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Challenges of Communicating Science: Perspectives From the Philippines

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Abstract

Science communication research is dominated by Western countries. While their research provides insight into best practices, their findings cannot be generalized to developing countries. This study examined the science communication challenges encountered by scientists and science communicators from Manila, Philippines through an online survey and semi-structured, investigative interviews. Their answers revealed issues which have been echoed in other international studies. However, challenges of accessibility and local attitudes to science were magnified within the Philippine context. These results indicate the ubiquity of certain challenges in science communication and the need for country-specific science communication frameworks. Further research on the identified challenges is needed on a local and global scale.

Keywords Science communication in the developing world

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Since the establishment of science communication as an academic discipline, much of the literature produced has come from developed, typically Western, English-speaking countries with strong scientific institutions. The Western dominance of science communication research is reflected in Guenther and Joubert's [2017] bibliographic survey of articles published in three major science communication journals, namely *Journal of Science Communication*, *Public Understanding of Science*, and *Science Communication: Linking Theory and Practice*, from 1979 to 2016. Almost 70% of the surveyed articles originated from just five countries — the U.S.A., U.K., Canada, the Netherlands, and Australia.

Though studies from these countries offer insights into best practices in science communication, their findings cannot always be generalized worldwide. While science is often assumed to be a universal human endeavor, stark differences exist in the ways various cultures approach and perceive science and its communication [Iaccarino, 2003]. It is crucial to also highlight science communication experiences from developing, non-Western environments. This study therefore seeks to

examine the challenges faced by local scientists and science communicators when publicly communicating science in the Philippines, a populous Southeast Asian archipelago.

Science in the Philippines is characterized by limited funding, insufficient scientific capacity [UNESCO Institute of Statistics, n.d.], and middling research productivity [Nguyen and Pham, 2011]. Furthermore, with over 7,000 islands [Lasco, 2017] and more than 180 different languages [Simons and Fennig, 2018], the Philippines offers a distinct science communication context worth examining. This study aims to provide a glimpse of science communication in the Philippines from the perspectives of those on the front line. By preliminarily identifying challenges, this study also aims to highlight science communication issues that warrant further exploration on a local and global scale.

Context

Science communication in Philippine media and outreach efforts

Early records of science and technology stories in Philippine print and broadcast media are scarce, following the massive cultural losses suffered by the country after World War II [Bautista, 2007]. Nearly a century later, science news still rarely appears in local media. Due to influence from the former Spanish and American colonizers, Philippine scientific research has historically been skewed towards medicine and agriculture [Caoili, 1986]. Accordingly, these topics — along with weather and information technology in recent years — dominate science programming in the news, television, and radio. General science coverage is otherwise scarce.

Major Philippine broadsheets maintain topical science sections like Health or Technology. However, these pages only appear once or twice a week [Congjuico, 2016]. In terms of other media, local science books and magazines do exist, but are often aimed towards primary school children. As of 2018, the Philippines still has no local equivalent of prominent science magazines like Popular Science or New Scientist.

Although science is rarely visible on mainstream media, online efforts are working to overcome this. In 2009, the local broadcasting network GMA launched the nation's first dedicated science and technology online news section. To this day, it remains the only one of its kind in the Philippines. Individual science enthusiasts are also setting up homegrown websites, social media pages, and video channels to communicate science. Government agencies like the Department of Science and Technology [DOST] and its sub-departments are maintaining active pages on Facebook and Twitter that are widely subscribed.

The Philippines also has several science centres, all of which are situated within or adjacent to the capital region, Metro Manila. The most prominent of these is the Mind Museum, which has won several awards since opening in 2012 [Rappler.com, 2014]. In 2018, the Philippines' first natural history museum also opened to the public two decades after its initial proposal in the National Museum Act [Tantiangco, 2018b].

Science communication training in the Philippines

Science communication as an academic track in the Philippines developed from the need to translate the results of agricultural research to farmers. As early as 1960, the University of the Philippines Los Baños (UPLB) was offering courses in agricultural communication. By 1965, an MS Agricultural Communication program was already available [Montemayor, Navarro and Navarro, n.d.]. These forays into agricultural communication eventually transitioned into the more inclusive development communication (DevCom) program at UPLB, which tackles the role of communication in facilitating social development. However, given its humble roots in agricultural communication, UPLB's DevCom program still retains a strong focus on applied sciences and in fact, boasts the country's first-ever science communication department. Similarly, other agriculturally-oriented private and public universities across the Philippines also offer their own DevCom programs.

UPLB's DevCom program notwithstanding, tertiary-level science communication training in the Philippines has traditionally taken the form of one-off scientific writing or public speaking electives nestled within a wider science degree program. Only now are dedicated science communication programs being initiated by top-ranking institutions in the Philippines' capital region. For example, introductory science communication classes are now ongoing at the Ateneo de Manila University and De La Salle University, while the University of the Philippines Diliman has a science journalism class. In spite of these developments, many Filipino scientists and even professional science communicators continue to only receive formal science communication and media training from occasional workshops, fellowships, or seminars.

Attitudes of Filipino scientists and journalists towards science communication

Despite being integral drivers in science communication, studies on scientists and science communicators are rare, even in developed countries [Searle, 2013]. To their credit, Filipino researchers have produced some scientist/science communicator-focused output. Most of these studies are unpublished within peer-reviewed literature, contributing to the apparent dearth of Philippine science communication research. However, these studies confirm the prevalence of some themes in science communication.

For example, Mercado's study [2010] on the factors affecting Filipino biotechnologists' public engagement revealed that these scientists believed it was their duty to share scientific knowledge to the public — a sentiment also shared by scientists from Southeast Asia [International Service for the Acquisition of Agri-biotech Applications, 2014] and the U.K. [The Royal Society, 2006]. Lacbayo's survey [2012] on the attitudes and beliefs of Filipino scientists and science journalists toward local science journalism suggested the existence of a perceived clash between the scientists and journalists, caused by a lack of training and collaboration on both ends. Comparable findings have been documented in surveys from the United States [Hartz and Chappell, 1997] and Australia [Searle, 2013].

Another study unpublished in peer-reviewed literature comes from Ponce de Leon [2011], who compared the impacts of background cultures and worldviews of

Filipino and American scientists on science communication. The responses of Filipino scientists revealed that they still subscribed to the outdated deficit model of science communication, which assumes that the public is deficient in their science knowledge and that experts are needed to "enlighten" the public with facts [Bucchi and Trench, 2008]. This belief in the deficit model may explain their feeling of obligation to communicate to the public.

As indicated by these examples, local science communication research appears to focus on scientists. Research on science communicators seems to be limited to specialized science journalists, like Congjuico's [2016] article justifying the need for a science journalism program. Her study revealed the absence of dedicated science reporters and experts in newsrooms, low salaries, and evidence of unethical interactions with scientists and organizations. It is therefore worth examining if other science communication professionals in the Philippines also undergo similar experiences.

Research questions

In consideration of the gap in scholarly literature of science communication research from non-Western, developing contexts, there is a need to explore the communication experiences of scientists and science communicators from countries like the Philippines and how their experiences shape the local science communication landscape. Through qualitative research methods, this study will address the following questions:

> RQ1: How do scientists and science communicators perceive the quality of science communication in the Philippines?
>
> RQ2: What challenges do Filipino scientists and science communicators encounter when communicating science in the Philippines?

Methods

This paper used a mixed methods approach to address the research questions. Similar methods were adopted by other studies exploring science communication views and practices in both developing and developed contexts [Ndlovu, Joubert and Boshoff, 2016; Neresini and Bucchi, 2011]. A short online survey was first emailed to Filipino scientists and science communicators based in Metro Manila, Philippines to gather primary quantitative data on their past public science communication activities and attitudes towards these activities. The survey questions sought to identify the preliminary factors possibly affecting the respondents' science communication experiences, including: their level of science communication training, the science communication activities they engaged in, and the frequency of these activities. The respondents' perceptions toward the frequency of public science communication in the Philippines were also explored.

To substantiate initial survey findings, the second part of the methodology involved semi-structured, investigative interviews with survey respondents who had participated in a public science communication event within the past year and were willing to be interviewed. Interview respondents were asked to enumerate the challenges they had encountered while publicly communicating science in the Philippines. Their science communication funding situations and perceptions on the quality of local science communication efforts were also discussed.

Organizational and academic websites were used to initially identify potential survey respondents. To address RQ2, scientists and science communicators with public-facing science communication activities were sought out. An activity was considered as science communication if it was primarily targeted towards laypeople. Therefore, specialized conferences, articles in scientific journals, and others were not considered science communication activities.

To overcome the absence of public membership lists for local science communication organizations, a chain referral sampling strategy was used to identify potential respondents. The survey was emailed to 60 scientists and 55 science communicators, with 28 and 27 respondents from each group, resulting in response rates of 46.7% and 49.1% respectively.

From the subset of survey respondents, 13 scientists and 17 science communicators were contacted for individual interviews from January to February 2018. Most respondents were interviewed face-to-face, but voice calls using Facebook Messenger were also done when the respondent was overseas during the data collection period. A total of 30 interviews were carried out, with informed consent given by all respondents. Each of these interviews were held in a mixture of English and Filipino. All interviews, ranging from 19 to 70 minutes, were transcribed in English and Filipino and then analyzed using cross-case analysis.

Cross-case analysis allows the identification of emerging themes by grouping similar responses to interview questions, revealing the most prominent factors contributing to the Philippine science communication experience [Patton, 2002]. Considering the study's limited sample size, unique insights from the respondents were occasionally highlighted by the researcher to illustrate variations in the Philippine science communication experience.

Results

Background of respondents

A summary of survey and interview demographics can be seen in Table 1. The 'scientists' were distinguished from the 'science communicators' by their research activities. All of the surveyed and interviewed scientists were noted to primarily partake in basic and applied scientific research, whether it was within the university, at a government research agency, or in the industry. Therefore, these respondents were considered as 'scientists.' Meanwhile, respondents who did not perform basic and applied scientific research, but actively engaged in science communication activities or research were considered as 'science communicators'.

A majority of the 28 scientists within the survey had doctorate degrees, while the rest had either Masters or medical degrees. Their degrees and specializations ranged from medicine, marine science, and mathematics to data science and biology, among others. The scientists were mostly affiliated with the top universities in the Philippines, with the remainder having links to the industry and government.

Meanwhile, a majority of the 27 surveyed science communicators had bachelor's degrees in fields like journalism and creative writing, as well as more technical areas like molecular biology and engineering. The rest finished at least a Master's

degree in communications. They were also affiliated with various sectors like the academe and advocacy groups. Specialized science journalists affiliated with media outlets were also included within this group. Reflecting the survey demographics, most of the scientists interviewed had doctorate degrees and were associated with a university. Meanwhile, many of the interviewed science communicators had bachelor's degrees and were affiliated with media outlets.

Table 1. Survey and interview demographics for scientists and science communicators.

		Scientists		Science communicators	
		Survey	Interview	Survey	Interview
Total number of respondents		28	13	27	17
Highest educational attainment	Doctorate degree	20	7	2	1
	Masters degree	6	4	7	3
	Bachelor's degree	—	—	15	11
	Medical degree	2	2	—	—
	Certificate	—	—	1	—
	High school diploma	—	—	2	2
Affiliations	University	23	10	4	2
	Industry	2	2	—	—
	Government	2	1	2	2
	Science centre	—	—	7	2
	Media outlet	—	—	8	8
	Advocacy group	—	—	5	2
	International health agency	—	—	1	1
	Not indicated	1	—	—	—

To initially assess the depth of the respondents' science communication experiences, the survey respondents were given a list of public-facing science communication activities. From this list, they were asked to select the activities they had engaged in. As seen in Figure 1, written articles and interview features in print or online news media, as well as interview features were among the most popular activities for both scientists and science communicators, albeit with different rates of engagement for both groups.

For example, public talks during school visits were the most popular science communication activity for scientists, with 74% indicating their participation in such an event. This was followed by interview features (67% of scientists) and finally, written articles (64% of scientists) for print or online news media. In contrast, written articles for print or online news media were the most popular means of public engagement for science communicators, with 81% having previously published popular science articles. This was followed by public talks at schools (74% of science communicators) and then interview features for print or online news media (66% of science communicators).

Around 40% of respondents from each group also indicated other unlisted science communication activities. For scientists, these supplementary activities involved running science pages on social media platforms. For science communicators, these activities consisted of writing popular science books and working as science museum explainers.

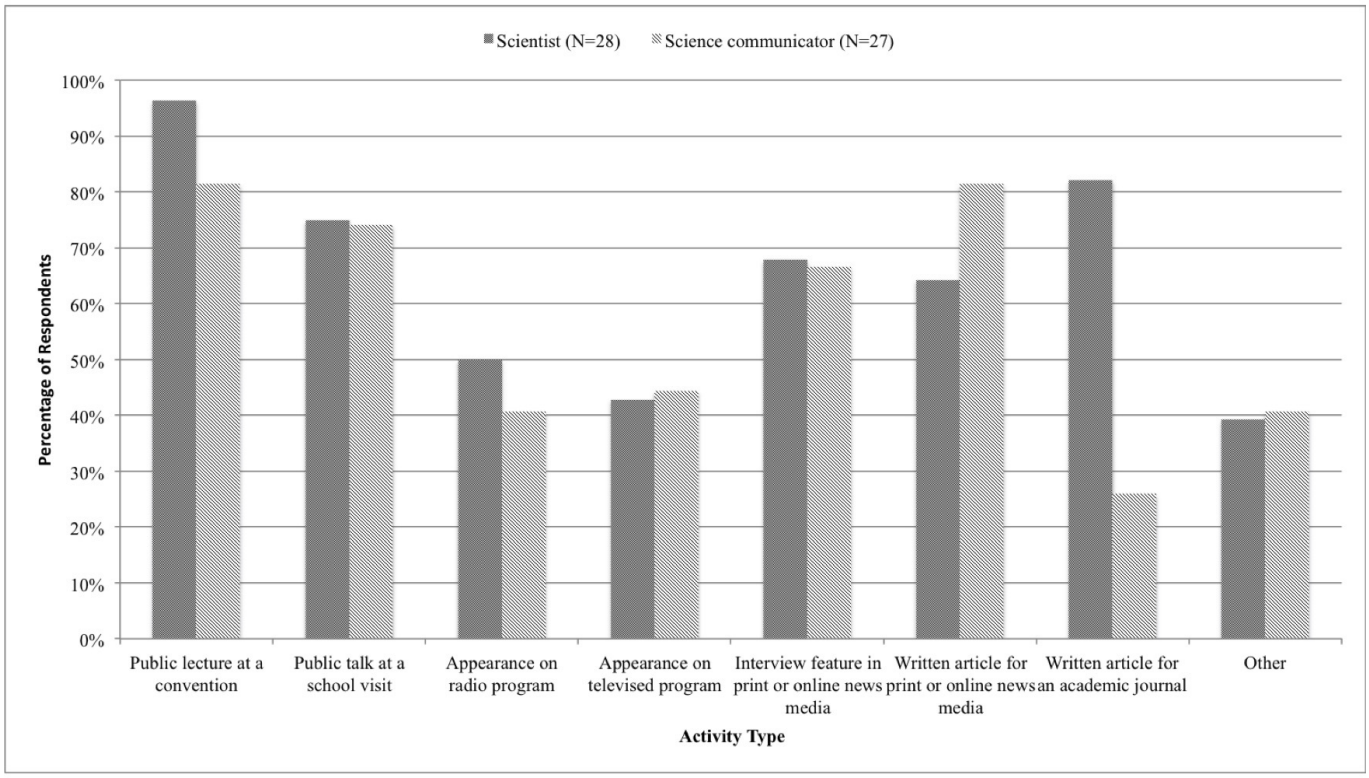

Figure 1. Types of public science communication activities done by survey respondents.

When asked to indicate the frequency of their personal public-facing science communication activities, more than a third (10 out of 28) of the scientists and more than half (15 out of 27) of the science communicators indicated they engaged in such activities on a weekly basis, as seen in Table 2. The remaining scientists indicated engaging in science communication activities less frequently, with 8 out of 28 scientists indicating participation in such activities only a few times per year. Remarkably, the rest of the science communicators also reported sporadic engagement in science communication activities, with one science communicator even indicating participation in a science communication activity only once a year.

Table 2. Frequency of survey respondents' personal public-facing science communication activities.

Frequency	Scientists (N=28)	Science communicators (N=27)
At least once a week	10	15
A few times per month	4	4
Once per month	4	2
Once every other month	2	3
A few times per year	8	2
Once a year	0	1

Perception of local science communication efforts

Both groups were also asked how often they thought science communication efforts as a whole were done within the Philippines, with the results seen in

Figure 2. The two most common responses were occasionally, followed by rarely. Nearly half of both scientists (46%) and science communicators (41%) thought public science communication only occasionally occurred in the Philippines. Meanwhile, around one fifth [21%] of the scientists and the remaining half (41%) of science communicators thought public science communication activities were a rare occurrence locally.

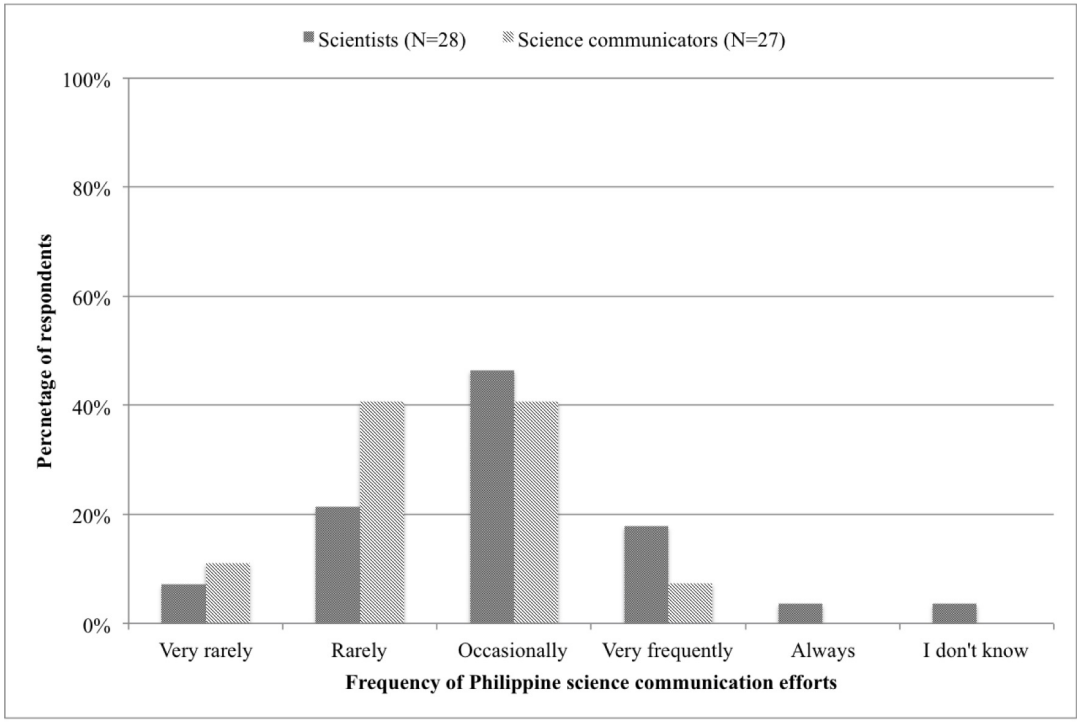

Figure 2. Perceptions on the frequency of public-facing science communication activities in the Philippines.

In the interviews, respondents were also asked to elaborate about their thoughts on the frequency of public science communication activities in the Philippines. Similar themes emerged from both groups. For example, both groups generally believed science news was rarely covered by mass media. According to some, science news only made the headlines after major events like natural disasters, and was usually peripheral to political, entertainment or sports news. This was articulated by a science news editor, who said,

> If you look at the main news outlets in the Philippines…how many times do they put out science stories? Very rare, right? Unlike in the U.S., sometimes the launch of a spaceship or a major DNA breakthrough, it could land you in the headlines right? In the Philippines, it's politics or even sports or entertainment…People seem allergic to science.

Several scientists and science communicators also brought up the politicization of science news by the media, with the technical details often overlooked — causing stories to lack scientific depth. Many cited the recent Dengvaxia scandal, a local public health controversy where children's deaths were attributed to a government dengue vaccination campaign. One industry scientist commented, "Dengvaxia was

kinda big, but they don't really care about the technicalities behind it, but the politics."

Interviewees were then asked their thoughts on the quality of local public science communication activities. A persistent theme across both groups was that the quality of local science communication efforts was very low, but some actors did it well. The science communicators, however, questioned the accessibility of these efforts. Some said that science news was only reaching those already interested in science, while others were more concerned with the social stratification of the communication efforts and their geographic reach. An agricultural journalist expressed,

> Science has to be visible in the media to those who need it…So like farmers, consumers in rural areas. We only have it in the newspapers, broadsheets. But what about the tabloids, they don't cover it at all, right? So there's a knowledge gap. Who has access to the broadsheets? Just the AB class, and so the CDE are left behind.

A science museum explainer also stated, "We have traveling exhibitions…we send people there but of course some far-flung areas will never even hear about science communication."

Challenges of communicating science

Core communication challenges

Time constraints. In the survey, a lack of time was cited by half of the 28 scientists as a deterrent to their public science communication activities. For scientists, their time is consumed by heavy workloads due to research, teaching, and administrative duties that are perceived to be more important than their science communication activities. A medical practitioner noted,

> I do the grant writing. I do the research. I finish the research and now they want me to still translate what we found out. And sometimes, doctors are saying, should that still be me? Can't it be somebody else?"

Interestingly, 13 of the 27 (48%) science communicators also specifically mentioned the lack of time in the survey. As revealed in the interviews, 8 out of 17 (47%) respondents had studies or jobs peripheral to their science communication activities. One science website owner commented, "I haven't updated [the website] recently because work has been a pain. So not having the time to devote to it full-time, like whole day — it kinda hampers the progress of the site."

Insufficient training. According to the survey, only 3 out of 28 (11%) scientists and 14 of the 27 (52%) science communicators had formal science communication training. Five science communicators (19%) indicated that they were taking or had tertiary qualifications in science communication. For the scientists, this training was mostly in the form of short-term media workshops. Primarily oriented

towards scientists in the academe, these one or two-day workshops are designed to enhance the self-confidence and comfort of scientists during media encounters and teach scientists strategies for adapting their message to a wider audience. No formal certification is given at the end of the workshops.

Aside from postgraduate studies in science communication, the formal training of science communicators — specifically the science journalists — mostly took the form of short-term media fellowships. In these fellowships, established science journalists further develop their ability to craft compelling stories on topics ranging from climate change to trans fats. In contrast to the scientist-oriented media workshops, science journalists who participate in such fellowships are thereafter known as official 'fellows' of the media agency or foundation. A freelance science journalist commented,

> If you take a typical science article written in the Philippines and compare it to say, an article from LiveScience or National Geographic, they can come up with articles that are a lot more interesting, compelling and that's not to say we don't have talented writers here. I think we don't have enough training.

Given their overall lack of science communication training, a few scientists emphasized the need for professional science communicators. One marine biologist stated outright, "We should have professional communicators to work with the scientists because scientists are not trained."

Language considerations. Considerations on the language used when communicating science were also raised by both groups. The discussion around language generally revolved around the many languages present in the Philippines, and their implications for science communication. A government science officer explained,

> The Philippines is an archipelago so the medium of teaching would vary from one island to another. There are places that we would have to communicate in the mother tongue, meaning that could be in Bisaya or Bicolano. There are areas where we need to speak in English, or in Filipino.

One science advocate stated, "We have to live with the fact that this is our history and culture and it's been affected a lot by the States…It's not really purely Tagalog [Filipino]. It's a mixture of all these different languages." A mathematics professor also remarked,

> It's very important to be able to communicate science in the language that they speak everyday, no? Not the language that you use when you read but the language that you use at home…That's the challenge because we're educated in English. But in other countries they don't have that problem.

Local science culture. Interviewees from both groups also consistently mentioned the resistance of the local culture to science and its communication. Many of the respondents thought that Philippine society generally perceived

science as boring and unimportant, resulting in disinterested audiences. This disinterest was attributed to many reasons. For example, one science museum explainer elaborated,

> When people look at science, it's just a subject I have to deal with. If I pass or fail it, it doesn't matter because I just need to make money to feed my family. In terms of Maslow's hierarchy, a lot of people are still taking care of the subsistence level. And science is not that critical if you're worrying about what your next meal is.

One of the industry scientists remarked, "The difference is that abroad, they've been exposed to stronger science, and they don't have to think about their daily survival. You have time to think of other pursuits." Another science museum explainer attributed it to the state of science education, saying,

> I could say the way science has been taught in the classroom and the way science is communicated outside the classroom, it's really communicated in a way that stresses memorization of facts. And therefore Filipinos, they have this idea that science holds absolute truths, which is wrong.

Other interviewees also blamed the discouraging attitudes of Filipino parents towards science. A mathematics professor said, "Parents should not talk about how difficult math is. A lot of the fear of mathematics is really reproduced in homes, in media, in school sometimes." Another freelance science journalist expressed,

> We started as really scientists, as curious kids. But when did we stop asking questions? Is it the education system, telling us to do one thing? Is it our parents, who are more focused on achieving financial stability that they push us towards market-driven jobs?

Challenges specific to scientists: limited science communication opportunities

In the survey, six out of 28 (21%) scientists said that the lack of invitations limited their science communication activities. One data scientist said, "There's not a lot of opportunities to speak to the public. Someone has to organize. I don't have the capacity nor desire to organize." However, almost all of the university-affiliated scientists mentioned that outreach efforts were mandated for all faculty members, with such efforts taken into consideration during promotions.

Challenges specific to science communicators: low numbers of science communicators and financial constraints

A barrier repeatedly mentioned by the science communicators in interviews was the scarcity of fellow science communicators, with many emphasizing how their work would be easier with more manpower. A senior science journalist stated, "We are not producing new generations of science writers because I'm meeting the same people that I've been meeting for the last two decades."

Financial constraints were also mentioned by many science communicators, particularly science journalists, as another major barrier to their public science communication activities. These constraints were in the form of either limited budgets or low salaries. According to some science communicators, their budgets were rarely enough, limiting the extent of their activities and sometimes causing them to release mediocre output. One science museum explainer said,

> It constrains us. We can't do many things that we'd like to do but it also forces us to be creative, to find ways to make do with what we have, which is also great. That sometimes makes us end up achieving mediocre things but it also makes us achieve amazing things with very little.

Another senior science journalist commented, "Say I wanted to do investigative pieces, like say, Wired or National Geographic, where I send someone out into the jungles to get me a science story. That of course, entails funding which we do not have."

Two science communicators simply attributed their meager salaries to the economic situation of the Philippines, with one saying, "It's just how people are paid in the Philippines and it's not great…I don't blame the company, it's just how the developing world kind of functions."

Many of those who mentioned low salaries as a deterrent also brought up how they had to do other jobs to make ends meet. A technology journalist said,

> We could see science coverage as a dead-end beat…There's not really much movement upwards. The income you would get from it, definitely is not enough to sustain a family.

Despite their financial constraints, some science communicators still managed to fund their activities out of their own pocket. A freelance agricultural journalist admitted, "Funding as of now, really out of my own expense. This is something I would do even for free because I really love communicating science."

Discussion

Quality of science communication efforts

This study found that although Philippine science communication efforts were perceived by both groups as poorly and infrequently done, many believed certain actors did it well. For most respondents, local science communication efforts were equated to depictions of science in the mass media. Surveys have consistently shown that the global public primarily gets their science information from mass media [Science and the Media Expert Group, 2010]. Filipino respondents were not alone in their sentiments regarding the perceived poor quality of local science communication. Even scientists and science communicators in developed regions like Europe and North America felt that media reporting of science was inadequate [Dudo, 2015].

Justifying this perception for many respondents was the disregard of science stories in favor of other topics and shallow science news coverage common in local media.

Stories about science have to compete against the sensational stories of politics, entertainment, and business — all of which are regarded as easy "sells" by the media and therefore dominate news stories and headlines [Radford, 2007]. In the developing world, scientific news is rarely tackled unless it includes a significant local, political, or economic component, or is highly controversial [Tagbo, 2010]. In such cases, the scientific basis often becomes peripheral to the story's other angles, lacking the technical depth desired by scientists.

Accessibility of science communication efforts

Both groups also brought up the limited reach of science communication efforts, as science was only being communicated to those already interested in science. This was reflected in the survey results, with scientists primarily communicating through public lectures at academic conferences and articles in scientific journals — avenues traditionally closed to non-scientists. These findings, however, are not unique to the Philippines. For example, Bubela et al. [2009] observed that traditional science media outlets were only reaching already knowledgeable science enthusiasts. Wilcox [2012] reiterated the inaccessibility of modern scientific journals, saying that 'science is almost entirely a monologue given to a very specific audience' [2012, p. 85].

Because the Philippines has over 7,000 islands, respondents also raised the challenge of communicating science in poorly-serviced and impoverished regions outside Metro Manila. This challenge is shared by large countries like Australia [Stocklmayer, 2003] and Brazil [Massarani and De Castro Moreira, 2016], which have both launched mobile science initiatives to overcome geographical constraints. Although the Philippines has initiatives like the Mind Museum's traveling exhibitions [Tantiangco, 2018a] and the DOST's Science Xplorer Bus [Santisteban, 2017], one respondent noted that these efforts may never reach truly isolated areas.

Due to the fragmented geography of the Philippines, many regions have a distinct culture and language. Because of this, both groups also cited language as a barrier to their communication activities. There are approximately 180 different languages spread all over the country [Simons and Fennig, 2018]. Though Filipino and English are official languages, not all Filipinos are fluent in either or both languages [Estocapio, 2017]. Many Philippine languages are also mutually unintelligible, exacerbating the problem of communicating with those from other regions. Local science communication efforts are challenged to adapt to these linguistic variations, or risk excluding a significant amount of the Philippine population.

Given the increasing economic inequality in the Philippines [Caraballo, 2017], the social stratification of science communication audiences was also mentioned by both groups. Joubert [2001] states that science communication in developing countries is challenged to cater not only to affluent communities with first world living standards but also to poor communities with little to no exposure to science. Many science communicators admitted that efforts in the Philippines were not yet meeting the challenge. As it is, science is barely present in the major broadsheets read by those with higher incomes. Yet according to most respondents, it is even rarer in the forms of media consumed by those in the lower rungs of society, like tabloids, public radio, and television channels.

General science communication challenges

Certain challenges were more prevalent in each group. Scientists tended to complain more about the lack of science communication opportunities. Although outreach activities are mandated by the universities many scientists were affiliated with, their responses indicated a lack of deliberate effort to publicly communicate science. This is similar to the findings of Andrews and colleagues [2005], who studied the science communication motivations of scientists from Colorado. Their study revealed that scientists would not pursue science communication opportunities if it required additional effort on their behalf and that scientists were more open to outreach activities if these were clearly defined and coordinated by others. Both of these views were echoed by Filipino scientists in this study.

Meanwhile, Filipino science communicators have to contend with their low numbers. The lack of manpower is particularly evident in the field of science journalism. Because of the rising costs in today's media landscape, even developed countries like the U.S. [Brumfiel, 2009] and New Zealand [Ashwell, 2016] face staff cuts and dwindling science news sections. Developing countries like the Philippines [Congjuico, 2016] and South Africa [Joubert, 2001], however, have to grapple with the absence of such staff and news sections in the first place.

One reason for the scarcity of Filipino science communicators may be the financial disincentives for a science communication career. For example, respondents said that the low budgets allotted to science communication activities constrained the quality and depth of their output. Local science journalists are unable to do investigative pieces, similar to other countries in Africa [Joubert, 2001], while museum explainers and science advocates have to moderate their activities to fit within the budget. Further exacerbating the situation is the absence of local funding bodies for science communication activities.

Science communicators also overwhelmingly mentioned their poor salaries. Science journalists seem to be poorly paid worldwide [Science and the Media Expert Group, 2010], but in the Philippines, even museum explainers and other professional science communicators think their salaries fall short. This may be attributed to the economic realities of living in a developing country, where salaries are generally much lower than those in developed regions [Mariano, 2016]. To maintain even basic living expenses, some of the interviewed science communicators have no alternative but to take other, more lucrative full-time jobs due to the low salaries from their science communication activities. These jobs take away time that could be spent on communicating science, making it more of a part-time activity for some of the respondents. Despite this, many continue to perform such activities out of a passion for science communication.

Science communicators not having enough time to communicate science in the first place seems to be a phenomenon unique to the developing context. In wealthier countries like Australia [McKinnon et al., 2017] and New Zealand [Ashwell, 2016], time constraints led to science communicators — specifically science journalists — having less time to check facts, causing inaccurate reporting. The communication activities of Filipino scientists in this study were also affected by time constraints. This is to be expected, as multiple studies worldwide report that heavy research and teaching workloads impede public science communication

activities. This suggests that such institutional demands are a pervasive barrier to science communication worldwide [Andrews et al., 2005].

Another shared challenge was the lack of formal science communication training. The lack of formal science communication training is particularly evident as some of the science communicators still subscribe to deficit model, which has long been disproven in literature. This can be attributed to the limited number of Philippine universities offering dedicated science communication courses. The lack of training of scientists and science communicators [usually journalists] has also been repeatedly tackled in literature. Scientists have been noted to lack communications training even in past local research [Ponce de Leon, 2011], while science journalists have long been rebuked for lacking science training [Fjaestad, 2007].

Local science culture

Both groups also felt that the local science culture was not conducive for science communication, resulting in disinterested audiences. This disinterest was blamed on several factors, like science's relative unimportance compared to the daily struggle to survive. In 2015, around 20% of the Philippine population lived below the poverty line [Asian Development Bank, 2017]. For all the value of science, it is challenging to make it meaningful to impoverished people when science seemingly has no relevance in everyday life [Joubert, 2007]. While a basic understanding of some scientific aspects can improve lives [Joubert, 2001], most poor Filipinos have never experienced science's emancipatory potential.

Instead, many do not trust science. In fact, farmers — considered one of the poorest sectors in Philippine society [Philippine Statistics Authority, 2016] — tend to believe that technological improvements make them vulnerable to the influence of multinational corporations [Pertierra, 2003]. Such corporations have historically taken small land holdings from local farmers, causing this distrust [Kahl, 2006, p. 79]. This widespread skepticism towards science was also reflected in the 2012 World Values Survey, where a majority of the surveyed Filipinos agreed with the statement "It is not important for me to know about science in my daily life." Interestingly, the same survey found that a majority of surveyed Filipinos agreed with the statement "Science and technology are making our lives healthier, easier, and more comfortable." [Montemayor, Navarro and Navarro, n.d.]

Although the Philippine society's overall indifference to science was a consensus view among the respondents, findings from studies like the Relevance of Science Education (ROSE) report further reinforce the conflicting attitudes of Filipinos to science [Sjøberg and Schreiner, 2010]. In 2004, thousands of secondary school students from 40 countries were asked about their views towards science education for ROSE. Students from the Philippines and other developing countries were found to view science education much more positively compared to students from developed countries

This pattern of students from developing countries being more interested in learning school science was attributed by Sjøberg and Schreiner [2010] to differences in the accessibility of education between developing and developed countries. Secondary education in developing countries is characterized by high

attrition rates. In the Philippines, around 7% of secondary school students drop out every year [Senate of the Philippines, 2015]. Because of this, the remaining students are more likely to see education as a luxury and be interested in learning in general. Students in developed countries, in contrast, see education as an obligation and are more selective about which specific subjects they like and dislike.

A majority of Filipino students surveyed in ROSE also perceived science education as a positive influence on career prospects, but only half indicated interest in pursuing a career in science. This may be blamed on the discouraging attitudes of many Filipino parents towards science, as mentioned by respondents in this study. Students in the Philippines have historically been encouraged to enroll in employable courses that their parents can afford [Caoili, 1986]. Careers in STEM entail longer study periods, and are therefore more expensive to pursue. In addition, scientists are barely visible in Philippine society, reinforcing the misconception that there are no employment opportunities in science [Pertierra, 2003]. Thus, while Filipino students may initially view science and its associated careers favorably, negative connotations about science may have been perpetuated within the household.

Conclusions

This study found that scientists and science communicators in the Philippines perceive local science communication efforts as poorly done and face communication challenges similar to their counterparts in developing countries. Some challenges, however, are amplified within the developing context. For example, the generally low numbers and salaries of science communicators worldwide are even lower in the Philippines. Local science communication efforts are also challenged to cater to the country's unique culture, like its many languages and conflicting attitudes to science.

Some limitations should be considered when interpreting findings from this research. This study only included scientists and science communicators based in the Philippines' capital region, Metro Manila. While Manila has a high concentration of scientists and science communicators relative to the rest of the country, the experiences of respondents in this study cannot be generalized to their regional counterparts. As the Philippines is an archipelago, each region has a distinct culture that is reflected in the experiences of scientists and science communicators from those regions. Future studies should therefore explore the perspectives of respondents beyond Manila. Another limitation is the small sample size of respondents involved in the study. Due to the use of the chain referral sampling strategy, many respondents were skewed towards a particular institution or field. Future research should increase and diversify the sample population by including respondents from underrepresented affiliations.

Still, the universality of certain science communication challenges raised in this study indicate an underlying disregard for science communication by institutions worldwide. Recommendations like incentivizing outreach and providing more training have previously been suggested in literature, but it remains unclear if these practices will be adopted on a global scale. It may be useful to conduct multi-country studies tackling these universal challenges among developing and developed countries to confirm emerging patterns and conclusively identify these challenges' root causes. However, further research should also be done on the local issues

introduced in this study. Addressing these issues may not only provide insight into solving some of the universal challenges but also potentially serve as a model for other developing countries with comparable science communication contexts.

It is also apparent that a framework for communicating science that accounts for the Philippines' unique culture should be devised. The complexity of interaction between the different challenges mentioned in this study suggests, however, that developing a local science communication framework is a wicked problem requiring sustained research and effort to solve.

A potential framework for analyzing science communication culture has previously been outlined by Trench et al. [2014], consisting of six parameters: "the degree of institutionalisation of the science communication infrastructure; the level of attention paid by the political system; the number and diversity of actors involved in science communication; the academic tradition for dissemination of research results; public attitudes towards science; the number and qualifications of science journalists." [2014, p. 215]. Considering this study's preliminary nature, continued research on each of these parameters within the local context is needed to achieve the analyses needed to finally build a Philippines-specific science communication framework.

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