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The Relevance of Using Digital and Social Media Tools to Implement Different Science Communication Models in Science Communication by Indian Scientists

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Abstract

Digital and social media have profoundly altered the information landscape in general, including science communication. It provides the public with direct, comprehensive, and generally free access to any form of scientific knowledge, frequently without the need for an intermediary, such as a specialist in the subject or a journalist. Simultaneously, digital and social media enable scientists to reach out to the general public without the need of intermediaries. Its merits include quick transmission and content amplification. By increasing public knowledge of science, public comprehension of science, scientific culture, and science literacy, digital and social media technologies may be some of the most rewarding and enlightening resources for scientists, particularly in developing countries like India. As more people seek knowledge about science and technology online, public communication of science through online platforms provides an increasingly essential opportunity to enhance conversation between science and society. While digital media and social media are important sources of general news, they appear to serve a little role in enlightening Indians about science. Based on many communication paradigms, this study emphasizes the significance of leveraging digital media and the social web as a beneficial science communication tool for scientists in the Indian context.

Keywords: Social media, Digital Media, Science Communication, Science communication models, Digital Science Communication

Introduction

In the present century, India is experiencing an extensive diffusion of science communication activities not only via traditional media but also through specific forms of interaction with a wide-ranging community using different channel of communication largely digital communication platforms. Science Communication (SciCom) refers to a method of presenting science related topics to non-scientists and non-scientific communities[1]. Scientists are those who bridge the communication gap between the complex scientific world and the simple information requirements of stakeholders or the masses. Digital media is a concept used to refer to the internet and the interplay between technology, images and sound. Most technologies described as "new media" are digital, with features of being interactive, networkable [2]. For a digital media to be considered as social media, it must be interactive with user generated content. Social media depends on mobile and web based technologies to create highly interactive platforms through which individuals and communities can share, recreate, discuss, and modify user generated content. The term 'social media' is an umbrella term that refers to the set of tools, services, and applications that allow people to interact with other network technologies[3]. Social media encompasses groupware, online communities, peer-to-peer and media-sharing technologies, and networked gaming. Instant messaging, blogging, micro blogging, forums, email, virtual worlds, texting, and social network sites are all genres of social media.

Models of Science Communication

For over a decade, science communication has been presenting the tale of its own evolution frequently and very evenly. The storey is simple: scientific communication used to be done in a 'deficit model', as one-way communication from experts with knowledge to publics without it; it is now done in a 'dialogue model', which involves publics in two-way communication and draws on their own information and experiences. Communicators in scientific communication often deal with three primary models: the deficit model, the conversation model or the Dialogue Model, and the Participation model [4] (Hetland, 2014; Trench, 2008).

- **The Deficit Model**

In the early 1960s, the word "deficit" arose from Snow's hypothesis (referenced in Schiele, 2008) to characterise the large gap between scientists and non-scientists. The idea represented, first and foremost, the social difference between two cultures, that of scientists and that of literary intellectuals, with the latter viewed as lacking in scientific understanding. This hypothesis was then used to investigate the divide between scientists and the general population (Schiele, 2008) [5]. Science might be communicated from an exclusive group of specialists (the scientist) to a large number of consumers via newspapers and other forms of mass media (the public). The mediators were responsible for understanding, explaining, and adjusting complicated concepts to an interested public in order to broaden the audience.

According to Nisbet and Scheufele (2009), the deficit model is defined as a transmission process in which the "prevailing assumption has been that ignorance is at the root of social conflict over science, and the public is capable of overcoming their ignorance through effective scientific communication [6]." The deficit model is also known as the 'Diffusionist' or 'Dissemination' model [7]. According to the deficit model, a single, undifferentiated public audience is incapable of understanding science without the participation of scientists and scientific communicators.

- **The Dialogue Model**

The 'dialogue model', also known as the 'public engagement model', is based on actual interaction with the public, which recognises and embraces differences in knowledge, beliefs, views, and interests. Based on deliberative public engagement approaches, it is a two-way or multi-way debate with public stakeholders about the advantages, downsides, and costs. This paradigm entails an interchange between scientists and the public, which is typically absent in the one-way model, in which information in the form of factual truth is given to the public.

Hetland (2014) cites five reasons why the conversation model is used [8]:

1) The researchers receive constructive comments and ideas
2) The users have the chance to engage
3) The study findings are more easily accepted and utilised by the users, if applicable
4) Both researchers and users gain information

5) Users get a better grasp of certainty and uncertainty when evaluating findings

- **The Participation Model**

The participation model varies from the deficit and conversation models in that the audience is participating in the scientific process from the start rather than getting the results at the end. Multiple methods of knowing are recognised in the participation paradigm, and non-scientific audiences are viewed as equal collaborators rather than passive vessels or suppliers of knowledge (Brossard & Lewenstein, 2010; Bucchi, 2008; Trench, 2008) [9]. This approach is based on the assumption that individuals have a high level of scientific knowledge. The participation approach is built on genuine dialogue and discussion between the public and the scientist. Unlike the conversation model, there is no predetermined agenda. Several societal groups, including scientists, contribute to progress through influencing concerns. Acceptance of heterogeneity is a key notion here. Controversies arise as a result of debates and discussions between groups and people, which are seen as natural aspects in this paradigm (Horst, 2008) [10].

Whereas the deficiency model focuses on knowledge transmission and the dialogue model on knowledge discussion, the participation model of science communication focuses on knowledge co-production by scientific experts and the general public. Besides that, the participation model incorporates traditional knowledge (local, indigenous) as well, non-scientific knowledge that both the deficit and dialogue models are criticised for undervaluing.

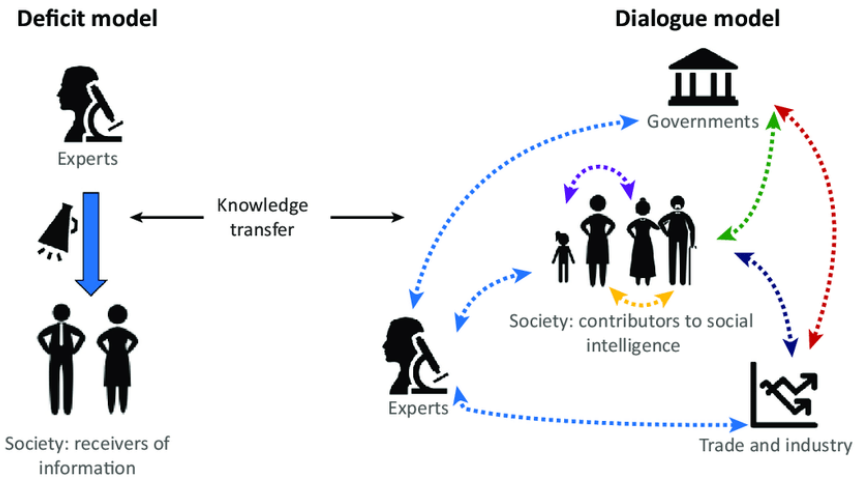

Figure 1: Correlation between Models of Science Communication

From "Public Understanding of Science" (PUS) to "Public Engagement with Science and Technology" (PEST)

Haywood and Besley (2014) try to encapsulate the debate by reconstructing two basic patterns: "public understanding of science" and "public engagement with science and technology" [11]. Public understanding fundamentally refers to the link of scientists and scientific professionals with nonscientists and the general public through science education. In contrast, public involvement is informed by the notion of participatory democracy and stresses openness, negotiation, and discussion in resolution making. The contrast between public "understanding" and "engagement" is an essential factor for categorizing views and preferences about science communication in the public sphere. A report, released in 1985 by the Royal Society to promote the PUS movement explicitly addresses the urgent need for a better understanding of scientific research by the public and emphasizes the role of scientists and scientific communities in the dissemination of scientific knowledge among the lay population.

"Scientists must learn to communicate better with all segments of the public, especially the media. […] It is clearly a part of each scientist's professional responsibility to promote the public understanding of science." (The Royal Society, 1985, p. 24)

The PUS style of science communication is typically defined as "one-way" or "top-down" communication and is viewed as an extension of public education in which scientists, scientific communities, and the (journalistic) media all play a critical role. The PUS movement accepted the science literacy approach's core assumption, known as the "deficit model": a lack of scientific understanding on the part of the public as the source of a lack of public participation and engagement for science and technology. The PUS movement, particularly the deficit model, has been chastised for ultimately seeking public support for science rather than public "knowledge" of science [12]. It is maintained that scientific discoveries and knowledge are not value-free and are frequently linked with the social environment, and that the public has the right to participate in scientific decision-making. Others claim that a lack of public support is caused not just by a lack of comprehension of science, but also by a lack of faith in science [13].

A more open style of communication between scientists and the general public is thus required and demands for conversation or interactive communication developed around same time. The emergence of the PEST movement is seen as an introspection of the PUS movement as well as a reflection on participatory

democracy in which transparency, negotiation, and tolerance of various viewpoints are emphasized. In PEST, the emphasis on science communication shifts from education to public participation in scientific research. The PEST paradigm stresses citizens' right to participate in decisions that impact their lives. It can be said that scientific competence and data are crucial in decision making, as the PUS movement properly assumed. However, the PEST paradigm adds the insight that decision-making involves a mutual understanding between science and society, in which facts, values, and disparities in facts and values are all taken into account. The PEST movement calls for scientists to not only debate and negotiate the consequences of scientific research with the public, but also to involve the public in decision-making and scientific agenda building.

Objective of the study

The specific objectives of the study is to identify the most desired science communication model, as well as preferred digital media and social web platforms for Indian scientists to share their work, and to investigate their social media consumption patterns

Research Methodology

In general, the term methodology signifies the manner in which a study is conducted. Research methodology refers to the systematic way of solving research problems.

Key Research Questions

Research questions may be characterised as a tentative conceptualization and the logic of that need to be tested. Some of the key research questions were:

- RQ1: What are the preferred social and digital media platform of scientists and researchers to communicate about their research works
- RQ2: What is the frequency to publish ongoing research updates on blogs, Twitter and other digital media and social web platform by the scientists and researchers?
- RQ3: What are the potential positives (favorable) and negative (unfavorable) consequences of using digital media and social web in research work based on the response of scientists and researchers?

- RQ 4: How do communication models differ among groups of scientists that choose to communicate with the public through digital media or through traditional media (traditional journalistic approach)?

Nonetheless, the researcher aims to examine in this context that Indian scientists who want to influence public discourses about science should use new media to enable interaction with the public by forming a hypothesis –

H0: Scientists who prefer digital media for communicating science are less likely to hold views similar to the engagement model (dialogue, participation) than scientists who prefer traditional mass media, conventional journalistic approaches, or do not wish to connect with the public at all.

H1: Scientists who prefer digital media for communicating science are more likely to hold views similar to the engagement model (dialogue, participation) than scientists who prefer traditional mass media, conventional journalistic approaches, or do not wish to connect with the public at all.

Sample Size & Sampling Method

First, a series of interviews with Indian scientists were performed followed by an online survey. Forty five interviews have been conducted with scientist who use social web to communicate with academics and others, while twenty interviews are conducted without using social web to explore the distinctions between these two categories. The interviews focused on the subjects of science communication and social web consumption as well as broad discussions on the issue of open science. A set of questions was developed with the goal of determining how much respondents agree with the public engagement approach to scientific communication. Survey respondents were questioned about their communication preferences. An invitation email with a survey link was forwarded over 300 people. Among that collected samples, 268 functional samples were taken into consideration for further study.

Research Findings & Discussions

The data collected from the survey questionnaires and accompanying interviews of the scientists has been summarized and organized in such an approach that it has capitulate answers to the present research problems. Also, Social Media profiles were obtained from different social media sites to analyze the content and nature of the posts.

RQ1: Preferred social web and digital media for scientists and researchers to communicate about their research works according to their response

Scientists and researchers mostly like to communicate about their research works in Twitter, Academia.edu, ReaearchGate. They also like to build their professional connections by using LinkedIn. They hardly communicate about their research in Facebook.

Table 1: Preferred social web and digital media for scientists and researchers to communicate about their research works

Particulars	Number of Respondents	Percentage
Twitter	266	99.25
Facebook	140	52.23
LinkedIn	243	90.67
ResearchGate	262	97.76
Academia.edu	257	95.89

Source: Primary Data

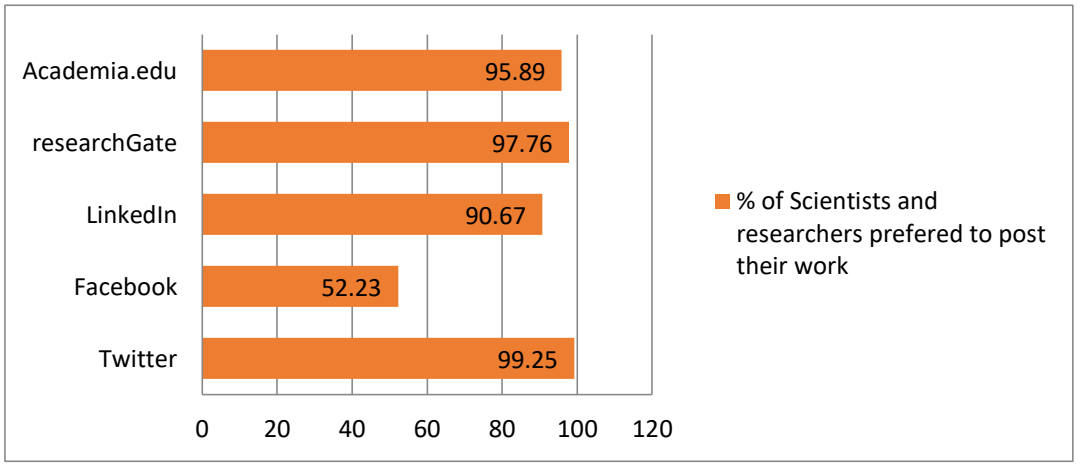

Figure 2: Preferred social web and digital media for scientists and researchers to communicate about their research works

RQ2: Analysing the frequency to publish ongoing research updates on blogs, Twitter and other digital media and social web platform

A major number of scientists and researchers hardly share information on social web but they share their research papers on Academia, ResearchGate or LinkedIn like platforms about their ongoing research. Sometimes they like to share about their ongoing research on their own twitter account or in the organizational blog page or twitter handle where they are associated. Some of the respondent scientists said that they share their research title and brief working information about research on LinkedIn platform for maintaining profession connectivity and also enrich their CV's. They hardly communicate on other social networking sites in the matter of sharing about their ongoing research projects.

Table 2: Respondents approach towards publishing ongoing research updates on blogs, Twitter and other digital media & social media

How often do you do any of the following in your research work?	Always	Often	Sometimes	Never
Publish research updates on blogs	6%	13%	22%	59%
Publish research updates on other social network sites	1%	3%	15%	81%
Publish research updates on Twitter	15%	12%	31%	42%
Publish research updates on LinkedIn	30%	35%	62%	11%
Publish research updates on Academia / ResearchGate	68%	81%	56%	2%

Source: Primary Data

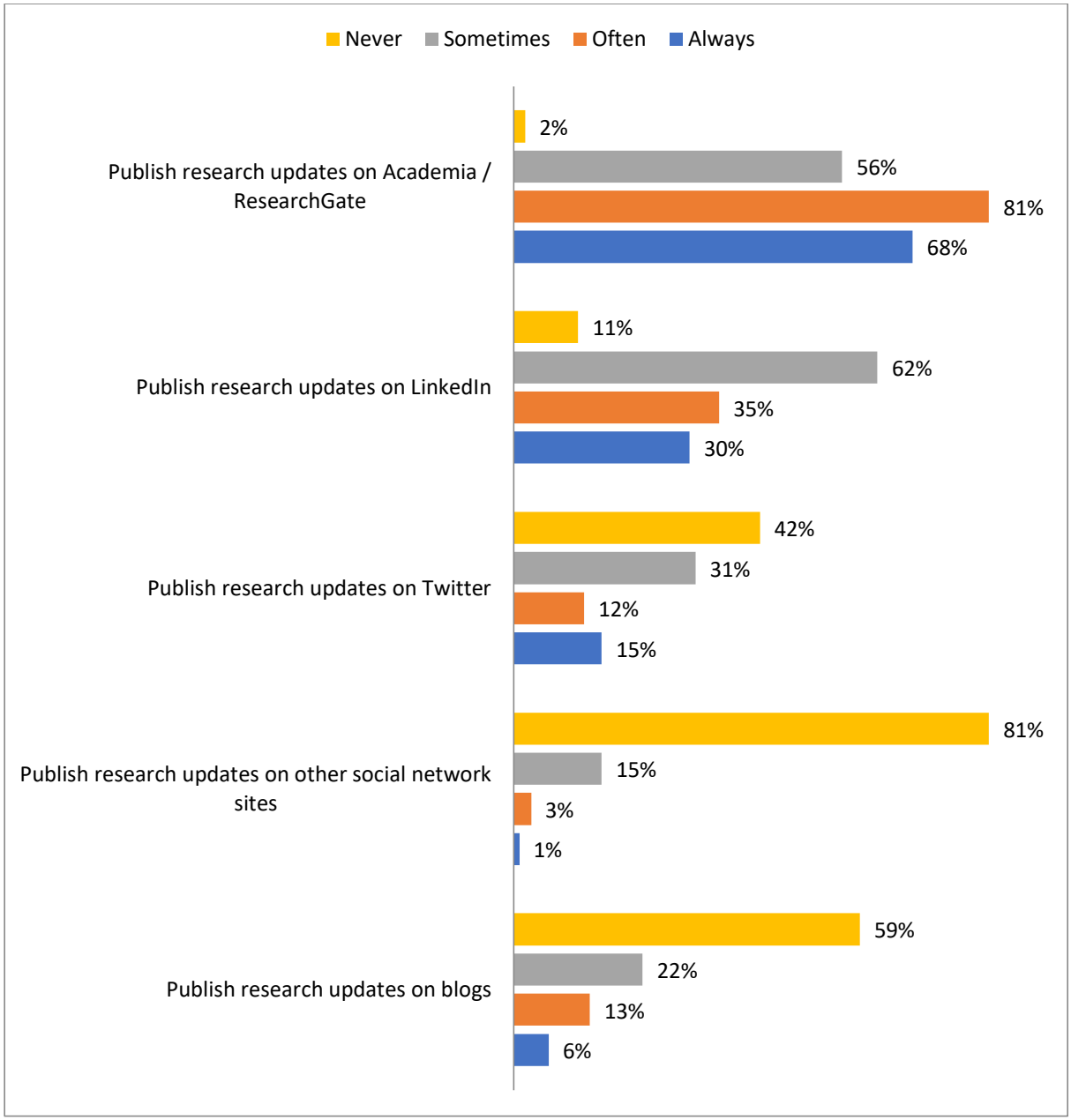

Figure 3: Publishing ongoing research updates on blogs, Twitter and other digital media & social web

RQ3: Analysis of the potential positive and negative consequences of using digital media & social web in research work based on the response of scientists and researchers

The majority of the scientists and researches agreed with the fact that communicating about their research work in social media will benefit the common people as they will be able to understand that how this research is going to benefit them as well as the society. There is a dilemma among the scientists and researchers that how this social web and digital platform will support them to uphold their professional profile or help them to find collaboration opportunities or amplify the probability of receiving funding. Few of them agreed with the fact that digital platform support them positively in this context, but most of them

never explored this medium as they are not sure about the possibilities of this newly emerging digital platform. Most of the scientists and researchers don't have the confidence on the researches published in digital platform, where some of them are not sure about the peer review process or about the credibility of those publications. Even they have self-doubting about the fact that their research ideas may be stolen if it is published in digital platform as they are not much aware about the copyright act of digital media and social web. So, there is an overall lack of knowledge about the effective usage of social web and digital media among scientists and also uncertainty is observed among scientists and researchers in this context.

Table 3: The potential positive and negative consequences of using digital media & social media in research work according to respondent's choice

To what extent do you agree or disagree with the following statements?	Strongly agree	Agree	Neither disagree nor agree	Disagree	Strongly disagree
Communicating research on social media benefits the public	9%	45%	35%	9%	2%
social media promotes my professional profile / helps me find collaboration opportunities / increases my chances of getting funding	7%	32%	40%	17%	4%
Research published on social media cannot be trusted	17%	41%	30%	10%	2%
Communicating research on social media risks my ideas being stolen	4%	26%	44%	23%	3%

Source: Primary Data

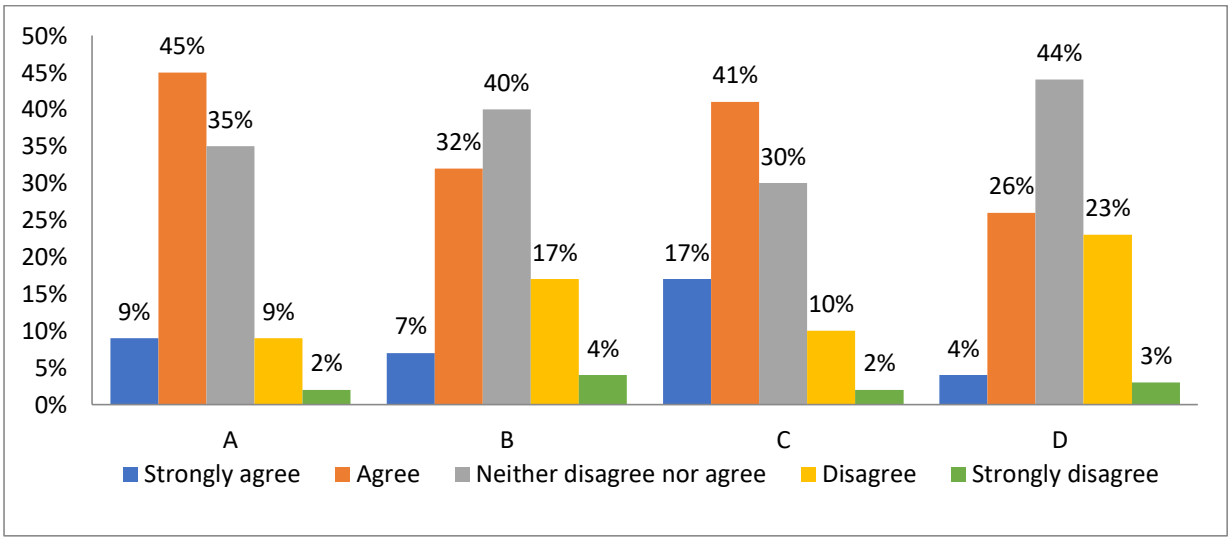

Figure 4: The potential positive and negative consequences of using digital media & social media in research work

['A' stands for communicating research on social media benefits the public, 'B' stands for social media promotes my professional profile / helps me find collaboration opportunities / increases my chances of getting funding, 'C' stands for Research published on social media cannot be trusted, 'D' stands for Communicating research on social media risks my ideas being stolen]

RQ4: Analyzing how the communication models differ among groups of scientists that choose to communicate with the public through digital media or through traditional media (traditional journalistic approach)

The goal of this research question on "public engagement" is to compare two methods to public science communication: the earlier "public understanding of science" approach and the more contemporary "public engagement with science and technology" approach. Answers to the survey questions were used to categories three types of scientists who prefer to communicate with the public through journalism, self-produced digital materials, or face-to-face encounters. Furthermore, a fourth group of scientists was established who openly declared that they are not interested in engaging with the public and a fifth group with other preference was negligible in percentage. A question concerning scientists' perspectives on several areas of public communication was posed. Some of the questions in that section pertain to views compatible with the "public understanding/deficit model", while others refer to beliefs consistent with the "public engagement model".

The survey items are shown in the table below –

Table 4: Items showing agreement with two public communication approaches

Public understanding of science (Deficit approach)	Public engagement of science (Participatory approach)
1) Scientists should strategically phrase their messages in order to influence the public's opinions.	1) Scientists should be open about internal disagreements with the public.
2) The general population lacks the necessary education to comprehend research facts and scientific findings.	2) The general population may lack scientific understanding, but it possesses a great deal of pertinent common sense and excellent judgment.
3) Scientists and laypeople have varying levels of expertise, making real dialogue impossible.	3) Scientists should work with non-scientists as 'lay researchers' to make scientific information more accessible to the public.
4) Interfering with the regulation of scientific activities and applications should be avoided.	4) Editors of scientific journals should require writers to make their articles understandable to interested laypeople.
5) Public science communication should be handled by specialist communication experts rather than by scientists.	5) Blogging and social media invites the public to take a more active role in science & technology

Table 5: Analysis of how scientists like to interact with the general population

Preference of communication ways	**Number of Respondents**	**Percentage**
Talking to journalists from the media houses who report on science	71	26.4
Writing myself for websites, blogs, or social networks or producing my own podcasts and videos	46	17.1
Interacting face-to-face with the public	93	34.7
Other ways	5	2.0
Not interested in communicating with the public	53	19.8

Ten factors were utilized to assess whether the two methods of communication were approved or rejected. Responses to these items form the basis for answering research question which inquires about the relationship between preferences for communication models and communication channels, as well as testing hypothesis stating that scientists who prefer digital communication hold beliefs more strongly correlated with the public engagement approach than scientists who prefer traditional communication channels.

Scientists had similar perspectives on two elements of the public understanding/deficit concept. They mildly agreed with the statement that "Scientists should strategically phrase their messages in order to influence the public's opinions" ($F=1.7$, $df=3$, $p>0.05$) and mildly disagreed with the claim that "Interfering with the regulation of scientific activities and applications should be avoided" ($F=0.96$, $df=3$, $p>0.05$). They also had similar perspectives on two issues, showing a proclivity for public participation. They agreed that "the general population may lack scientific understanding, but it possesses a great deal of pertinent common sense and excellent judgment" ($F=2.15$, $df=3$, $p>0.05$) and disagreed similarly that "editors of scientific journals should require writers to make their articles understandable to interested laypeople" ($F=1.99$, $df=3$, $p>0.05$). However, the communication views of scientists with various communication preferences differ in numerous ways. Scientists who were not interested in interacting with the public were more likely to agree with two assertions linked to the public understanding/deficit approach. Those who were not engaged in

public communication agreed with the statement "Scientists and laypeople have varying levels of expertise, making real dialogue impossible" (F=8.0, df =3, p<0.01) than the other scientists. Furthermore, they agreed more with the assertion that "the general population lacks the necessary education to comprehend research facts and scientific findings" (F=3.3, df=3, p<0.05). It is not unexpected that scientists who were not engaged in public communication were also less supportive of the public engagement strategy. These scientists agreed less than the other scientists on the statement "Scientists should be open about internal disagreements with the public" (F=5.8, df=3, p<0.01). Scientists who are not engaged in public communication expressed modest disagreement with the item "Scientists should work with non-scientists as 'lay researchers' to make scientific information more accessible to the public" (F=4.7, df=3, p<0.01). Furthermore, scientists who were uninterested in public communication were more likely to agree that "public science communication should be done by specialized communication professionals, not by scientists themselves" (F=8.4, df=3, p<0.01). Consistent with their stronger refusal of the public engagement approach and their stronger agreement of the public understanding/deficit approach as demonstrated in figure bellow, for scientists not interested in public communication the item that "Blogging and social media invites the public to take a more active role in science & technology" was a less significant motivator for social media and blogging than for scientists preferring one of the three options of public communication (F=9.8, df=3, p<0.01).

It is unsurprising that scientists who are not engaged in public communication have different communication ideas. To answer this present study and evaluate the current hypothesis, which claims a difference in scientists' preferences for different public communication media channels, the researcher only examined the two groupings of scientists who prefer to communicate "to journalists from the media who report on science" and those who prefer to write for "websites, blogs, or social networks", respectively. A t-test comparing the mean values of the two subgroups was performed for each item depicted in the figure bellow.

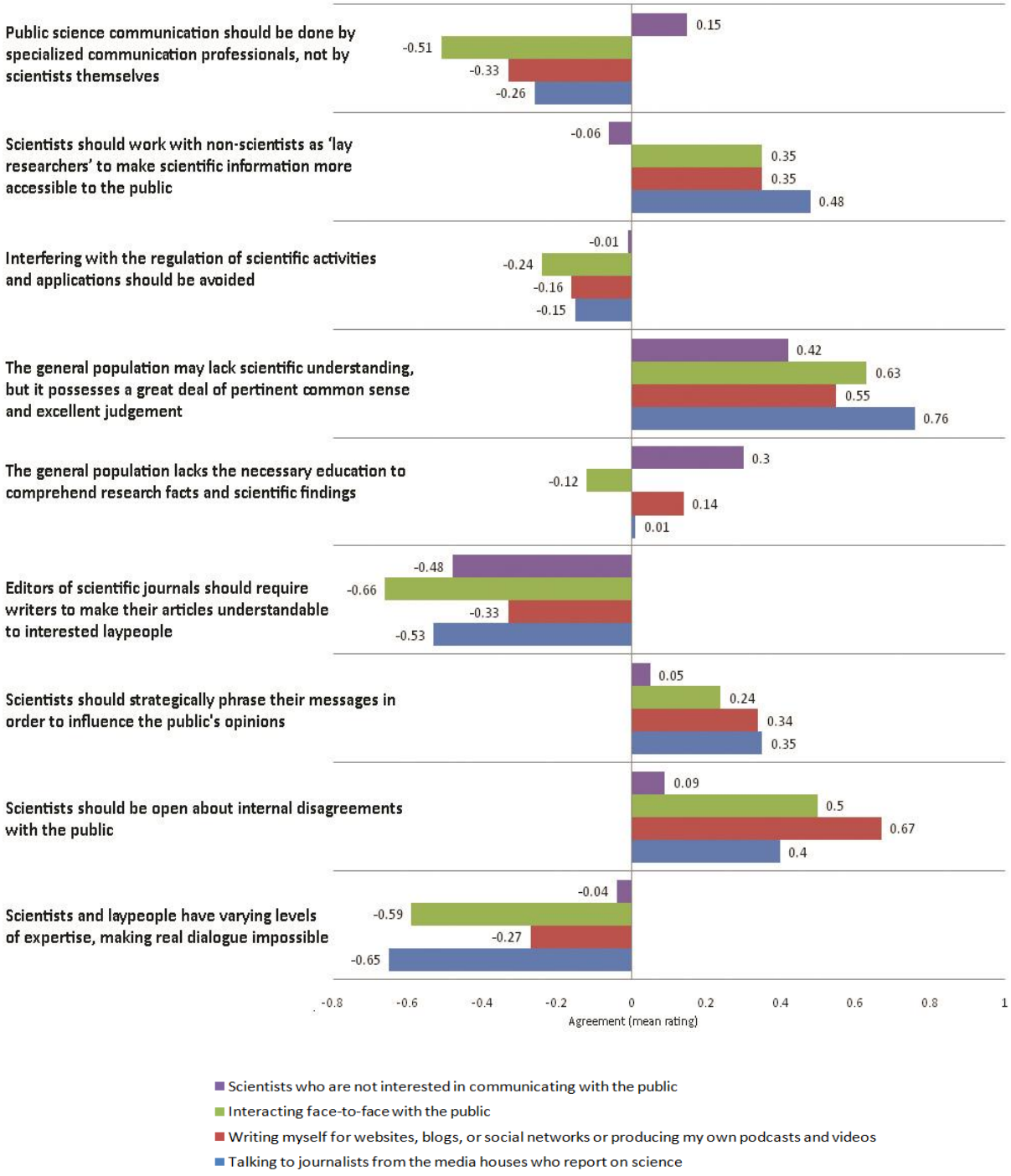

Figure 5: Scientists' preference to communication models (PUS/deficit vs. PEST approach) by communication preference (Question Part-II, 5 & 6, Appendix A). Bars represent mean values of a rating scale ranging from -2 (strongly disagree) to 2 (strongly agree).

Scientists who preferred talking to journalists were more strongly opposed to the statement stating the impossibility of "real dialogue" between scientists and laypeople than those who preferred digital media as a means of communication ($p<0.01$). This disparity suggests that scientists with an attraction in journalism are more likely to prefer public involvement than scientists with a background in digital and social media. However, scientists with a likeliness in journalism were less equipped to make scientific information accessible to laypeople ("Scientists should share internal differences of opinion with the general public")

than digital media-affine scientists ($p<0.05$), showing a lack of interest in public involvement. The results are mixed when it comes to the two items that indicate a statistically significant difference between the two groupings. There are no persistent variations in communication model preferences across groups of scientists that prefer contact with the public through digital media or through journalism. On the one hand, scientists with a background in journalism are more likely to prefer the public engagement strategy than scientists with a background in digital media, since they believe in the potential of a genuine dialogue between scientists and laypeople. Scientists with traditional journalistic approach preference, on the other hand, were less willing to make scientific information visible to laypeople than scientists with digital and social media preference, showing a lack of interest in public involvement.

As a result, the findings do not support the hypothesis that scientists who prefer digital media for communicating science are more likely to hold views similar to the engagement model (dialogue, participation) than scientists who prefer traditional form of mass media, conventional journalistic approaches, or do not wish to connect with the public at all.

Conclusion

Science communication is the much needed light to brighten the prospects of the millions of Indian hoping for a better quality of life. India's human development status is in a need of more science journalism with a renewed focus on poverty reduction, livelihoods, basic health care, local innovation, disaster management and environmental conservation for sustainable development. Experiments in using digital and Social Media may become the only way to evaluate whether and in which cases the gap between scientists and laypersons really can be reduced. The Deficit and Dialogue model, these two are linear, and Participatory model is multidirectional: communication takes place back and forth between experts and publics and between publics and publics. There are opportunities for a more creative, dialogue-based relationship between scientists, science organizations and the public, which would help to overcome the knowledge gap and transform the model of conducting and communicating science. In the age of digitization, the research findings suggest that digital and social media tools provide new opportunities for more open and two-way science communication for scientists. Such communication can be a valuable part of the research process; it can contribute to the development of collaborative problem solving and lead to a more informed public as

they find new ways to engage with scientists and scientific research. Social media has been transformative in how it has democratized communication. But it's a double-edged sword: social media allows scientists to correct misinformation by communicating their findings to audiences and promote an understanding of complex issues. Equally dangerous though, social-media activism has the potential not only to distort public understanding of these critical issues but also to disrupt governmental support and policy regulations. This research disclose that while many scientists recognize the importance of more effective diverse communication, and for some, the public duty of more open science communication, the use of some of tools is still limited, where the implementation of digital media and social networking platforms can become more relevant.

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