DivulgaMicro is a Brazilian Science Communication and Outreach project run by three young female scientists. In 2020, due to the COVID-19 pandemic, we promoted the first virtual edition of the DivulgaMicro Workshop. Here, we describe adaptations implemented to deliver the virtual edition, and its assessment by the participants. We offered a 3-day workshop addressing manuscript writing and publishing, poster design and oral presentations, and strategies for effectively communicating with the lay public, on the first, second, and third days, respectively. Each daily session was divided into short lectures and active learning through interactive and cooperative activities. We applied pre- and postsession surveys daily to assess participants’ learning and an opinion questionnaire at the end of the workshop. We selected 50 of 221 applicants, but only 38 participants took the course. Correct answers were significantly higher ($P < 0.01$) in the post-session surveys each day. Most of the 34 participants who answered the opinion questionnaire (97%) would recommend the workshop to their colleagues. Participants stated the workshop content was transmitted clearly and straightforwardly and considered the online format suitable for knowledge acquisition. Participants were satisfied with the organization, dynamics, and interactivity. Topics addressed on the third (61.8%) and first days (23.5%) were most liked and were considered most useful in the participants’ careers. We believe that the overall success of the workshop is due to the combination of short lectures with active learning activities, the use of virtual platforms that enabled effective communication between participants and instructors, and the support of our collaborators.

INTRODUCTION

There is a growing understanding that science communication skills are essential for several aspects of science and society. Science communication training and resources can increase appreciation and understanding of science, create/strengthen networks, debunk misinformation, influence decision-making and policy, among others (1). Altogether, these benefits seek to effectively promote changes in society. Personal benefits, including increased confidence to communicate with experts and nonexperts and a heightened sense of belonging at scientific meetings, can also be achieved, especially for early-career scientists (1). In the last decades, science communication has established itself as a research field to be addressed in universities across the world as a discipline for undergraduate and graduate students and also as a master’s degree program (2). Such activities have had a significant breakthrough in Brazil in recent years, despite
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some limitations. One of the great current challenges of science communication in Brazil concerns the quantity, quality and geographical distribution of training courses throughout the country, which in general are concentrated in the urban centers of the Southeastern and Southern regions (3, 4). Thus, the offering of online science communication training courses could reach stakeholders in different regions of Brazil and allows the professional development of journalists, scientific communicators, undergraduate and graduate students, and early-career scientists (4).

DivulgaMicro is a Brazilian Science Communication and Outreach project that aims to develop young scientist’s communication skills, as well as to promote the public understanding of science. The project is run by three young female scientists from Brazil and it has been supported by American Society for Microbiology (ASM) since its beginning in 2018. Our activities are based on two main cornerstones: we provide educational resources and science communication content via our website (http://www.divulgamicro.com.br/en/index.html) and our social media accounts (@divulgamicro), and we offer on-site science communication workshops throughout Brazil (5).

Every year we promote at least five on-site DivulgaMicro Workshops in universities or scientific meetings; one in each of the five Brazilian geographical regions. It is a 1-day-long workshop that addresses several aspects of science communication, including best practices for preparing manuscripts and posters, as well as tips for preparing oral presentations and strategies to communicate effectively with the lay audience (5). Since its launching, DivulgaMicro has promoted 11 editions of our workshop, reaching nearly 600 Brazilian graduate and undergraduate students as well as early-career scientists (6). In Brazil, initiatives to train students and early-career scientists in science communication are still rare, stating the importance of our initiative (7).

In 2020, due to the COVID-19 pandemic, in-person activities in Brazil and across the globe were put on a break. Soon after, the World Health Organization (WHO) declared COVID-19 a pandemic in March 2020, quarantine and social distancing became a reality in people’s life around the world (8). In Brazil, universities have reduced research activities to a minimum, and have adapted the in-person teaching activities to the remote environment, including both synchronous and asynchronous classes (9, 10). In-person teaching represents most educational courses in Brazilian higher education institutions. For that reason, many professors do not have the expertise required to organize and run online educational courses and have been struggling to adapt their in-person courses to remote teaching (9, 11). Online educational and professional development courses are well recognized as effective in delivering knowledge to students and other intended audiences (1, 12, 13). However, there are still many challenges in keeping online courses engaging and effective in delivering information.

In this scenario, the on-site DivulgaMicro Workshop was adapted to the online format. To keep a highly engaged and informative workshop, we invited a team of scientists to help us develop this new format. To assess participant’s learning gain, their socioeconomic profile, as well as their level of engagement in the online format, we applied pre- and post-session surveys, and socioeconomic and opinion questionnaires. The present work describes the adaptations implemented in DivulgaMicro Workshop to migrate from the in-person to a virtual format, as well as the general perception and knowledge acquisition by the participants. Our aim in this study was to answer two questions: Does an online professional development workshop increase participants’ knowledge of science communications skills? And can we have engaging workshops even in the virtual environment? The information provided here can be replicated by others to turn in-person workshops to the online format and might foster the development of online versions of training courses on science communication across the world.

METHODS

Participants selection process

Workshop candidate attendees filled out an online application form about their demographic and educational background, and they also stated their motivation to participate in the workshop (see Appendix 1). Based on these criteria, we conducted a blind recruitment process and selected 50 participants. Since our workshop aims at giving the participants an introduction on science communication topics, we prefentially selected people with less experience on the subject. To select a diverse group of participants, we also took into account the geographical region of the applicants, as well as if they self-reported as being part of a minority group.

Study design

The online version of DivulgaMicro Workshop was a 24-h course (8 h per day) offered between September 21 and 23, 2020. The original content of the workshop was maintained (5), but it was adapted to a 3-day workshop format. The in-person DivulgaMicro Workshop is 1 day long and is offered since 2018 in universities and scientific conferences across the country (5). Here, we describe the adaptations we have made to convert the DivulgaMicro Workshop from the in-person to the remote environment. Briefly, on the first day we explored the best practices for writing manuscripts and publishing scientific articles, where we addressed the basic structure of a scientific manuscript; the importance of sending a clear message; how to organize your data into figures and tables; and the submission process to a journal. On the second day, we talked about best practices for poster design and presentation, as well as oral
presentation at scientific meetings, being that we delved into face-to-face communication process; how to prepare for lectures, seminars and videoconference; and recommendations on formatting posters to conferences and how to prepare its presentation. During the last day, we addressed strategies for effective communication with the lay public, where we discussed storytelling and journalism techniques applied to science outreach; how to use social media to talk with society; and how to organize and run science communications events.

Each daily session was divided into short lectures, followed by active learning activities to be performed by the students, in groups. Participants were divided into 10 groups of five people each and were instructed to work cooperatively to perform the exercises assigned. During the activities, instructors would mentor different groups to facilitate discussion and help them develop their ideas into completing the exercises. Every hands-on activity in groups was followed by a discussion among instructors and participants. On the first day, each group had to write an abstract (250 words) based on a scientific data set prepared by the DivulgaMicro team; on the second day, they used their own abstracts to: (i) write a pitch (up to 3-min speech), (ii) prepare a poster draft, and (iii) make a three-slide oral presentation for a scientific meeting. On the third day, the abstract was used to prepare content focusing on the lay public for three different social media, at their choice, Twitter, Instagram or Facebook, such content was then posted at DivulgaMicro’s social media.

We used the Zoom video conferencing platform to broadcast the workshop sessions in a synchronous format. We used the breakout rooms tool offered by Zoom to divide participants into groups, and Google Drive so they could work together in real time during the group activities. In parallel, we used Slack for text communication between participants and instructors during and after classes. We also created channels in Slack for each group, so instructors could talk to participants from each group about activities. We used Google Drive for sharing suggested readings, the course program, and other files.

To help us with the logistics and with the content of the workshop, we invited a team of scientists with a science communication background. They helped us develop the online format of the workshop, acted as speakers, and helped us assist the participants throughout the workshop.

Evaluation questionnaires

To evaluate this new workshop format, we asked the participants to fill in different questionnaires using the Google Forms application. At the beginning of the workshop, participants completed a sociodemographic questionnaire, as well as a questionnaire about their prior knowledge on general aspects of the workshop content (see Appendix 1). To assess participants’ learning gain, we applied in each day a pre- and post-session multiple-choice questions survey, covering the content of the day. Finally, at the end of the workshop, participants evaluated the entire workshop through an opinion questionnaire (see Appendix I). The last four items of the opinion questionnaire were open-ended questions to give a chance for participants to express their opinion.

The ethical committee of Universidade Federal do Rio de Janeiro (CAAE: 28948019.0.0000.5257) approved this study. All participants signed a consent and authorized the publication of data collected in the questionnaires.

Statistical analysis

Both sociodemographic and opinion questionnaires were analyzed similarly. The open-ended questions were analyzed qualitatively, and closed-ended questions were analyzed quantitatively, where the frequency of each answer was expressed in percentage.

Data for the multiple-choice questions applied every day are reported as the number of correct responses per session compared with postsession. The participants’ performance data set consists of, on average, 33 answers by day, since not all participants answered all questionnaires every day. All statistical analyzes were performed in R Software (14). We used the Shapiro-Wilk to test data normality and the Wilcoxon signed-rank test to evaluate the significance. The formula (postsession – presession)/(1 – presession) was used to calculate the normalized learning gains (15). Statistical significance was considered when $p$ was <0.01.

RESULTS

Participant selection and sociodemographic questionnaire

A total of 221 candidates applied to the workshop from all the five geographical regions of Brazil. After the blind recruitment process, we selected 50 participants. At the end, 38 participants took the workshop, and 33 (87%) participants were women.

Thirty-five participants answered the sociodemographic questionnaire. Participants’ age ranged from 17 to 34 years old, but most of them (63%) were 21 to 25 years. Most (60%) participants lived in the Southeast region of Brazil, followed by Northeast (14.3%), Midwest (14.3%), and North (11.4%) regions. Regarding the academic degree, most participants were graduate (40%) or undergraduate (37.2%) students. We also asked the participants to indicate the scientific field in which they act, according to the Brazil’s Ministry of Education classification (16). Biological Sciences was the most frequent answer (45.7%), followed by Health Sciences (25.7%), Exact and Earth Sciences (17.1%), Agricultural Sciences (8.6%), and Engineering (2.9%).

We also assessed the participants’ previous experience in
science communication. Overall, 60% of participants had never taken a course to improve their science communication skills, and nearly 70% declared they had never submitted a manuscript for publication in a scientific journal. Regarding the experience in preparing and presenting a poster in a scientific meeting, 40% of participants had never submitted an abstract to a scientific meeting, 34.3% participants had already presented a poster in up to three scientific meetings, and 25.7% had the experience of presenting a poster in more than three scientific meetings. Approximately half (51.4%) of participants had never have any previous contact with activities focusing on communicating science to the lay public.

**Student performance**

Groups successfully executed all assigned activities (first day: 250-word abstract; second day: a pitch, a poster draft and an oral presentation for a scientific meeting; third day: publication for social media), considering the relatively short time frame they had (Fig. 1).

Overall, postsession surveys had higher percentages of corrected answers in all days (Fig. 2). Interestingly, best practices for writing and publishing scientific articles, explored in the first day, was the topic least previously known by the participants, with less than 25% of correct answers in three out of five questions in the preworkshop questionnaire (Fig. 2a). However, the question that asked if there is a difference between scientific article and manuscript (Q1, Day 1) (Fig. 2a) and the question that inquired about what should first come to mind when communicating with the nonspecialized public (Q2, Day 3) (Fig. 2c) had fewer than 50% of correct answers in the postsession questionnaires. Interestingly, the number of correct answers to the question “When we are planning an in-person science communication event, what should we plan first?” (Q4, Day 3) (Fig. 2c) decreased in the postsession questionnaire.

When assessing participants’ learning gain by day, the overall correct answers were significantly higher ($P<0.01$) in the postsession questionnaires, every single day (Fig. 3), being that the normalized learning gains by day were 0.36, 0.53, and 0.28 considering the first, second, and third day, respectively.

**Opinion questionnaire**

Thirty-four (89.5%) of the 38 participants filled out the opinion questionnaire, which was designed to evaluate participants’ level of satisfaction and collect feedback that will
FIGURE 2. Average frequency of correct answers in the pre- (black) and post-session questionnaire (red), from each question (Q1, Q2, Q3, Q4 and Q5), from the first (A), second (B) and third (C) days.
be used to improve future DivulgaMicro Workshops. Overall, participants enjoyed the workshop and declared that they would recommend it to their colleagues. Participants also stated that the workshop content was transmitted clearly and straightforwardly, and that they acquired knowledge on science communication.

Participants were satisfied with the workshop organization, dynamics, and interactivity. They also considered the online format suitable for knowledge acquisition. Participants approved both the workshop content and the speakers’ performance. They liked the way we conducted the workshop, with short lectures and active learning-based activities (Table 1). Participants liked the third day (61.8%) and the first day (23.5%) the most. These sessions were also considered by the attendees as the most useful in their careers (41.2% votes each).

When asked “What do you believe made your knowledge acquisition in the online format easier?” and “What did you like the most about the workshop?”, participants acknowledged the interactive format of the workshop with hands-on group activities, the speakers, and the content addressed. Answers included sentences like “What I liked the most was the hands-on group activities,” “I loved everything! The dynamics, the interactivity, the content, and the speakers!,” “I liked the content addressed, the speakers and the network with people from different regions of the country.” When answering “What do you believe made your knowledge acquisition in the online format more difficult?,” the vast majority of the participants stated that technological limitations, especially Internet connection instability, were the main cause of difficulties faced during the workshop.

The last open-ended question was “What did you not like about the workshop?”. Some people felt that the 3-day workshop was exhausting, others complained about the schedule delays that occurred over the workshop and, for some people, the time to perform the hands-on activities should be extended. However, most participants declared they were satisfied with all aspects of the workshop, and sentences such as “Everything was great.” “I have nothing to complain about. I learned a lot!,” “I liked everything, congratulations!” were predominant among the answers.

DISCUSSION

The 2020 DivulgaMicro Workshop gathered a diverse group of students and early-career scientists from different regions of Brazil, acting in different scientific areas, and showing different backgrounds regarding previous knowledge on science communication. The online format enabled the attendance of participants from more diverse regions from Brazil, as most in-person workshops take place at capitals, larger cities or academic centers. Overall, participants had never had a science communication training and had little or no experience in the field. This is a reality in the academic community, since it is still rare for undergraduates and graduates to have formal training to develop science communication skills (17). Such students usually struggle to prepare well-written scientific articles and abstracts for scientific conferences, to produce engaging and visually attractive posters, and to communicate science to the lay public. In addition, they rarely have the necessary know-how about the process of submitting and publishing scientific manuscripts (1, 18–20). This scenario reinforces and justify initiatives like the DivulgaMicro Workshop.

After the daily sessions, participants improved their knowledge on the topics addressed, indicating the workshop contributed to their professional development on science communication. The combination of short
lectures to introduce a subject followed by active learning activities contributed to that and is especially beneficial in online learning (21). Short lectures are a good way to deliver new concepts, but active learning—here employed by hands-on cooperative group activities—has been shown to result in higher achievement, greater retention and more positive feelings about the subject (22). In addition, hands-on experience has already proven to be a valuable resource in science communication training (23).

However, when we analyzed some specific questions of the pre- and post-session surveys, we noticed that some points of the workshop’s content can be improved, as well as the need to review these questions. Surveys are useful tools to assess short-term effectiveness of training courses on improving professional development skills, and they have been extensively used to evaluate in person and online training courses (1, 24). The next step will be reviewing the content that addressed those questions to make improvements.

Participants stated that the topics of communicating science with the lay public and scientific writing and publishing were the most attractive and useful for their careers. Overall, they approved the workshop format and content, and considered that it enhanced their knowledge and improved their science communication skills. The interactive and dynamic format of short lectures followed by hands-on group activities in Zoom’s breakout rooms were also highly praised by the participants. Zoom’s breakout rooms and group’s channel on Slack enabled closer and direct student-speaker and student-student interactions, which are common in in-person courses, and are rare but essential features of a well-designed online course to promote student learning. This was actually the main reason to extend the workshop length, so participants would have more time to perform activities and interact with their colleagues and with the instructors. We observed that participants’ impressions regarding the workshop format are in accordance with previous studies that showed well-designed online courses can be as effective as the in-person ones (24, 25). Moreover, Zoom is a dynamic and user-friendly video conferencing platform that provides a wide range of features to promote students’ engagement and learning, including breakout rooms, live chats, and screen sharing; while Slack is a digital workspace for collaborative activities that enables direct, fast and efficient communication among users; Google Drive is another user-friendly tool that facilitates group activities as participants and instructors can work together on documents in real time. As well as in the online version of DivulgaMicro Workshop, Zoom, Slack, and Google Drive have been useful in other initiatives of remote teaching to facilitate students’ learning, and can be implemented by teachers with basic informatics experience (26–27).

The feedback we received through the open-ended questions of the opinion questionnaire indicated that the participants were very satisfied with the workshop dynamic. Most comments were about the high quality of speakers and the content addressed in the workshop. However, participants pointed out some topics that could be improved in future online editions of the DivulgaMicro

### TABLE 1

<table>
<thead>
<tr>
<th>Questions</th>
<th>Answers (%) – score from 1 to 5&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>In general, what is your opinion on the conduction of the workshop?</td>
<td>0.0 0.0 0.0 14.7 85.3</td>
</tr>
<tr>
<td>Was the content of the workshop transmitted clearly and straightforwardly?</td>
<td>0.0 0.0 0.0 8.8 91.2</td>
</tr>
<tr>
<td>How much do you consider the workshop contributed to the acquisition of new knowledge?</td>
<td>0.0 0.0 2.9 14.7 82.4</td>
</tr>
<tr>
<td>Would you recommend the online DivulgaMicro Workshop to colleagues?</td>
<td>0.0 0.0 2.9 2.9 94.1</td>
</tr>
<tr>
<td>With regard to conducting the workshop in the online format, evaluate the following aspects:</td>
<td></td>
</tr>
<tr>
<td>Organization</td>
<td>0.0 2.9 0.0 29.4 67.6</td>
</tr>
<tr>
<td>Dynamic</td>
<td>0.0 0.0 5.9 8.8 85.3</td>
</tr>
<tr>
<td>Interactivity</td>
<td>0.0 0.0 0.0 5.9 94.1</td>
</tr>
<tr>
<td>Suitable for knowledge acquisition</td>
<td>0.0 0.0 0.0 20.6 79.4</td>
</tr>
<tr>
<td>Content quality</td>
<td>0.0 0.0 0.0 0.0 100</td>
</tr>
<tr>
<td>Performance of instructors (speakers)</td>
<td>0.0 0.0 0.0 11.8 88.2</td>
</tr>
<tr>
<td>What is your opinion about the approach used in the workshop, combining short lectures with active learning-based activities?</td>
<td>0.0 0.0 2.9 20.6 76.5</td>
</tr>
</tbody>
</table>

<sup>a</sup> Five-point scale: 1 = Awful, 2 = Poor, 3 = Regular, 4 = Good, 5 = Excellent

The data represent the answers from 34 workshop participants.
Workshop. Some participants considered the 3-day schedule of the workshop sessions long and somewhat tiring and suggested the inclusion of asynchronous speaker presentations in the workshop program, because of some technical issues they experienced due to instabilities in the Internet connection.

The remote teaching is an educational practice whose effectiveness had already been demonstrated; however, until 2020 it was mostly applied to hybrid courses and for distance learning purposes (24, 28). For instance, in Brazil, remote teaching has been explored by Fundação Oswaldo Cruz (FIOCRUZ) to offer a training course on science outreach, available in the Massive Open Online Course (MOOC) format (campusvirtual.fiocruz.br/gestordecursos/hotis/divulgacao-cientifica-mooc/). In addition, educational online platforms like Coursera (coursera.org) and Stanford Online (online.stanford.edu/) have been widely used for knowledge dissemination in several scientific areas, including science communication. Now, due to the COVID-19 pandemic, remote teaching environments became imperative to all kinds of educational activities, although challenges in delivering effective content in an engaging way in the online format exist. Giving participants the opportunity to evaluate the course through open-ended questions allowed us to be aware of what worked for them and what did not work so well, and to evaluate the usefulness of the workshop on addressing the students’ career needs (1). The format adopted to migrate the DivulgaMicro Workshop from the in-person to the online environment can be applied by others and proved to be effective in promoting the students’ professional development.

Based on our experience, we believe the overall success of our workshop—from enhancing participant’s learning on science communications skills to the participants’ approval of the online workshop format—could be mostly explained by three points: (i) the combination of short lectures with active learning activities contributed to the participant’s increased knowledge acquisition; (ii) the use of Zoom, Slack and Google Drive to communicate effectively with the students, also enabling communication between them, provided a more friendly and interactive environment; and (iii) the efforts and support of our collaborators, from the online workshop format planning to the participation in the workshop as speakers and assistants, that really enriched the workshop experience. We recommend other on-site workshops aiming at going online to apply one or more practices here described to provide a successful workshop experience.

SUPPLEMENTAL MATERIAL

Appendix I: Questionnaires of DivulgaMicro workshop online

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