

Measuring the Impact of a Science & Technology Communication Workshop on Participants' Attitudes

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ABSTRACT

Effective science communication is crucial for public engagement, policy influence, and research support, yet many scientists struggle to convey complex concepts to non-expert audiences. To address this challenge, the Council of Scientific and Industrial Research-National Institute of Science Communication Policy Research, in collaboration with Global Health Strategies, conducted a Science & Technology Communication workshop in June 2024. This study evaluates the workshop's impact through pre and post-workshop surveys based on Social Cognitive Career Theory (SCCT), assessing participants' confidence, skills, and perceptions in science communication abilities, particularly in writing, verbal engagement, and social media use. Participants reported increased confidence, a greater appreciation for science communication, and an intention to integrate these skills into their careers. Interactive elements such as group discussions and hands-on exercises were especially effective. The workshop exceeded expectations, highlighting the need for continued training and support to sustain skill development and long-term engagement in science communication.

Introduction

In today's world, where science and technology are central to societal progress, effectively conveying scientific knowledge to the public is more critical than ever. However, translating

complex scientific ideas for a general audience presents a substantial challenge. This communication gap contributes to public mistrust and misunderstanding of science, impacting government regulation and science policy (Hunter, 2016). Good science journalism has the potential to bridge this divide, but several factors often complicate the relationship between scientists and science communicators/science journalists. Many scientists need help explaining intricate concepts to laypeople due to discipline-specific jargon and a lack of formal training in science communication. Effective communication requires deliberate practice and a clear understanding of the audience's existing knowledge. Unfortunately, most scientists do not receive formal training in communicating their work to the public, and opportunities for such training are limited (Darling-Hammond *et al.*, 2019).

Despite the growing acknowledgment of science communication as an essential skill, few science programs include coursework that offers practical experience in this area. Science outreach events, particularly those that involve active, hands-on learning, can help fill these educational gaps. These events increase interest in STEM fields and teach scientific concepts through direct engagement with STEM professionals. They provide scientists with valuable opportunities to develop their communication skills by interacting with a diverse audience. STEM graduate students, often at the forefront of scientific research, play a crucial role as communicators during outreach activities. These interactions benefit both the participants, who better understand scientific concepts, and the graduate students, who enhance their ability to communicate effectively early in their careers (Brownell *et al.*, 2013; Brownell *et al.* (2), 2013; Kompella *et al.*; 2020).

To address the issue of science communication, it is essential to recognise scientists' unique challenges when trying to convey their work to the public. The specialised language and technical details inherent in scientific research can be significant barriers to understanding. Without proper training, scientists may struggle to translate their findings into accessible language that resonates with a broader audience. This disconnect can lead to public skepticism and a lack of support for scientific initiatives, influencing policy decisions and funding allocations.

The relationship between scientists and science communicators/science journalists is another critical factor in effective science communication. Journalists play a key role in translating scientific findings for the general public, but their interactions with scientists can be challenging. Scientists may be wary of being misquoted or having their work oversimplified, while journalists may struggle to convey complex scientific ideas accurately within the constraints of their medium. Building stronger relationships between scientists and journalists through mutual understanding and respect for each other's roles can improve the quality of science reporting. Scientists can benefit from media training that helps them navigate interviews and convey their messages clearly, while journalists can better appreciate scientific research's nuances. Improving science communication requires a multifaceted approach that includes education, outreach, and collaboration between scientists and the media. By prioritising communication skills in science education, providing opportunities for practical experience, and fostering positive relationships with journalists, the scientific community can bridge the gap between complex scientific concepts and the general public. This, in turn, can lead to greater public understanding and support for science, influencing policy decisions and funding in ways that benefit society (Wilkes, 2002; National Academies of Sciences, Engineering, and Medicine, 2017; Huntington *et al.* 2002, San-Valero *et al.*, 2019).

To address the need for a training program for science communication, a Science & Technology Communication workshop was conducted by the Council of Scientific and Industrial Research-National Institute of Science Communication Policy Research, New Delhi, in collaboration with Global Health Strategies in June 2024. The workshop aimed to equip participants with key skills for effectively and engagingly conveying scientific concepts. The surveys were designed to evaluate the workshop's impact on improving participants' communication abilities and altering their perspectives on science communication. By administering pre- and post-workshop surveys, we sought to assess changes in participants' confidence and intentions as a result of the training.

The workshop centered around several key themes:

1. Mastering Stakeholder Interactions: A Guide to External Communications - Equipping participants with strategies to engage effectively with diverse stakeholders.
2. Understanding Messaging & Simplifying Science - Techniques for distilling complex scientific information into accessible messages.
3. Making S&T Go Viral: Communications for Social Media - Leveraging social media platforms to broaden the reach of scientific communication.
4. A Simulation Exercise: Manage Communications in Real-Time - Practicing real-time communication strategies through simulated scenarios.

The pre- and post-surveys were based on previous research that integrates Social Cognitive Career Theory (SCCT) with sociolinguistic theories of identity development, suggesting that an individual's self-efficacy and outcome expectations are pivotal in fostering interest and setting goals for pursuing a career in a specific domain. By enhancing science communication skills—defined as writing, speaking, and presenting—participants gain practical competencies and strengthen their science identity, which has been shown to increase the intention to pursue research careers (Dahlstrom *et al.*, 2022; Iksan *et al.*, 2012). While writing, speaking, and presenting may not initially attract individuals to research careers, they are essential for success. Previous studies found that science communication outcome expectations and science communication productivity directly predicted research career intentions, while science communication self-efficacy had an indirect effect through outcome expectations. Engaging in science communication and receiving active mentoring in these skills significantly influenced persistence in doctoral and postdoctoral research careers. Additionally, they found that frequency of engagement, rather than quality, was the key predictor of persistence. Further, mentoring effects were based on engagement rather than specialised techniques. Encouraging trainees to frequently engage in all forms of science communication—writing, presenting, and spontaneous

speaking—can strengthen their science identity and increase their intention to continue in research. These findings emphasised the importance of integrating SC training and mentoring into research career development (Cameron *et al.*, 2020).

India's scientific institutions have been increasingly recognising the need for effective science communication. Government initiatives like the Scientific Social Responsibility (SSR) guidelines and STIP 2020 have recently included science communication as a part of their guidelines, thus highlighting this shift (Scientific Social Responsibility Guidelines, 2022). In a recent SciComm-Thinklabs report, FAST-India emphasised the need to design tailored science communication training programs for students and scientists in India and identified popular science writing and digital content creation as key training needs, with scientists prioritising public engagement. A structured science communication training framework should integrate theory, multimedia skills, ethics, and experiential learning. Strengthening science-media collaboration through formal programs and clear guidelines is crucial. Scientists should actively communicate research, while the media should ensure accuracy and balance, fostering public trust and deeper engagement with science through accessible storytelling (SciComm Thinklabs Report, 2024).

Our study focuses on evaluating the change in participants' perceptions and skills, asking questions such as:

- Has the workshop positively changed your opinion on the importance of communicating science to the layperson?
- How confident are you in your ability to communicate science through writing, verbally, and via social media after this workshop?
- Which sessions did you find most interesting?
- Has your intention to pursue science communication in your future career changed positively after this workshop?

This study's results can inform future initiatives aimed at improving science communication skills and fostering a culture of clear and impactful science dissemination.

Methods

The pre-workshop survey was distributed to the participants before the beginning of the workshop and the post-workshop surveys were distributed at the end of the workshop. Participation was limited to 20 individuals, of which 16 completed the survey, providing valuable insights into the workshop's effectiveness. Both of these surveys received ethical approval from the institutional review committee (NIScPR/CoA/2024, dated 11/06/2024). The background of the participants included science communicators, teachers, researchers and educators from various backgrounds, such as life sciences, physics, astronomy, etc. All responses remain confidential, emphasizing the study's academic purpose and ensuring participants' privacy.

Pre and Post-Survey Design for the Workshop on Science & Technology Communication

The pre and post-surveys were developed to evaluate the workshop's impact on participants' self-efficacy, outcome expectations, and goals related to science communication (see Supplementary file for details).

Assessment of Self-Efficacy

Self-efficacy refers to an individual's confidence in their ability to perform specific tasks. The surveys included many questions measuring participants' large confidence in key aspects of science communication before as well as after the workshop and this data was used to evaluate the workshop's effect.

Writing:

Pre-survey: "You are confident in your ability to communicate science through writing."

Post-survey: "How confident are you in your ability to communicate science through writing after this workshop?"

Verbal Communication:

Pre-survey: "You are confident in your ability to communicate science verbally."

Post-survey: "How confident are you in your ability to communicate science verbally after this workshop?"

Social Media Use:

Pre-survey: "You are confident in your ability to use social media to communicate science."

Post-survey: "How confident are you in your ability to communicate science through social media after this workshop?"

These questions were designed to gauge initial confidence levels and identify perceived growth or changes in confidence resulting from the workshop.

Assessment of Outcome Expectations

Outcome expectations reflect what participants believe will result from engaging in science communication activities. To address this, the surveys asked participants about their perception of the importance of science communication:

Importance of Communicating Science to the Layperson:

Pre-survey: "It is important to communicate science to the layperson."

Post-survey: "Your opinion on the importance of communicating science to the layperson has changed positively after this workshop."

By comparing responses from pre- and post-surveys, we could assess whether the workshop shifted participants' attitudes toward the value and impact of science communication.

Assessment of Goals and Career Intentions:

To understand the participants' aspirations and long-term goals related to science communication, we included questions focused on their intentions to pursue science communication:

Career Goals:

Pre-survey: "You intend to pursue science communication in your future career."

Post-survey: "Your intention to pursue science communication in your future career has changed positively after this workshop."

These questions captured participants' career-related goals and whether the workshop influenced their motivation to incorporate science communication into their professional trajectory.

Session-Specific Feedback

Participants were also asked about their interest in and engagement with specific sessions to evaluate which components of the workshop were most effective:

Pre-survey: "Which sessions are you most interested in?"

Post-survey: "Which sessions did you find most interesting?"

This allowed us to assess the alignment of participants' expectations with their actual experiences and identify the sessions that contributed most to their learning outcomes.

Results and Discussion

Participant Characteristics

The workshop participants primarily belonged to the 26–35 age group (10 individuals), with two participants each in the 21–25 and 61–65 age ranges. Additionally, one participant each in the 41–45 age group, and another in the 51–55 category. This shows that there is an interest for science communication training across various age groups. Regarding gender distribution, 56% of the participants were female, while 44% were male. In terms of educational background, the majority (81%) held postgraduate qualifications, while 19% had a PhD). The participants' professional backgrounds included 11 researchers, 4 science communicators, and 1 astronomy

educator. Since the workshop took place in Delhi, most attendees were from the Delhi NCR region, with 13 participants from Delhi, 1 from Uttar Pradesh, and 2 from Haryana.

Survey Results

The workshop feedback survey indicates improvements in various aspects of participants' science communication skills. The data compares pre-survey and post-survey responses across several key metrics: changes in the perception of the importance of science communication, confidence in science communication through writing, verbal communication, social media, and intentions to pursue science communication in future careers.

Pre-Workshop Survey:

The pre-workshop survey was conducted to gauge the participants' initial understanding and expectations. The survey revealed that a significant portion of the participants had limited prior knowledge of the workshop topics. Many participants expressed a keen interest in enhancing their skills and acquiring new knowledge. The majority anticipated that the workshop would be highly beneficial for their professional development (in Table 1 of Supplementary file).

Post-Workshop Survey:

The post-workshop survey aimed to measure the impact of the workshop on the participants' knowledge and skills. The results indicated a marked improvement in the participants' understanding of the workshop topics (Figures 1, 2 and 3). Most participants reported that the workshop met or exceeded their expectations. There was a notable increase in confidence among participants regarding the application of the newly acquired skills in their professional settings.

How confident are you in your ability to communicate science through writing after this workshop?

16 responses

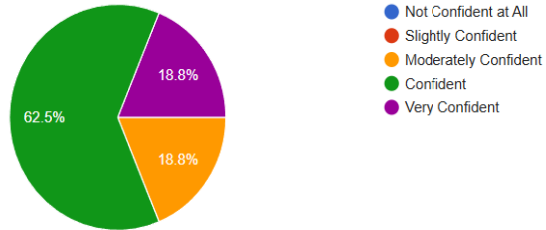


Figure 1 — Participants' Post-Workshop Survey Responses on “How confident are you in your ability to communicate science through writing after this workshop?”

How confident are you in your ability to communicate science verbally after this workshop?

16 responses

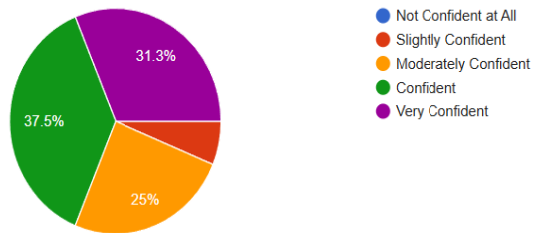


Figure 2 — Participants' Post-Workshop Survey Responses on “How confident are you in your ability to communicate science through writing after this workshop?”

How confident are you in your ability to communicate science through social media after this workshop?

16 responses

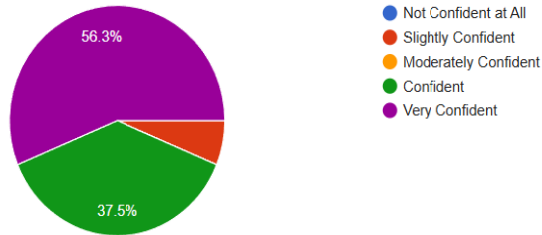


Figure 3 — Participants' Post-Workshop Survey Responses on “How confident are you in your ability to communicate science verbally after this workshop?”

The comparison between the pre- and post-workshop surveys highlights the effectiveness of the workshop in achieving its educational objectives. Initially, participants had limited knowledge, but the structured and interactive sessions facilitated significant learning gains. The positive feedback in the post-workshop survey underscores the workshop's relevance and utility.

Motivations for Workshop:

Participants' responses to the question, “What motivated your interest in this workshop?” during the workshop registration process showed their initial motivations to participate in the workshop. The participants were interested in improving their science communication skills to make complex scientific concepts accessible, explore career opportunities, stay updated on trends, and network with professionals. Their goals included enhancing outreach and understanding social media strategies. Some sought to apply new techniques to encourage public interest in science, while others aimed to create science communication films or contribute to science policy and administration. Some examples included:

“I am interested in this workshop to enhance my skills in making complex scientific concepts accessible to the public, stay updated on the latest trends in science communication, and network with professionals in the field. This aligns with my goal of promoting science literacy, contributing effectively to science policy, and advancing my career in scientific administration and communication.”

“Because I am working as a science communicator, astronomy educator and want to enhance my skill.”

“To gain a deeper understanding of how science should be communicated on social media particularly when it comes to health-related information.”

“I want to make a science communication movie or Film”

Changes in the Importance of Communicating Science

Pre-survey: Most participants strongly agreed (10), with a few agreeing (4), and one neutral (1).

Post-survey: Responses showed an increase in strong agreement (12), indicating a positive shift in the perceived importance of communicating science.

Confidence in Communicating Science Through Writing:

Pre-survey: Participants' confidence levels varied, with very confident (3), confident (8), and moderately confident (5).

Post-survey: There was a notable increase in confidence, with very confident (4), confident (10), and a reduction in moderately confident (2).

Confidence in Communicating Science Verbally:

Pre-survey: A mix of very confident (5), confident (8), and moderately confident (3) was reported.

Post-survey: The number of very confident responses increased (7), confident (6), and moderately confident (2), showing enhanced confidence in their verbal communication.

Confidence in Communicating Science Through Social Media:

Pre-survey: Participants reported very confident (6), confident (7), and moderately confident (3).

Post-survey: The participants reported an increase in confidence, with very confident (8) and confident (6).

Intentions to Pursue Science Communication in Future Careers:

Pre-survey: The majority were strongly agreeing (7) or agreeing (5), with some participants being neutral (4).

Post-survey: Strong agreement increased (9), indicating a heightened intention to pursue science communication, with fewer participants being neutral (3).

The workshop successfully enhanced participants' appreciation of the importance of science communication, reflected in the increased strong agreement post-survey. Confidence in various forms of communication saw marked improvements, particularly in writing and social media, where most participants shifted from moderate to high confidence levels. This indicates the effectiveness of the workshop's practical components and interactive sessions.

Moreover, the intention to engage in science communication as a career also increased, suggesting that the workshop inspired participants to consider this field more seriously. The data underscores the workshop's role in not only improving specific communication skills but also in fostering a long-term commitment to science communication among participants. Future workshops could build on these findings by incorporating even more targeted exercises and providing ongoing support to maintain and further these skills (more details in Table 1 of supplementary file).

Several key themes emerged from the feedback:

Increased Knowledge and Skills: Participants reported a substantial increase in their understanding of the workshop topics. This suggests that the workshop content was well-aligned with the participants' learning needs and was effectively delivered.

Practical Application: Many participants felt confident about applying the new knowledge and skills in their professional roles. This indicates that the workshop provided practical

insights and hands-on experience, which are crucial for real-world application.

Engagement and Interaction: The interactive elements of the workshop, such as group discussions and practical exercises, were highly appreciated. These elements likely contributed to the enhanced learning experience by encouraging active participation and engagement.

Overall Satisfaction: The overall satisfaction levels were high, with participants expressing that the workshop exceeded their expectations. This reflects the quality of the workshop content, the expertise of the facilitators, and the effectiveness of the teaching methods used.

The workshop demonstrated positive growth in key areas, particularly in boosting confidence in social media skills, where five participants reported improvement. Additionally, confidence in writing skills and verbal communication also saw growth among three participants each, while two participants developed a stronger appreciation for the importance of communicating science to the layperson. Notably, a significant number of participants maintained their initial confidence levels across all metrics, showcasing stability in these areas. These results highlight the workshop's success in enhancing specific skill sets, particularly in social media engagement, while also providing insights into areas requiring further focus, such as sustaining motivation for science communication.

Conclusion and Discussion

The workshop feedback survey reveals significant improvements in participants' science communication skills, comparing pre- and post-survey responses. Initially, participants had limited knowledge but anticipated the workshop would enhance their skills. The post-workshop survey confirmed substantial learning gains, with increased understanding, confidence, and satisfaction. Participants reported notable improvements in their ability to communicate science through writing, verbal communication, and social media.

Key metrics showed an increase in the perceived importance of science communication and in confidence in written and

verbal communication. Participants also expressed a greater intention to pursue science communication in their careers. Practical application was highlighted, with many participants feeling equipped to apply the skills learned. Interactive elements like group discussions and hands-on exercises were particularly valued.

Overall, the workshop had a positive impact with high satisfaction levels attributed to well-aligned content, expert facilitation, and effective teaching methods. The findings underscore the workshop's success in fostering skill development and long-term engagement in science communication. Future workshops could further enhance outcomes by incorporating targeted exercises and offering continued support for skill retention and growth.

Some limitations of the current study include the limited sample size as it was dependent on in-person participation. Replicating this study with more workshops with a greater number of participants in the future can provide more evidence. Further, post workshop assessments at regular intervals can also be used to determine how the confidence and skills varied with time. Future studies can be planned with 3- or 6-month follow-ups to examine how these changed over time.

In summary, the importance of effective science communication cannot be overstated in an era where science and technology shape many aspects of our lives. Addressing the challenges scientists face in communicating with the public, providing training and opportunities for practice, and fostering collaboration with journalists are crucial steps towards bridging the communication gap. By enhancing science communication, we can build a more informed and supportive public, ultimately advancing scientific progress and its positive impact on society.

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