Social media have transformed educational environments, with the COVID-19 pandemic and move to online platforms further accelerating this change. Use of social media is ubiquitous with sites such as TikTok and Instagram boasting more than 800 million and 1 billion monthly users, respectively.⁸ Our survey results showed that most participants heard of our program through some form of social media. The most frequently cited social media that facilitated BRAINterns publicity was TikTok (33.23%; $n = 1251$). This platform was followed by Instagram (29.46%; $n = 1109$), word of mouth (18.80%;

Table 5. Self-Rated Likelihood (1–10) of Pursuing a Career in Neurosurgery by Sex, Yearly Household Income (U.S. \$), Race or Ethnicity, and of Having a Family Member in Health Care Before and After the Webinar Series in a Cohort of Medical Students

	Likelihood of Pursuing a Career in Neurosurgery		P value
	Before	After	
Overall sex			
Male (n = 102)	6.828	8.596	<0.0001
Female (n = 279)	5.693	7.588	<0.0001
Annual household income			
USD15,000 (n = 80)	6.192	8.333	<0.0001
USD15,000–29,999 (n = 47)	6.500	8.239	0.0002
USD30,000–49,999 (n = 327)	6.267	7.967	<0.0001
USD50,000–74,999 (n = 29)	5.357	6.893	0.0301
USD75,000–99,999 (n = 12)	4.833	6.833	0.0574
USD100,000–150,000 (n = 15)	5.333	7.200	0.1005
>USD150,000 (n = 14)	4.429	6.929	0.0014
Race			
White (n = 104)	5.911	7.663	<0.0001
Asian (n = 140)	5.906	8.101	<0.0001
Black/African American (n = 24)	7.087	8.391	0.0702
Hispanic/Latino (n = 61)	6.433	7.917	0.0026
Another race or ethnicity (n = 20)	4.850	7.200	0.0056
Continues			

Table 5. Continued

	Likelihood of Pursuing a Career in Neurosurgery		P value
	Before	After	
Middle Eastern or North African (n = 25)	5.696	7.348	0.0426
Family member in health care			
Yes (n = 174)	5.966	8.049	<0.0001
No (n = 208)	6.047	7.635	<0.0001

n = 708), and Facebook (16.95%; n = 638). Twitter was the least frequently cited source of social media publicity at 2.34% (n = 88). When choosing which social media platforms to consider using when publicizing programs, it is prudent to consider the age-group of the target audience.⁹ Studies conducted by Pew Research Center show that of these social media platforms, younger adults aged 18–29 years old more frequently use Instagram and TikTok.¹⁰ Data from Pew also highlight that social media use can vary by racial and ethnic demographic. Instagram is used by 52% of Hispanic and 49% of black Americans polled in their study, compared with 35% of white Americans. These trends can guide strategic use of social media in driving student recruitment into educational programs.

Limitations

This study was conducted through the distribution of an optional exit survey. The demographic data that we gathered and analyzed are from survey responders, not from all participants in the webinar series, and, thus, may not be representative of the entire group because of potential survey response bias. Given the high number of survey responses, this effect is likely minimal. This study also relied on self-rated proficiency scores, which are subjective assessments susceptible to response bias. Respondents were told that the results would be anonymized before analysis, but concerns over anonymity may have limited negative responses. In addition, although participants were instructed to complete the exit survey only once, it is possible that they may have completed duplicate entries. To reduce confounding variables among survey respondents, a single survey that was written in English was distributed to all participants. It is possible that this strategy created a barrier for completion in Spanish-only-speaking participants who attended the week in Spanish.

Table 6. BRAINterns Social Media Presence During the First (2020) and Second Iterations (2021) of the Series

Media Platform	Media Title	Primary Media Manager	Total Number of Subscribers/ Members	Total Number of Posts/ Messages Sent	Total Number of Reactions
Instagram (1)	Ihhbrainterns	Ambassadors	2130 followers	57 posts	6241 likes
TikTok (1)	Ihhbrainterns	Ambassadors	6997 followers	26 posts	156,700 likes
Facebook (1)	Lenox Hill Hospital BRAINterns	Course director	15,800 members	50 posts	6306 reactions
YouTube (1)	BRAINterns Webinar Series	Course director	6150 subscribers	167 posts	118,760 views
Slack (2)	Lenox Hill Neurosurgery BRAINterns	Course director	3491 members	6127 messages	1563 reactions
	BRAINterns Ambassadors	Course director	433 members	2453 messages	1725 reactions
Web site (1)	www.brainterns.com	Course director	N/A	N/A	N/A

CONCLUSIONS

Webinar-based education continues to play a role in education beyond the COVID-19 pandemic despite a significant return to in-person learning. Data from BRAINterns 2.0 suggest the durability of Web-based learning as a viable component of future medical education. Social media and the use of educational ambassadors are effective recruitment tools to improve visibility of educational programs across a diverse population of students. Medical educators should continue to use and modify these tools in a post-pandemic world to take advantage of the large impact and low-cost of Web-based modalities that can maintain long-term influence on the career decisions of a highly motivated population of diverse students.

CRedit AUTHORSHIP CONTRIBUTION STATEMENT

Amanda V. Immidisetti: Conceptualization, Investigation, Data curation, Formal analysis, Methodology, Writing – original draft. **Ashley E. Rosenberg:** Conceptualization, Investigation, Data curation, Formal analysis, Methodology, Writing – original draft. **Joshua Katz:** Conceptualization, Investigation, Data curation,

Formal analysis, Methodology, Writing – original draft. **Artur Shlifer:** Conceptualization, Project administration, Resources, Writing – review & editing. **Jason Ellis:** Conceptualization, Investigation, Supervision, Methodology, Writing – review & editing. **Rafael A. Ortiz:** Conceptualization, Investigation, Supervision, Methodology, Writing – review & editing. **John A. Boockvar:** Conceptualization, Investigation, Supervision, Methodology, Writing – review & editing. **Randy S. D’Amico:** Conceptualization, Investigation, Supervision, Methodology, Writing – review & editing. **David J. Langer:** Conceptualization, Investigation, Supervision, Methodology, Writing – review & editing.

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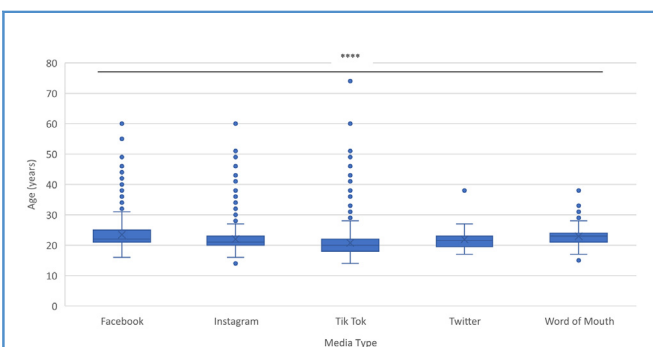


Figure 2. Methods by which participants heard about BRAINterns 2.0 by age (****indicates significance $P < 0.00001$).

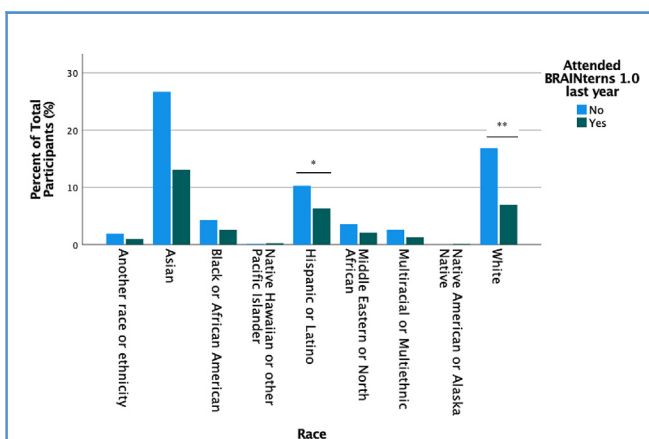


Figure 3. Percent of participants retained from the first iteration of BRAINterns or new to the program by race (*indicates significance $P < 0.01$, **indicates significance $P < 0.001$).

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SUPPLEMENTARY DATA

Supplementary Table 1. List of Survey Questions
Demographic Questions
1. Which country do you live in?
2. Which state do you reside in? Select "I do not live in the United States" if applicable
3. In what year were you born?
4. What is your sex?
a. Male
b. Female
c. Prefer not to say
5. What is your gender identity?
a. Woman
b. Man
c. Genderqueer or non-binary
d. Agender
e. Trans male/trans man
f. Trans female/trans woman
g. Prefer not to say
h. Not specified above, please specify
6. What is your race or ethnicity?
a. Asian
b. Black or African American
c. Hispanic or Latino
d. Middle Eastern or North African
e. Multiracial or multiethnic
f. Native American or Alaska Native
g. Native Hawaiian or other Pacific Islander
h. White
i. Another race or ethnicity
7. What is your household's yearly income in US dollars?
a. Under \$15,000
b. Between \$15,000 and \$29,999
c. Between \$30,000 and \$49,999
d. Between \$50,000 and \$74,999
e. Between \$75,000 and \$99,999
f. Between \$100,000 and \$150,000
g. Over \$150,000
h. Do not know
i. Prefer not to answer
8. What is the highest level of education that you completed?
Continues

Supplementary Table 1. Continued
a. Elementary school
b. Middle school
c. High school
d. College
e. Graduate school
f. Professional school
g. Doctorate
9. What phase of education/training are you currently in (for the 2020-2021 school year)?
a. Middle school
b. High school
c. College
d. Graduate school (Master's/PhD)
e. Medical school (MD/DO/MD PhD)
f. Medical residency
g. Medical fellowship (completed medical school and medical residency)
h. Nursing school
i. PA school
j. Not currently enrolled in an academic program (working/non-traditional student)
k. None of the above
10. How did you hear about this course?
a. Instagram
b. Facebook
c. Word of mouth
d. Twitter
e. TikTok
f. University/college
g. Do not recall
h. Other
11. Did you watch any part of the Netflix special, "Lenox Hill"?
a. Yes
b. No
12. Did watching the Netflix special "Lenox Hill" influence you to enroll in the course?
a. Yes
b. No
c. Unsure
d. N/A, did not watch
13. Were you aware of this course prior to watching "Lenox Hill"?
a. Yes
b. No
Continues

Supplementary Table 1. Continued
c. Unsure
d. N/A, did not watch
14. Did watching "Lenox Hill" increase your interest in pursuing a healthcare profession?
a. Yes
b. No
c. Unsure
d. N/A, did not watch
e. I do not intend on pursuing a healthcare profession
15. Do you have a family member(s) who works in a healthcare profession?
a. Yes
b. No
16. If yes, which best describes this role(s)? Please select all that apply
a. Physician (MD/DO)
b. Advanced care practitioner (NP, PA)
c. Nurse
d. Hospital administration
e. N/A, I do not have a family member in healthcare
f. Other (please specify)
17. What do you hope to gain from this course? Please select all that apply
a. Explore all healthcare fields (physician, nursing, physician assistant, hospital administration, etc.)
b. Explore the physician track in particular (MD/DO)
c. Explore neurosurgery in particular
d. Virtual OR shadowing
e. Insight into how COVID-19 was managed in hospitals
f. Lectures from physicians
g. Lectures from other healthcare workers (such as NPs, PAs, administrators, etc.)
h. Lectures from medical students
i. Opportunity to ask questions live
j. Lectures from women in the healthcare system
k. Lectures from people of color (POC) in the healthcare system
18. How has COVID-19 impacted your education? Please select all that apply
a. Canceled or modified classes
b. Canceled or postponed standardized exams (SAT, GRE, MCAT, USMLE, etc.)
c. Canceled scientific meetings/conferences
d. Canceled shadowing
e. Canceled volunteering opportunities
f. Canceled job/internship
g. Canceled research opportunities
Continues

Supplementary Table 1. Continued
h. Canceled study abroad
i. Delayed graduation date
j. Delayed application to college or professional school
k. Postponed or modified rotations in medical school
l. Canceled away rotations in medical school
m. Difficulty obtaining letters of recommendation
n. Canceled or modified residency interviews
o. Canceled in-school enrichment activities (lunch lectures, student club meetings, etc.)
p. Less face to face time with faculty
q. N/A, I am not enrolled in an academic program
19. Which educational enrichments activities were you able to participate in during the COVID-19 pandemic? Please select all that apply
a. In-person lectures/classes
b. Online lectures/webinars
c. Independent study
d. Remote research (chart review, meta analysis, systemic reviews, etc.)
e. COVID-related volunteering (such as equipment collection efforts)
f. Telemedicine initiatives
g. Summer/gap year job or internship
h. In-person Clinical Experiences (Shadowing, volunteering, scribing)
i. Other
20. Which platforms have you used while learning from home? Please select all that apply
a. Video conference (Zoom, WebEx, Skype, Facetime, etc.)
b. Pre-recorded lectures provided by your school
c. YouTube
d. Instagram
e. Facebook
f. Twitter
g. Microsoft Teams
h. Other
For those who marked "currently enrolled in medical school" on item 9-pleased answer items 21-31, then proceed to item 32. For all others, please proceed directly to item 32
Demographic questions specific to medical students:
21. Which medical school do you attend?
22. Which year of training are you in (for the 2020-2021 academic year)?
a. MS1
b. MS2
c. MS3
PA, physician assistant; NP, nurse practitioner; N/A, not available; MS, medical school; OR, operating room; ACP, advanced care practitioner.
Continues

Supplementary Table 1. Continued	
d. MS4	
e. Other (research year, MD/PhD, non-4 year program, etc.)	
23. Do you plan to take a research year?	
a. Yes	
b. No	
c. Unsure	
d. In progress	
24. Have you completed an internal medicine clerkship?	
a. Yes	
b. No	
c. In progress	
25. Have you completed a general surgery clerkship?	
a. Yes	
b. No	
c. In progress	
26. Have you completed a neurology clerkship?	
a. Yes	
b. No	
c. In progress	
27. Have you completed a neurosurgery elective?	
a. Yes	
b. No	
c. In progress	
28. Do you plan to complete a neurosurgery sub-internship?	
a. Yes	
b. No	
c. In progress	
29. Have you completed a scrub training session?	
a. Yes	
b. No	
c. In progress	
30. To what extent have you identified your field(s) of interest for residency applications?	
a. Only considering 1 field	
b. Considering 2-5 fields	
c. Considering 6 or more fields	
31. What areas do you seek improvement in? Please mark your top five (5) choices	
a. General background on internal medicine concepts	
b. Subspecialty knowledge not covered in core curricula	
c. General surgical etiquette	
d. Suturing skills	
Continues	

Supplementary Table 1. Continued	
e. Positioning patients	
f. Neurosurgical concepts	
g. Cardiology concepts	
h. Neurology concepts	
i. Radiology interpretation	
j. Interdisciplinary cooperation	
k. Knowledge of technology used in the OR	
l. Research methods	
m. Knowledge of medical technology	
n. Exposure to current medical literature	
o. Physical exam skills	
32. Do you have concerns that COVID-19 negatively impacted your medical education?	
a. Extremely concerned	
b. Very concerned	
c. Somewhat concerned	
d. Very slightly concerned	
e. Not at all concerned	
33. I am concerned that COVID-19 negatively impacted my medical education	
a. Strongly agree	
b. Agree	
c. Neutral	
d. Disagree	
e. Strongly disagree	
Items 34-45 will have answer choices presented on a 10-point Likert-type scale with an "N/A" option	
34. Likelihood of pursuing a track in healthcare <i>before</i> webinar?	
35. Likelihood of pursuing a track in healthcare <i>after</i> webinar?	
36. Likelihood of pursuing a career in neurosurgery <i>before</i> webinar?	
37. Likelihood of pursuing a career in neurosurgery <i>after</i> webinar?	
38. Likelihood of pursuing the physician track (MD/DO) <i>before</i> webinar?	
39. Likelihood of pursuing the physician track (MD/DO) <i>after</i> webinar?	
40. Likelihood of pursuing the NP track <i>before</i> webinar?	
41. Likelihood of pursuing the NP track <i>after</i> webinar?	
42. Likelihood of pursuing the PA track <i>before</i> webinar?	
43. Likelihood of pursuing the PA track <i>after</i> webinar?	
44. Likelihood of working in hospital administration <i>before</i> webinar?	
45. Likelihood of working in hospital administration <i>after</i> webinar?	
Items 46-83 will have answer choices presented on a 10-point Likert-type scale	
46. Knowledge of cranial anatomy <i>before</i> webinar?	
47. Knowledge of cranial anatomy <i>after</i> webinar?	
Continues	

Supplementary Table 1. Continued
48. Knowledge of spine anatomy <i>before</i> webinar?
49. Knowledge of spine anatomy <i>after</i> webinar?
50. Knowledge of intracranial trauma <i>before</i> webinar?
51. Knowledge of intracranial trauma <i>after</i> webinar?
52. Knowledge of intracranial congenital defects <i>before</i> webinar?
53. Knowledge of intracranial congenital defects <i>after</i> webinar?
54. Knowledge of brain tumors <i>before</i> webinar?
55. Knowledge of brain tumors <i>after</i> webinar?
56. Knowledge of epilepsy <i>before</i> webinar?
57. Knowledge of epilepsy <i>after</i> webinar?
58. Knowledge of cerebrovascular events/stroke <i>before</i> webinar?
59. Knowledge of cerebrovascular events/stroke <i>after</i> webinar?
60. Knowledge of spine trauma <i>before</i> webinar?
61. Knowledge of spine trauma <i>after</i> webinar?
62. Knowledge of congenital spine defects <i>before</i> webinar?
63. Knowledge of congenital spine defects <i>after</i> webinar?
64. Knowledge of spine malignancy <i>before</i> webinar?
65. Knowledge of spine malignancy <i>after</i> webinar?
66. Knowledge of degenerative disease of the spine <i>before</i> webinar?
67. Knowledge of degenerative disease of the spine <i>after</i> webinar?
68. Knowledge of technology used in the OR <i>before</i> the webinar?
69. Knowledge of technology used in the OR <i>after</i> the webinar?
70. Knowledge of OR procedures <i>before</i> the webinar?
71. Knowledge of OR procedures <i>after</i> the webinar?
72. Overall knowledge of neurosurgery <i>before</i> the webinar?
73. Overall knowledge of neurosurgery <i>after</i> the webinar?
74. Overall knowledge of neurology <i>before</i> the webinar?
75. Overall knowledge of neurology <i>after</i> the webinar?
76. Overall knowledge of cardiology <i>before</i> the webinar?
77. Overall knowledge of cardiology <i>after</i> the webinar?
78. Ability to interpret diagnostic imaging of the brain <i>before</i> the webinar?
79. Ability to interpret diagnostic imaging of the brain <i>after</i> the webinar?
80. Understanding of the postgraduate medical education (residency & fellowship) <i>before</i> the webinar?
81. Understanding of the postgraduate medical education (residency & fellowship) <i>after</i> the webinar?
82. If pursuing the physician track, how likely were you to apply to neurosurgical residency <i>before</i> the webinar? (If not applicable leave question blank)
83. If pursuing the physician track, how likely were you to apply to neurosurgical residency <i>after</i> the webinar? (If not applicable leave question blank)
Continues

Supplementary Table 1. Continued
84. What do you see as challenges to pursuing neurosurgery? Please select all that apply
a. Board exam scores
b. Length of training
c. Possibility of taking a research year
d. Publication volume
e. Lifestyle
f. Obtaining mentorship
g. Fewer available spots
h. Technical difficulty of neurosurgery
i. Incorporation of new technology into the field
j. None of the above
Items 45-94 will have answer choices presented on a 5-point Likert-type scale 1) Agree, 2) Somewhat agree, 3) Neither agree nor disagree, 4) Somewhat disagree, 5) Disagree
85. The course provided me with a comprehensive background on healthcare fields
86. The course provided me with a comprehensive background on the role of physicians in the healthcare system
87. This course provided me with a better understanding of the role of ACPs (PAs/ NPs) in the healthcare system
88. This course provided me with a better understanding of neurosurgery
89. This course provided me with a better understanding of cardiology
90. This course provided me with a better understanding of neurology
91. This course helped me review science concepts that were already covered in school
92. This course introduced me to new science concepts that were not yet covered in school
93. This course was a good use of my time in a remote learning environment
94. This course helped me replace some of the learning opportunities that were made unavailable due to COVID-19
95. The components of this course that best prepared me for a career in healthcare were: (check all that apply)
a. Neurosurgery subspecialty lectures (neuroradiology, neuromonitoring/neurophysiology)
b. Neurology lectures
c. Medical school prep
d. Virtual neuro-oncology OR
e. Cardiology lectures
f. ACP Corner presented by NPs/PAs
g. Virtual spine OR
h. Administration station presented by hospital administrators
i. Virtual cerebrovascular OR
PA, physician assistant; NP, nurse practitioner; N/A, not available; MS, medical school; OR, operating room; ACP, advanced care practitioner.
Continues

Supplementary Table 1. Continued
j. Innovation, research, and entrepreneurship discussions
k. Chairman's Corner presented by Dr. Langer
l. Special summer series
m. Women in medicine lectures
n. Diversity in medicine lectures
o. Neurosurgery research lectures
p. N/A, do not plan to pursue healthcare
96. The components of this course that did not directly prepare me for a career in healthcare were: (check all that apply)
a. Neurosurgery subspecialty lectures (neuroradiology, neuromonitoring/neurophysiology)
b. Neurology lectures
c. Medical school prep
d. Virtual neuro-oncology OR
e. Cardiology lectures
f. ACP Corner presented by NPs/PAs
g. Virtual spine OR
h. Administration station presented by hospital administrators
i. Virtual cerebrovascular OR
j. Innovation, research, and entrepreneurship discussions
k. Chairman's Corner presented by Dr. Langer
l. Special summer series
m. Women in medicine lectures
n. Diversity in medicine lectures
o. Neurosurgery research lectures
p. N/A, do not plan to pursue healthcare
97. How likely are you to recommend the webinar series to a friend?
a. Very likely
b. Likely
c. Neither likely nor unlikely
d. Unlikely
e. Very unlikely
98. Please let us know if you have any suggestions for materials to include in future sessions (type answers into the box below)
99. Approximately what percentage of classes did you attend in total (live on Zoom or on YouTube)?
100. What percentage of the classes that you attended were live on Zoom?
101. What percentage of the classes that you attended were on YouTube?
102. Did you complete the BRAINterns Webinar Series Survey in 2020?
a. Yes
b. No
103. Which of the following best describes how you felt about the length of the series?
Continues

Supplementary Table 1. Continued
a. I wish the series was longer than 3 weeks
b. I wish the series was shorter than 3 weeks
c. I thought 3 weeks was the right length for the series
PA, physician assistant; NP, nurse practitioner; N/A, not available; MS, medical school; OR, operating room; ACP, advanced care practitioner.

Supplementary Table 2. Prewebinar and Postwebinar Series Average Self-Rated Competency Scores for Overall Knowledge of Neurosurgery, Technology Used in the Operating Room and Operating Room Procedures Stratified by Sex, Household Income (U.S. \$/year), Current Phase of Education, Race, and of Having Family Member in Health Care

	Overall Knowledge of Neurosurgery		Knowledge of Technology Used in the OR		Knowledge of OR Procedures	
	Before	After	Before	After	Before	After
	<i>P</i>		<i>P</i>		<i>P</i>	
Overall (n = 3483)	3.795	7.047	3.567	6.735	3.721	6.787
	<0.0001		<0.0001		<0.0001	
Sex						
Male (n = 640)	3.909	6.914	3.795	6.769	3.880	6.713
	<0.0001		<0.0001		<0.0001	
Female (n = 2843)	3.769	7.077	3.515	6.727	3.685	6.804
	<0.0001		<0.0001		<0.0001	
Household income (U.S. \$/year)						
15,000 (n = 325)	4.249	7.606	3.920	7.351	4.148	7.397
	<0.0001		<0.0001		<0.0001	
15,000–29,999 (n = 329)	4.015	7.480	3.714	7.046	3.778	7.082
	<0.0001		<0.0001		<0.0001	
30,000–49,999 (n = 314)	4.070	7.366	3.809	7.035	3.898	6.997
	<0.0001		<0.0001		<0.0001	
50,000–74,999 (n = 333)	3.859	7.045	3.592	6.709	3.805	6.736
	<0.0001		<0.0001		<0.0001	
75,000–99,999 (n = 263)	3.692	7.004	3.551	6.665	3.829	6.817
	<0.0001		<0.0001		<0.0001	
100,000–150,000 (n = 403)	3.538	6.670	3.407	6.479	3.541	6.568
	<0.0001		<0.0001		<0.0001	
>150,000 (n = 372)	3.468	6.640	3.202	6.355	3.430	6.398
	<0.0001		<0.0001		<0.0001	
Race						
White (n = 827)	3.924	6.989	3.610	6.607	3.857	6.677
	<0.0001		<0.0001		<0.0001	
Asian (n = 1390)	3.560	6.815	3.474	6.592	3.443	6.575
	<0.0001		<0.0001		<0.0001	
Black/African American (n = 239)	4.004	7.438	3.713	7.025	3.858	7.025
	<0.0001		<0.0001		<0.0001	
Hispanic/Latino (n = 578)	4.122	7.468	3.736	7.190	4.043	7.247
	<0.0001		<0.0001		<0.0001	
Another race or ethnicity (n = 100)	4.060	7.620	3.660	7.010	3.900	7.190
	<0.0001		<0.0001		<0.0001	

OR, operating room.

Continues

Supplementary Table 2. Continued

	Overall Knowledge of Neurosurgery		Knowledge of Technology Used in the OR		Knowledge of OR Procedures	
	Before	After	Before	After	Before	After
	<i>P</i>		<i>P</i>		<i>P</i>	
Middle Eastern or North African (n = 197)	3.747	7.086	3.828	6.929	3.601	6.727
	<0.0001		<0.0001		<0.0001	
Native American or Alaska Native (n = 3)	6.333	10	6.333	9	6.333	9.333
	0.1194		0.3035		0.2028	
Native Hawaiian or other Pacific Islander (n = 12)	4.083	4.417	4.250	7.250	4.583	7.000
	0.7355		0.0023		0.0239	
Multiracial or multiethnic (n = 137)	3.482	6.737	3.321	6.380	3.409	6.453
	<0.0001		<0.0001		<0.0001	
Family member in health care						
Yes (n = 1527)	3.910	7.080	3.750	6.830	3.920	6.840
	<0.0001		<0.0001		<0.0001	
No (n = 1979)	3.700	7.020	3.420	6.650	3.570	6.740
	<0.0001		<0.0001		<0.0001	
Current phase of education						
Middle school (n = 18)	4.611	7.278	3.333	6.056	4.389	6.889
	0.0066		0.0035		0.0064	
High school (n = 894)	3.465	6.889	3.305	6.573	3.432	6.625
	<0.0001		<0.0001		<0.0001	
College (n = 1751)	3.646	6.933	3.467	6.649	3.589	6.702
	<0.0001		<0.0001		<0.0001	
Graduate school (Master's/Ph.D.) (n = 108)	4.380	7.361	3.898	7.194	4.130	7.093
	<0.0001		<0.0001		<0.0001	
Medical school (M.D./D.O./M.D.Ph.D.) (n = 360)	4.992	7.800	4.481	7.467	4.794	7.497
	<0.0001		<0.0001		<0.0001	
Medical residency (n = 14)	6.571	8.786	5.500	8.071	6.929	8.857
	0.0014		0.0013		0.0223	
Medical fellowship (n = 6)	3.333	8.333	5.000	9.000	3.833	7.500
	0.0036		0.0052		0.0196	
Nursing school (n = 27)	3.963	7.370	3.556	7.000	3.889	7.074
	<0.0001		<0.0001		<0.0001	
Physician assistant school (n = 8)	4.000	6.250	3.500	7.125	3.500	6.250
	0.0313		0.0003		0.0039	
Not currently enrolled in academic program (n = 245)	3.718	6.988	3.482	6.506	3.620	6.600
	<0.0001		<0.0001		<0.0001	

OR, operating room.

Supplementary Table 3. Prewebinar and Postwebinar Series Average Self-Rated Competency Scores for Ability to Interpret Diagnostic Imaging, Knowledge of Cranial and Spinal Anatomy, Cerebrovascular Events/Stroke, Spine Trauma, and Brain Tumors Stratified by Sex, Household Income (U.S. \$/year), Current Phase of Education, Race, and of Having Family Member in Health Care

	Average ability to interpret diagnostic imaging		Average knowledge of cranial anatomy		Average knowledge of spine anatomy		Average knowledge of cerebrovascular events/stroke		Average knowledge of spine trauma		Average knowledge of brain tumors	
	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After
	P value		P value		P value		P value		P value		P value	
Overall (n = 3483)	3.113	5.848	3.989	6.618	3.862	6.461	3.931	6.436	3.393	6.032	3.920	6.763
	<0.0001		<0.0001		<0.0001		<0.0001		<0.0001		<0.0001	
Sex												
Male (n = 640)	3.481	6.047	4.217	6.606	4.186	6.569	4.114	6.467	3.597	6.073	3.936	6.633
	<0.0001		<0.0001		<0.0001		<0.0001		<0.0001		<0.0001	
Female (n = 2843)	3.031	5.803	3.937	6.620	3.789	6.437	3.890	6.429	3.348	6.023	3.917	6.792
	<0.0001		<0.0001		<0.0001		<0.0001		<0.0001		<0.0001	
Annual household income												
<USD15,000 (n = 325)	3.609	6.631	4.563	7.314	4.502	7.126	4.548	7.182	4.040	6.877	4.502	7.471
	<0.0001		<0.0001		<0.0001		<0.0001		<0.0001		<0.0001	
USD15,000–29,999 (n = 329)	3.337	6.109	4.322	7.091	4.140	6.909	4.304	6.909	3.693	6.495	4.167	7.512
	<0.0001		<0.0001		<0.0001		<0.0001		<0.0001		<0.0001	
USD30,000–49,999 (n = 314)	3.609	6.631	4.338	6.946	4.137	6.850	4.162	6.691	3.611	6.366	4.156	7.038
	<0.0001		<0.0001		<0.0001		<0.0001		<0.0001		<0.0001	
USD50,000–74,999 (n = 333)	3.093	5.868	3.976	6.673	3.805	6.538	3.898	6.468	3.375	6.033	3.820	6.736
	<0.0001		<0.0001		<0.0001		<0.0001		<0.0001		<0.0001	
USD75,000–99,999 (n = 263)	3.019	5.764	3.822	6.426	3.821	6.243	3.833	6.354	3.255	5.894	3.753	6.544
	<0.0001		<0.0001		<0.0001		<0.0001		<0.0001		<0.0001	
USD100,000–150,000 (n = 403)	2.814	5.444	3.747	6.280	3.618	6.092	3.615	6.052	3.074	5.648	3.630	6.385
	<0.0001		<0.0001		<0.0001		<0.0001		<0.0001		<0.0001	
>USD150,000 (n = 372)	2.763	5.314	3.462	6.051	3.247	5.817	3.457	5.809	2.933	5.392	3.530	6.360
	<0.0001		<0.0001		<0.0001		<0.0001		<0.0001		<0.0001	
Current phase of education												
Middle school (n = 18)	3.278	4.833	3.333	5.333	3.333	5.167	3.500	6.111	3.000	4.833	5.111	6.667
	0.1256		0.0337		0.0514		0.0051		0.0631		0.1042	

Continues

Supplementary Table 3. Continued

	Average ability to interpret diagnostic imaging		Average knowledge of cranial anatomy		Average knowledge of spine anatomy		Average knowledge of cerebrovascular events/stroke		Average knowledge of spine trauma		Average knowledge of brain tumors	
	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After
	P value		P value		P value		P value		P value		P value	
High school (n = 894)	2.522	5.379	3.060	5.984	2.911	5.856	3.257	5.903	2.774	5.531	3.652	6.651
	<0.0001		<0.0001		<0.0001		<0.0001		<0.0001		<0.0001	
College (n = 1751)	3.003	5.797	3.905	6.559	3.745	6.356	3.755	6.335	3.248	5.954	3.691	6.577
	<0.0001		<0.0001		<0.0001		<0.0001		<0.0001		<0.0001	
Graduate school (Masters/PhD) (n = 108)	3.759	6.463	4.704	7.333	4.667	7.185	4.583	6.981	3.907	6.657	4.463	7.259
	<0.0001		<0.0001		<0.0001		<0.0001		<0.0001		<0.0001	
Medical school (MD/DO/MDPhD) (n = 360)	4.750	7.131	6.039	8.047	6.039	7.925	5.850	7.819	5.233	7.356	5.328	7.744
	<0.0001		<0.0001		<0.0001		<0.0001		<0.0001		<0.0001	
Medical residency (n = 14)	6.857	8.500	7.143	8.929	7.214	8.929	6.786	8.786	6.286	8.357	6.143	8.500
	0.0418		0.0116		0.0100		0.0035		0.0084		0.0034	
Medical fellowship (n = 6)	4.167	7.667	5.000	7.833	3.667	8.333	4.333	7.000	5.667	8.000	3.667	8.667
	0.0307		0.0788		0.0044		0.1449		0.1612		0.0022	
Nursing school (n = 27)	2.778	5.593	4.074	6.704	4.037	6.593	4.222	6.778	3.111	6.037	3.963	6.852
	<0.0001		<0.0001		<0.0001		<0.0001		<0.0001		<0.0001	
Physician assistant School (n = 8)	3.000	4.875	4.250	6.500	3.625	6.750	4.375	7.000	3.500	6.250	4.125	7.125
	0.0596		0.0004		0.0002		0.0037		0.0252		<0.0001	
Not currently enrolled in academic program (n = 245)	2.984	5.604	4.327	6.706	4.302	6.706	4.159	6.522	3.441	5.935	3.816	6.547
	<0.0001		<0.0001		<0.0001		<0.0001		<0.0001		<0.0001	
Race												
White (n = 827)	3.232	5.746	4.261	6.571	4.112	6.355	4.141	6.355	3.511	5.777	4.007	6.583
	<0.0001		<0.0001		<0.0001		<0.0001		<0.0001		<0.0001	
Asian (n = 1390)	2.984	5.685	3.716	6.425	3.648	6.287	3.670	6.212	3.224	5.880	3.709	6.608
	<0.0001		<0.0001		<0.0001		<0.0001		<0.0001		<0.0001	
Black/African American (n = 239)	3.271	6.121	3.942	6.821	3.788	6.667	4.138	6.696	3.467	6.350	4.113	7.179
	<0.0001		<0.0001		<0.0001		<0.0001		<0.0001		<0.0001	

Hispanic/Latino (n = 578)	3.250	6.307	4.279	7.088	4.109	6.914	4.210	7.016	3.619	6.616	4.188	7.176
	<0.0001		<0.0001		<0.0001		<0.0001		<0.0001		<0.0001	
Another race or ethnicity (n = 100)	3.590	6.380	4.230	6.850	4.090	6.890	4.260	6.910	3.630	6.320	4.510	7.470
	<0.0001		<0.0001		<0.0001		<0.0001		<0.0001		<0.0001	
Middle Eastern or North African (n = 197)	3.040	5.904	3.970	6.561	3.692	6.389	3.687	6.288	3.409	6.131	3.788	6.758
	<0.0001		<0.0001		<0.0001		<0.0001		<0.0001		<0.0001	
Native American or Alaska Native (n = 3)	5.333	9.000	6.333	9.333	5.333	9.333	7.333	8.333	6.667	8.000	6.333	10.000
	0.2318		0.2595		0.0058		0.6745		0.5615		0.1194	
Native Hawaiian or other Pacific Islander (n = 12)	4.250	6.250	5.500	7.250	4.667	7.417	5.500	7.583	3.667	6.667	6.000	8.000
	0.0637		0.0932		0.0133		0.0383		0.0072		0.0511	
Family Member in Healthcare												
Yes (n = 1527)	3.220	5.910	4.080	6.660	3.970	6.520	4.050	6.540	3.500	6.080	4.000	6.820
	<0.0001		<0.0001		<0.0001		<0.0001		<0.0001		<0.0001	
No (n = 1979)	3.040	5.800	3.910	6.580	3.770	6.410	3.840	6.360	3.310	5.990	3.850	6.720
	<0.0001		<0.0001		<0.0001		<0.0001		<0.0001		<0.0001	