Framing and Sourcing of Science in Philippine Newspapers from 2017 to 2019

Jon Benedik A. Bunquin

Abstract

Science journalism can be challenging in societies with an emerging science culture such as the Philippines. In addition, the demands of the interest-based and taste-driven field of journalism can clash with the rigorous and technical nature of science. Science reporters must balance readability, comprehensiveness, and urgency of science stories to maintain high news quality. This study examines the coverage of science by Philippine newspapers and investigates the link of framing and sourcing to science news quality. Content analysis was performed on 394 news articles published from 2017 to 2019 and article characteristics, framing, sourcing, and news quality were coded during data collection. Results show that science reports in mainstream print media were understandable, relatable, contextualized, and explained thoroughly. However, there is much to improve on framing and sourcing of science news by Philippine print journalists, especially since these variables have been found to be significantly correlated with news quality.

Keywords: science journalism, content analysis, framing, sourcing, news quality

Plaridel Open Access Policy Statement

How to cite this article in APA

Bunquin, J. B. A. (2020). Framing and sourcing of science in Philippine newspapers from 2017 to 2019. *Plaridel*. Advance online publication. http://www.plarideljournal.org/article/framing-and-sourcing-of-science-in-philippine-newspapers-from-2017-to-2019/

Introduction

Advancements in science and technology (S&T) are crucial for societal development. Economically, S&T investments advance a country's GDP, as technological developments boost productivity and improve efficiency (Clarete et al., 2014). In the health sector, S&T breakthroughs promote the well-being of the citizens through the discovery of new medicines, production of new medical technologies, improvement of health systems, and discovery of vaccines, among others (Blumenthal, 2010). S&T research and development also leads the creation and advancement of infrastructure, while research in education aids in advancing educational tools and systems for better learning (Waddell, 2015).

Such advancements are fostered through a strong science culture, which refers to the public mentality that supports science, technology, and innovation, and promotes scientific breakthroughs and scientific careers (Bauer & Suerdem, 2016). In the Philippines, this culture appears to be weak; there are only 198 researchers per one million Filipinos in the country, when the United Nations Educational, Scientific, and Cultural Organization (UNESCO) standard declares a minimum of 380 per one million (Philippines, n.d.). Science and technology research and development investments are also observed to be unprioritized by the Philippine government, and scientists in the country lament the late integration of science in the basic educational system, as well as the lack of a system for inter-disciplinary collaboration (Panela, 2017).

One of the institutions crucial in spurring a country's science culture is the media. Popularizing science through the media can stimulate various players to make decisions for the benefit of the scientific community. Specifically, governments can be made aware of the benefits brought about by scientific discoveries and be urged to provide stronger financial support for research and development (R&D) for science and technology. Citizens can gain better appreciation for science through better and more positive visibility in the media. Popularizing science can also influence young people's career preference and stimulate interest in pursuing careers in science, technology, engineering, and mathematics (STEM) (Strelau, 2004).

But the communication of science through the media is not an easy feat. The nature of scientific breakthroughs, the perceived newsworthiness of science, and its technical nature are the biggest hurdles journalists must go through to make science popular and visible in the media (van den Brul, 1995).

Establishing scientific truth takes time

Scientific discoveries are made through a highly rigorous process. Findings cannot be automatically claimed as facts without peer review. Results must be subjected to multiple tests, undergo cross-examination and validation of findings through triangulation with other methods and previous results, and be accepted by the scientific community through peer review and replication before they can be claimed as factual. A consensus must be made before scientists can strongly declare research findings to be acceptable. Hence, scientific findings are usually tentative (Van Witsen & Takahashi, 2018; van den Brul, 1995), and it takes time before a breakthrough can be made. This is also one of the reasons why scientists must be careful when disseminating findings, whether through niche or popular channels.

Thus, science journalists on the lookout for science breakthroughs face this difficulty. Most of the time, they resort to reporting studies that are still under development and treat ongoing studies as factual or vetted, or as if these studies have been accepted by the scientific community. In a study on the reportage of newspapers on biomedical issues, around one in every two (48.7%) research findings, reported in the media, have not been validated or are poorly replicated (Dumas-Mallet et al., 2017). Only half of the biomedical news published by the media can be considered as accurate, and it can be ascertained that this may be true for other types of scientific news reports.

Caroline Van den Brul (1995) notes that:

> In science, something eventually becomes of note through replication. For journalists, certified ideas are old news. The emphasis on breaking news is often seen to be detrimental to good coverage of science when the significance is long-term. Editors want color and excitement; scientists want accuracy and significance (p. 213).

The desire to break new and exciting scientific findings steers journalists to put out news that have not been vetted and confirmed.

Science stories cannot keep up

Stories are judged based on a set of qualities known by journalists as news values. News values describe the qualities that make news interesting and publishable (Badenschier & Wormer, 2012). For Philippine editors, relevance and consequence can be considered as the fundamental values in reporting science. This means that science news would only "sell" if audiences see its direct impact on their lives (Delgado & Ong, 2010).

Moreover, most of the science reported on the news are developing stories, so they look pale in comparison to murder or rape stories that sell better as news (Wilkie, 1991). Unlike other topics that possess high news values, such as politics (through prominence and relevance) and crime (through proximity), science journalists must flip through the pages of scientific journals to find newsworthy information, or package stories to make them "newsworthy."

Timeliness is another indicator of newsworthiness (Delgado & Ong, 2010), which scientific breakthroughs may contain. Yet, these breakthroughs take time and those considered groundbreaking do not happen overnight and are often not accessible to local media. To make science reports more interesting, some journalists sensationalize their reporting. Journalists also link science to pseudo-scientific events as well as mysticism to increase the newsworthiness of their reports (Congjuico, 2016).

Thus, the perceived unworthiness of science reports make science unable to compete with other stories, which is why science issues are put on a low priority by mainstream news. Evidently, the low priority on science news poses implications on the work of journalists covering the science issues. In New Zealand, science journalists, while passionate about the subject they cover, do not always get to focus on their beat (Ashwell, 2014). Instead, they have to look for stories in other beats or areas often as instructed by their editors (Ashwell, 2014). Similarly, in the Philippines, there is also a lack of a dedicated science beat and journalists devoted solely to the reportage of scientific issues and events. In some cases, science beat reporters still have to cover other stories, which make in-depth or investigative science reporting difficult to produce (Congjuico, 2016).

Scientific stories are difficult to understand

When scientific discoveries are made, they usually become available through peer-reviewed science journals. These journals usually cater to specialist audiences, i.e., other members of the scientific community, so reports in these journals usually contain jargons or technical words used by a discipline.

This poses another issue for journalists, as readability of scientific reports have been observed to decrease. Noting the role of clear and accurate language in scientific reports, scholars have found that scientific research published in scientific journals have decreasing levels of readability (Plavén-Sigray et al., 2017). The use of jargons, as well as loaded sentence constructions and the use of highly academic language, have contributed to the inaccessibility of scientific texts to lay audiences (Plavén-Sigray et al., 2017).

But journals are not the only scientific reports observed to have decreasing levels of readability. For instance, assessment reports by the Intergovernmental Panel on Climate Change (IPCC) have been becoming more and more difficult to read (Barkemeyer et al., 2016), which is problematic given that these reports are used by non-specialist audiences, including journalists, as reference materials.

Given the technical nature of science, audiences must rely on science journalists to "translate" the scientific jargon and make sense of the highly technical information and why it matters to non-specialist readers. Reporters serve as "knowledge-brokers" (Van Witsen & Takahashi, 2018), so they must possess the ability to understand scientific information and communicate them to non-specialist audiences. It is recommended that newsrooms be populated with reporters who understand scientific jargon. Aside from a change in personnel and an increase in journalism training, journalism schools must produce graduates who have the competency in discerning, understanding, and communicating highly technical information (Van Witsen & Takahashi, 2018).

Statement of the problem

The nature of science as a rigorous, truth-seeking discipline must meet with the demands of the temporal, interest-based, and taste-driven field of journalism. Science discoveries are only made after time-consuming efforts and may not always seen as newsworthy. Some of these discoveries are not always understandable for journalists, and in societies with a weak science culture such as the Philippines, reporting science could be extra challenging.

Thus, this study examined the state of science reporting in the Philippine media by analyzing content published in print newspapers. Specifically, it asked the question: How is science reported by Philippine newspapers?

Review of Related Literature

Coverage of Science

Science reporting is a broad field in journalism, focusing on a diverse set of issues and disciplines such as biomedical science, specifically in genetics (Conrad, 1999; Väliverronen, 2007), medical advances (Hong, 2013), obesity (Saguy & Alemling, 2007), disease, aging, and death (Molek-Kozakowska, 2016); environmental science, specifically in climate change (Cadorette et al., 2018), biofuel (Kim et al., 2013); and technology (Allan et al., 2010). Clearly, the field of science offers a lot of stories that could be covered by journalists. However, life sciences, specifically the biomedical discipline, dominate the news coverage (Hansen, 1994; Pellechia, 1997; Summ & Volpers, 2016), which can give the impression that some scientific fields are more relevant

than others (Šuljok, 2015). The non-visibility of other scientific disciplines in the media has an implication on their perceived importance in society.

The intersections of scientific findings with other facets of social life including its political or social implications may also be of interest to science reporters (Hornig, 1990; Kim et al., 2013). Science coverage can suggest controversy or consensus to the public (Hornig, 1990). In general, however, science stories with a human-interest angle are considered more newsworthy compared to straightforward reporting of facts (Summ & Volpers, 2016). Their newsworthiness also increases if they are linked to major disasters and developments in the economic and political sphere (Summ & Volpers, 2016). Their role in solving broader social and political problems are also considered (Hansen, 1994). Newsworthiness in science are also constructed through novelty, proximity/relevance, impact, drama (Cadorette et al., 2018; Molek-Kozakowska, 2016), conflict (Lore et al., 2013), and human interest (Hong, 2013).

Science reporters' main role is to be the "intermediary" or translator of science in a language that the general public will understand, a "watchdog" that discusses social and ethical implications of the scientific work, and a "tool giver" that provides readers the tools that they need to evaluate the issue (Kua et al, 2004). The primary concern of scientists and medical experts in science coverage is the accuracy of the report (Pellechia, 1997) and the journalists' low level of knowledge in these fields could lead to either exaggeration or omission of important facts (Larsson et al., 2019). Studies showed that when compared to the original research, news reports were found to omit important information, such as methodological details and research procedures (Pellechia, 1997), sensationalize results, commit error of inference (Molitor, 1993), and lack of context or detail that will enable the readers to understand its application to their own lives (Kua et al., 2004).

News quality is determined by story interest, readability, news content thoroughness, type of information conveyed (Bodle, 1996), simplification, accuracy, critical scrutiny, and acknowledgment of limitations (McKinnon et al., 2018). The main challenge for science reporters is the balance between simplification and accuracy. There is a need for simplification to make it accessible and understandable to the general population, but also accuracy to not oversimplify which may contribute to misrepresentation and misinformation to the public (McKinnon et al., 2018; Morin-Chassé, 2014). Thus, longer stories would tend to have better news quality as they are able to present more thorough content. In addition, specific news genres, such as feature stories and opinion pieces, are typically written in long formats, and would thus be more likely to have better news quality. Given these, the present study hypothesized that:

H_1: News quality is significantly positively related to article length

H_2: Feature and opinion articles have a significantly higher news quality than straightforward news articles.

Newspapers can also make use of certain techniques to make their stories better understood, such as the use of graphics or images, and the removal of jargon or technical language.

The public may draw clumsy inferences or generalizations from the information presented in the news (Morin-Chassé, 2014). For instance, the genetic attribution for mental disease and deviant behavior may cause and reinforce stigma and bias to the public believing that these are immutable and there is no opportunity for recovery (Morin-Chassé, 2014). Other indicators of poor science reporting are errors of omission, errors of inference, and sensationalized results. For example, a content analysis comparing a research study on Aspirin and how it was reported in national newspapers showed that they omitted important information such as Aspirin having no effect on heart attacks but leading to increased occurrence of stroke (error of omission), and they generalized the result to the general public, when in fact the effect was found in a highly unrepresentative sample (Molitor, 1993). These errors may promote and cause unhealthy behaviors to the public which may result in serious health problems and may also lead to greater confusion, and increase the likelihood that the audience will draw inaccurate conclusions (Molitor, 1993).

Framing of Science

The public relies heavily on media for information on science and technology. Due to this, their opinion can be easily altered because they do not have access to alternative sources of information to understand scientific and technical terms (Hornig, 1990).

Science news, much like other media content, undergo the process of framing. According to Robert Entman (1993), framing refers to the selection of "some aspects of perceived reality and make them more salient in the communicating text, in such a way as to promote a particular problem definition, causal interpretation, moral evaluation and/or treatment recommendation for the item described." (p. 53). The use of certain frames thus allows sources to predict its possible effects (Entman, 1993). By dictating what the issue is and which information is relevant (Beattie & Milojevich, 2016; Kenix, 2008), frames are able to shape the public ideology, and the public's understanding, interpretation, evaluation, and judgment of an issue (Kenix, 2008; Kim et al., 2013; Rodriguez & Lee, 2016). In turn, frames may affect public attitude (Duan & Miller, 2019), actions,

and behavior (Väliverronen, 2007). For instance, a coverage that frames a scientific development to be low-risk may stimulate complacency, but if it is framed as a high-risk, it may cause unnecessary panic to the public (Hornig, 1990).

Mauro Porto's (2007) work on frame diversity offers insight on the role of multiple voices in the information processing of news readers. For Porto, media's role is not just limited to informing audiences. Media must provide interpretive frameworks that allow audiences to understand the information conveyed to them. These interpretive frames offer explanations or context to the various issues presented in the media. These frames are provided by a source that offer specific interpretations of political events or issues (Porto, 2007). It is important, then, that a story is informed by multiple perspectives, to aid audiences in deciphering and interpreting events in a more creative and critical manner. Studies, however, show that there is a lack of diversity in framing of issues and audiences are only exposed to elite frameworks, i.e., those related to politics and business (Porto, 2007). Thus, it was hypothesized in the present study that:

> *H_3: Frame diversity is significantly positively related to news quality.*

Evidently, science can be framed in different ways, depending on the specific science discipline being covered. The challenge is to develop specific typologies that can be applied to any type of scientific story. Adrijana Šuljok's study in 2015, on the framing of science in Croatian newspapers, offers a succinct way of categorizing the way news media presents scientific information. Building on Matthew Nisbet's (as cited in Šuljok, 2015) work on climate change frames (2009), the study analyzed over 800 science news articles, and have generated seven main frames, namely: scientific and social progress frame, scientific controversy frame, political and ideological function and social status frame, scientific accountability frame, ethical aspects and risks frame, and "sciencetainment" frame (Šuljok, 2015).

Sourcing of Science Stories

Framing events are done through sourcing. In science reporting, sources are considered as the "primary definers" of topics because they dictate what information and arguments should be labeled as pertinent and important (Rodriguez & Lee, 2016). Audiences are affected by stories dominated by a single voice. People who read stories with multiple sources, with scientists and research reports, tend to perceive those stories as more credible (Cozma, 2006) and more in-depth (Ramsey, 1996) than those who only rely on one source. Hence, the present study hypothesized that:

H_4: Number of sources is significantly positively related to news quality.

Sourcing is also viewed as an outcome of a media outlet's slant. To illustrate, market-sponsored newspapers, which publish stories using a conflict and economic frame, were found to present multiple perspectives and more diverse sources compared to party-sponsored newspapers (Duan & Miller, 2019). Party-sponsored newspapers, meanwhile, tend to emphasize skepticism in their articles (Duan & Miller, 2019). Journalists must exercise caution when they publish press releases and other ready-to-print PR materials.

As independent watchdogs, science reporters must not rely on such materials and exercise their duty to validate information and get alternative perspectives on science issues (McKinnon et al., 2018). Diversity in news is one of the determinants of quality. Diversity, which refers to the presence of multiple perspectives, viewpoints, and sources (Duan & Miller, 2019) demonstrates the journalist's ability to gain access to data, expert opinion, and informed interpretations (Rodriguez & Lee, 2016). Thus, the present study hypothesized that

H_5: Source diversity has a significant positive relationship with news quality.

Source can be categorized into two: elite and non-elite (Stroobant et al., 2017). Elite sources are the advocates and experts such as scientists, researchers, government officials (Cozma, 2006; Hansen, 1994; Rodriguez & Lee, 2016; Stroobant et al., 2017), and health professionals and medical practitioners (Appiah et al., 2015). These sources are considered by science writers as the most important and credible sources of information as they help to shape the news by providing information, interpretation, and perspective (Appiah, et al., 2015; Conrad, 1999). Non-elite sources refer to ordinary citizens and their individual experiences or subjective accounts, which are mostly cited in human interest stories because it can appeal to people's emotions through dramatization of experiences (Stroobant et al., 2017). However, the problem with non-elite sources is that most of the time they are deemed as less credible and require greater work for journalists to fact-check and revise information (Stroobant et al., 2017). Elite sources are used most often in science news. Non-elite sources, who were in fact directly and most affected, were rarely cited and their viewpoints were unheard despite their experience, which shows that the voices of the marginalized and underprivileged group were not heard by the public (Beattie & Milojevich, 2016; Conrad, 1999). Stories with non-elite sources

humanize science stories and provide context to technical information. Thus, the present study hypothesized that:

> *H_6: Articles with non-elite sources have significantly better news quality than articles that only have elite sources.*

Methodology

The study covered news articles published in print newspapers from January 2017 to October 2019. The researchers sought archiving assistance of the University of the Philippines College of Mass Communication Library, which has subscriptions from all the major Philippine daily broadsheets. These broadsheets are the *Manila Bulletin*, *Manila Standard*, *Philippine Daily Inquirer*, *Philippine Star*, and the *Manila Times*.

Archiving assistants were asked to scan these broadsheets on a daily basis and collect all articles with an explicit mention of any science-related concept or field, which included the following topics: science and technology, agriculture, biology, biotechnology, chemistry, engineering, geology, mathematics, health and medicine, and physics.

A total of 1364 news articles were collected during the archiving period. This constituted the universe of news articles to be analyzed. A stratified sampling approach was used to ensure that each broadsheet will be included in the sample. The articles were grouped per broadsheet in which they were published, and articles were numbered from 1 to n, with n being the total number of articles from the respective broadsheet. A random number generator was used to determine the starting point of sample collection in each broadsheet. A sampling interval was computed based on the proportion of broadsheets to the news article population, and articles identified with the sampling interval were included in the final sample. A total of 394 articles were included in the analysis.

Five coders were hired to analyze the articles. The coders went through five rounds of pre-testing until variables of interest reached an acceptable inter-coder reliability score of 0.7 based on Krippendorf's alpha.

Variables and Measures

The study examined the manifest article characteristics, specifically, article length (number of words), presence of graphics (absent or present), number of graphics, type of graphics present (human subject, landscape, laboratory, equipment, discovery, phenomenon, infographic, and others), and article genre (news, feature story, opinion/commentary/editorial, and others). The discipline of science being covered in the news article was also coded.

The presence of jargons was also coded in the study. Adopting the definition of Jordana Rosenberg (2012), jargons refer to words or phrases

that are only used in specific contexts and for specific audiences, concepts named after a person, and excessively long words that are difficult to pronounce.

Frames were also analyzed in each article. The frame typologies in Šuljok's (2015) study were adapted as frame categories, as shown in Table 1. A news story may contain more than one frame; if a sentence or a paragraph in a story contains any of the indicators shown below, the corresponding frame was marked as "present." Frame diversity was then computed as the total amount of unique frames used in the article.

Table 1. Frame categories adopted from *Šuljok* (2015)

Frame	Description
Scientific progress	Science news frame in which developments, milestones, and progress made in any scientific endeavor are presented
Scientific controversies	Science news frame which refers to uncertainties and controversies involved in science, whether in terms of knowledge, processes, consequences, or conflicts of interest. These include stories about science as not yet final, unsolved puzzles, research that refute previous findings, conflicting explanation
Scientific failure/ underachievement	Science news frame in which blunders and under-developments in any scientific endeavor are presented
Political and ideological function and social status	Science news frame in which scientific evidence or data is used or cited to support an ideology or belief.
Scientific accountability	Science news frame in which scientists or the scientific community provides evidence-based warnings about any issue or event, including discoveries by other scientists
Ethical aspects and risks	Science news frame which focuses on the ethical aspect of science discoveries, especially in its application. This also includes moral implications of science issues.
Sciencetainment	Science news frames that puts funny trivia and interesting facts into focus to make scientific information accessible and entertaining

To examine sourcing of science news articles, the study coded the type of sources of information in science articles. These sources included scientists, academics, lawyers, government officials, non-government organizations, corporations, material sources (such as documents and research papers), and ordinary citizens. An "others" category was used to capture sources not included in the aforementioned categories. Moreover, the study also

checked which of these sources were directly quoted by science journalists. Source diversity was computed as the number of unique type of sources present in the article.

The study also examined if the science story (1) did not require multiple readings just to be understood, (2) related the issue to other non-scientific issues, (3) showed possible implications, (4) provided context to the scientific issue being discussed, and (5) showcased engaging elements through writing. Each item was marked as either "present" or "absent," and these served as news quality indicators measured in the study. A news quality index was computed by adding the total number of news quality indicators present per article. Thus, scores ranged from 0 to 5.

Independent samples t-tests, analysis of variance, and correlation tests were performed to test the study hypotheses.

Results and Discussion

Descriptive statistics were performed to describe the coverage of science in the Philippine media. Table 1 shows the distribution of articles per characteristic examined.

The biggest number of the articles came from the *Manila Bulletin* (43%). More than half of the articles (59%) were straightforward news story, which means that most science stories were informational in nature. Around one in every three articles (36%) were feature stories, which allow for a more in-depth presentation of scientific issues, while less than 5% of the articles were opinion pieces. Based on the top-line results, it seemed that Philippine print news articles have become less technical and more contextual. Articles mostly covered science-related policies (41%) and scientific facts or information (37%). Policy-related coverage may be indicative of a more nuanced view of science. By covering topics outside traditionally newsworthy science topics, such as new breakthroughs and discoveries, and reporting its intersection with other facets of social life, such as policy and governance, the Philippine media may be expanding its definition of what constitutes as "science" news. Understandably, informational coverage is still imminent, given that a third of the articles were related to scientific facts or information.

Table 2. Frequency distribution of news articles per article characteristic (N=394)

Characteristics	**f**	**%**
Publication Name		
Manila Bulletin	171	43.4
Manila Standard	26	6.6

Characteristics	f	%
Philippine Daily Inquirer	78	19.8
Philippine Star	48	12.2
The Manila Times	71	18.0
Article genre		
News story	232	58.9
Feature story	141	35.8
Opinion/Commentary/Editorial	19	4.8
Others	2	0.5
Article topic		
Scientific discovery	62	15.7
Scientific policy	161	40.9
The Scientist	12	3
Scientific facts or information	144	36.5
Others	15	3.8

Science articles have an average of 477 words. As shown in Figure 1, one-third of the science articles were accompanied by graphics (38%), and only a quarter of the news articles (25%) have at least one jargon. The remaining 75% do not contain a single jargon, which may indicate good readability.

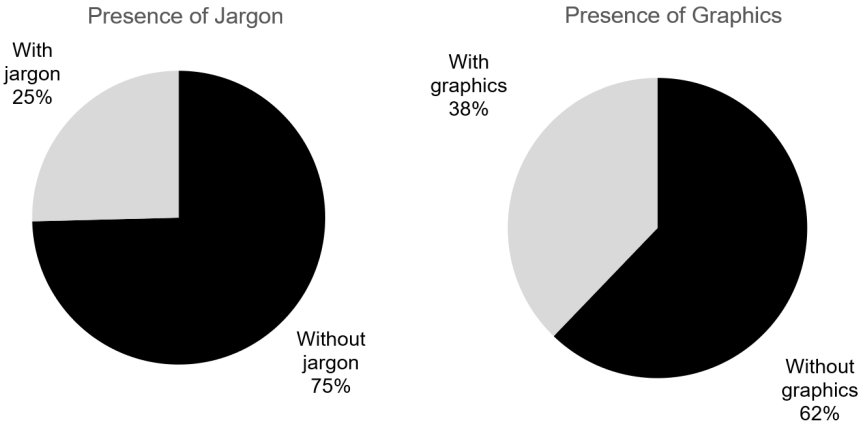

Figure 1. Presence of graphics and jargon in the articles (N=394)

As shown in Table 3, around one in every five science news articles come from the field of health and medicine (20%), followed by environmental science (16%), and agriculture (14%). Engineering, marine science, and mathematics were least covered in the sampled articles, each comprising

less than 1% of the sample. The prevalence of health news in the sample supports the results of previous studies, specifically on the disciplines that get the largest exposure in the media (Hansen, 1994; Pellechia, 1997; Summ & Volpers, 2016).

Table 3. Frequency distribution of news articles per science discipline (N=394)

Science Discipline	**f**	**%**
Health and Medicine	79	20.1
Environmental Science	61	15.5
Agriculture	55	14.0
General Science	38	9.6
Biology	33	8.4
Geology	23	5.8
Physics	21	5.3
Technology	18	4.6
Others	15	3.8
Meteorology	14	3.6
Astronomy	12	3.0
Chemistry	9	2.3
Computer Science	7	1.8
Engineering	3	0.8
Marine Science	3	0.8
Mathematics	3	0.8
Total	394	100

Following Porto's (year) frame diversity argument, a story may be framed in different ways. In the case of science, around two frames were typically used, and the scientific progress frame was used most often, as shown in Figure 2. Around seven in every 10 (73%) articles focused on the developments and milestones made in the field of science. This frame was followed by the failure frame (43%), or stories that focused on the blunders and the underdevelopments in the field. The sciencetainment frame was used least (2%) by the articles examined.

When it comes to sourcing, government officials got the largest share of voice in news stories. More than half of science news articles (55%) got their reports from government officials or agencies. This was followed by material documents and research papers (29%), and scientists themselves (25%). Lawyers and legal experts were least used as sources (1%).

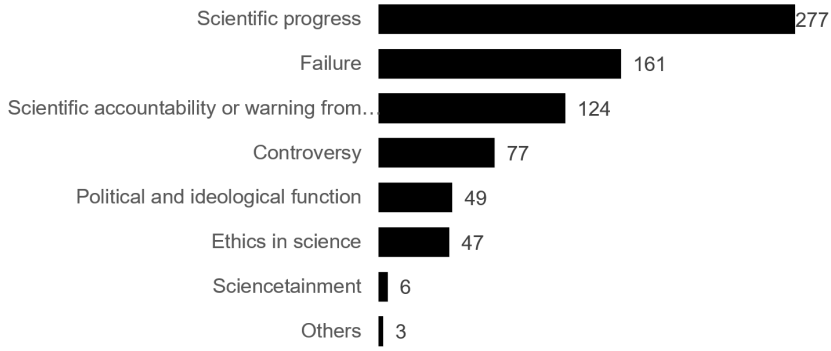

Figure 2. Distribution of news articles per frame (N=394)

The government, which included cabinet secretaries and official spokespersons, were also quoted most often in Philippine science news stories. More than half of science reports contain quotations from government officials (56%), followed distantly by non-government organizations (20%) and scientists (17%). Likewise, lawyers and legal experts were least quoted (1%). Figure 3 shows the distribution of articles per source cited and directly quoted.

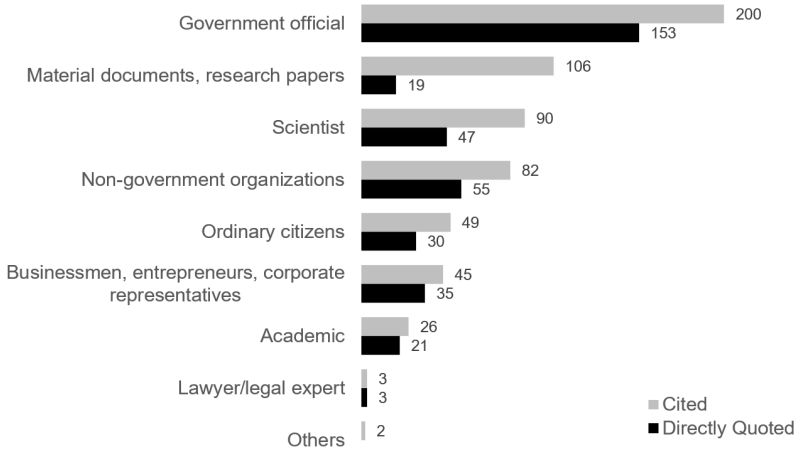

Figure 3. Distribution of news articles per source cited and directly quoted (N=394)

Aside from framing and sourcing, the study looked into the quality of news articles from Philippine broadsheets. Quality is indicated by the readability or understandability of the news article, its communication and contextualization of scientific information to non-scientific matters, and

its emphasis on the importance or impact of science issues. Table 5 shows the number of stories containing such news qualities. A composite score was also developed based on the number of news quality indicators per article. The score ranged from 0 to 5. On the average, science news articles examined had a score of 3.43, indicating that articles usually had at least three of the five news quality indicators.

Based on the results, almost all the articles reviewed could be understood in one reading (92%), which means that they have been written for non-specialist readers.

A large majority (68%) of the articles were also related to at least one non-scientific sector, indicating multi-dimensional coverage. Through such coverage, readers can get a better understanding of science and its role in other sectors of society.

Three in every four articles (75%) also explicitly discuss the implications of science and technology (S&T) issues to ordinary citizens. By explicitly writing the impact of S&T issues to ordinary citizens, science journalists provided tools to readers in making sense of technical issues and its applicability in everyday living.

Findings also revealed that the coverage of Philippine print newspapers are contextualized (69%), which helped clarify the role of science in various phenomenon.

While most of the news quality indicators show that the coverage of science is understandable, relatable, implicated, and contextualized, only four in every 10 articles were considered as engaging (40%). This means that these articles may not be interesting enough to be finished by readers.

Table 5. Frequency and percentage of news articles with presence of news quality indicator

News quality indicators	f	% of cases
The story can be understood in one reading.	362	91.9
The story is related to at least one non-scientific sector.	268	68.0
The story explicitly discusses the implications of the issue to an ordinary citizen.	294	74.6
The story provides context to the findings, scientific information, processes, and jargon.	272	69.0
The story engages the reader to finish the article.	156	39.6

Relationships were hypothesized to further explicate content-related variables associated with news quality.

Correlation tests revealed that news quality index increases with length of news article ($r = .37$, $p = .000$), providing support to Hypothesis 1 of the

study. This indicates that longer articles were more likely to be better science stories. It can be surmised that longer articles tend to be more thorough and accurate, factors that determine news quality (Bodle, 1996), given the amount of information that are presented in news stories.

It follows, then, that article genres that are typically longer would have better news quality. Feature articles and opinion pieces, which contain more details and extensive explanations as they provide more information and present more context, would usually be longer than straightforward news articles. As shown in the ANOVA tests, these articles tend to have a significantly higher news quality score than straightforward news articles [$F(3,390) = 6.09$, $p = .000$)]. Post-hoc comparisons using the Tukey HSD test indicated that news quality ($M = 3.43$, $SD = 1.29$) was significantly higher for feature stories ($M = 3.69$, $SD = 1.12$) and opinion/commentary/editorial articles ($M = 4.05$, $SD = 1.03$). This finding provides support to Hypothesis 2 of the study. Aside from the length of these stories, the content of feature stories, which are typically narrative-type human interest stories, may have contributed to the quality of news. The presentation of alternative viewpoints in editorials and thoroughness of reporting in feature stories make these types of articles more accurate (McKinnon et al., 2018; Morin-Chase, 2014).

Stories that are lengthy and genres that are written in longer formats can utilize different news frames when reporting science stories. In this study, it was hypothesized that frame diversity, or the use of different frames based on Šuljok's typologies would have better news quality. Frame diversity was computed as the total number of unique frames used in the story, and the correlations test indicated that news quality significantly increases with frame diversity ($r = .29$, $p = .000$). This supports Hypothesis 3 of the study, which was based on Porto's argument on the principle of news diversity (Porto, 2007).

Evidently, stories that are framed in multiple ways come from a diverse set of sources. As journalists involve more sources in science stories, they are able to present information from multiple viewpoints and improve the quality of reports. Hence, Hypothesis 4 posited that the number of sources used had a significant positive relationship with news quality. This hypothesis was supported through a correlations test, which indicated that the news quality tended to increase with the number of sources in science news ($r = .27$, $p = .000$).

Following the diversity argument, however, it is not enough that stories have a lot of sources. The type of sources utilized also matters. Science stories benefit from a diverse set of sources, because then science issues can be presented in non-scientific ways. Hypothesis 5 articulated the

relationship of source diversity and news quality, and it was found through correlations tests that there is a significant positive relationship between the two variables ($r = .27$, $p = .000$).

Scholars even argue that science news is better understood and contextualized through the use of non-elite sources (Beattie & Milojevich, 2016; Conrad, 1991). This provided the basis for Hypothesis 6 of the study, and the findings using independent samples t-test showed that news quality is significantly higher in stories with non-elite sources ($M = 3.77$, $SD = 1.28$) than sources that exclusively used elite sources ($M = 3.30$, $SD = 1.27$) [$t(392) = -3.23$, $p = .001$]. These results signify that stories that include insights or perspectives from non-government organizations and ordinary citizens tend to be better understood, more contextualized, more relatable, and more engaging.

Conclusions and Recommendations

The role of good science reporting in the development of a society's science culture is crucial. It is important that science issues are presented in a way that could be understood by audiences, so they can make decisions guided by scientific evidence. But evidently, the very nature of science as a rigorous, time-consuming discipline clashes with journalism as a temporal, interest-based field. This study thus sought to examine how the Philippine print media reported science and technology issues, looking into concepts of framing and sourcing as key content-related factors that drive news quality.

In summary, science issues reported in the Philippine print media from 2017 to 2019 has been understandable, relatable, contextualized, and explained using multiple frames from multiple sources of information. However, most were not written in a manner considered to be engaging for audiences.

There is still space left to improve on the coverage of science. When it comes to framing, science journalists still take on the scientific progress frame, and while this is understandable, journalists are encouraged to take on different framing techniques when writing stories about science, such as their intersections with political and social issues, and the ethical issues surrounding scientific developments. Understanding the link between science and other aspects of social life is crucial, so journalists can present science issues in more critical, creative, and nuanced ways. It also helps audiences realize the role of science in other contexts, such as the home and the workplace. Moreover, science journalists can also explore topics that typically do not get visibility in the news, such as chemistry, marine science, engineering, marine sciences, and mathematics, as it can enrich

how audiences think about the varied ways in which science contributes to different areas in society

Sourcing is also an issue that needs to be addressed by journalists. Since science reports require expertise of scientists and researchers, it is important that they take the spotlight in reporting. However, scientists only come in third as the most utilized source in science reports, following material sources of information (such as journal articles). As experts, scientists provide technical and research-based inputs to different issues. They can also provide nuanced insights to help journalists make sense of findings from material sources. Thus, it could be recommended that journalists develop better relationships with scientists from various fields, to ensure that they can tap into an expert whenever their expertise is needed. Scientists, meanwhile, must be open for interviews, or even reach out themselves, whenever a specialist is needed to shed light on science-related issues. Institutions that produce scientific research, such as the academe, can also strengthen public dissemination efforts through better linkages with the media and providing opportunities for interviews with available expert resources.

Non-elite sources also help in storytelling. As shown in the study, getting the insights of non-government organizations and ordinary citizens can help improve science reporting as they provide more nuance and context to the statistics and other technical information typically provided by technical sources.

The study provided evidence on the role of diverse framing and sourcing on the quality of scientific information. Consistent with the literature, the presentation of multiple viewpoints and thoroughness in reporting are crucial to make sure that stories are complete and understandable. Ultimately, the goal is to ensure that audiences are provided the crucial information they need and aid in the interpretation of science-based phenomenon. Future research can explore reception-based content analysis, to examine how content-related variables intersect with audience characteristics. Moreover, in-depth interviews and case studies may shed light on the framing and sourcing practices of journalists to improve the overall practice of science journalism in the country.

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Grant Support Details

Author Contributions: All research activities and writing were done by J.B. Bunquin. The author has read and agreed to the published version of the manuscript.

Funding: This research was funded by the Communicating Science and Technology Research and Development (CoST U.P.), an emerging interdisciplinary research (EIDR) program of the University of the Philippines Office of the Vice President for Academic Affairs. The UP System Research Program Code is EIDR C07-009.

Acknowledgement: The author would like to acknowledge the research assistance of Geomyr Delarmente and Jamie Lyn Loristo.

Conflict of Interest: The author declares no conflict of interest.

About the Author

JON BENEDIK A. BUNQUIN is an Assistant Professor at the University of the Philippines' (UP) Department of Communication Research. He obtained his undergraduate degree in journalism and master's degree in communication from the UP (corresponding author: jabunquin@up.edu.ph).