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Establishing Autonomy and Responsibilities of Science Writers

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Ana Nadhya Abrar[1*], I Gusti Ngurah Putra[1], Adam Wijoyo Sukarno[1], Desmalinda[1], Mirfath[1]

[1]Universitas Gadjah Mada
Jl. Sosio Yustisia No. 1, Bulaksumur, Yogyakarta 55281 - Indonesia
*Correspondent Author: ana.abrar@mail.ugm.ac.id

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Abstract
An important theme of science communication research is research on science article writers. However, not many scholars are interested in doing this research. Based on this fact, we conducted a research on the ideal position of a science article writer. It turns out that he definition of science writer has changed in Indonesia. Quantitative content analysis of articles reported by The Conversation Indonesia during December 2021 found that the writerss motivated the public to understand and use scientific principles to meet their daily needs. The results of in-depth interviews with three prominent professors at Universitas Gadjah Mada confirm the same fact. They do not just tell the object of research in a certain context. This fact certainly needs to be imitated by other science writers. However, there is a basic recipe that must be practiced by other science writers. The practice of the recipe will make them autonomous and responsible to society. Thus, the article will explain the ways that can be taken to make it happen.
Keywords: Autonomy and responsibility; In depth-interview, Quantitative content analysis, The conversation Indonesia; Science writer

Introduction

The science writers referred to in this research are those who write research in reputable scientific journals and journalists who write articles about science in the mass media. For example, in health research, good science writers are the ones who can make recommendations to improve public understanding comparable to those proposed by the scientific community (Cooper et al., 2002). In addition, science writers must consider the content of writings based on novelty, applicability, controversy, credibility, and entertainment (Geller et al., 2005). Interests that aim to make the public understand the information written are the main aspects that science writers must have. The concept of audience theory explains the essence of how the public is interested in and attentive to the communication messages that the author produces and is intended for the public to understand, experience, and respond to in one way or another (Littlejohn & Foss, 2009).

Good science writing has the potential to help improve people's science literacy index. In general, Indonesia's science literacy index is not yet known. However, referring to

the digital literacy rate and Indonesia's reading interest index, it is still considered to be in low category. In fact, according to Word Bank data in 2018 (World Bank, 2018), as many as 55% of Indonesians are still functionally illiterate. From the same data, functionally illiterate means being able to read the text but not being able to answer questions related to the text.

Therefore, it is necessary that scientists actively and openly engage with the public, communicating their research in an accessible and effective way (Smith, 2016). It is time for research results to practically become a source of public reference. In line with this, from the perspective of Communication Science, Hermin Indah Wahyuni (2021) once said that communication is a determinant of the effectiveness of building a system response. Subsequently, she wrote:

> "…..The more people have a good quality of communication, the more they will come to how to respond to community problems that in the future will certainly be more complex (2021: 5)."

In this section, the differences between writing science in scientific journals and popular media will be explained as follows: writing in scientific journals according to O'Connor & Joffe (2014), is an elaboration of the system between the process of checking and mobilizing neutrality values (2014). The checking process covers the development of scientific ideas. These ideas are assimilated into the involvement of human common sense so that the human brain can finally process the information.

Furthermore, on the values of neutrality, the process of obtaining information is interpreted to eliminate personal and cultural *biases* inherent in a writer, so there are no restrictions on any kind of representation in scientific writing aimed at the public sphere.

When we compare to popular media, we must consider the differences between each type of audience interest (Kua et al., 2004). Writing in popular media, according to O'Connor & Joffe (2014), is analogized to examining the information (experimental practices) generated from the *scientific laboratory*, so the results are transmitted to the public into the influence of the media environment towards the production of content that is in line with the characteristics of contemporary society.

Science is a puzzle-solving process (Kua et al., 2004); it means that the culture of science could help the readers comprehend how scientific discoveries are made and place the findings into the context of writing about science issues.

According to scientific context, John Durant proposed a tripartite model for the Public Understanding of Science in this following (cited in Kua et al., 2004):

> "……The first model is "knowing a lot of science," the second model is "knowing how science works," and the third model is "knowing how science *really* works," (2004: 309-310)"

The three models above, according to Kua et al., (2004), are used to find the facts of science (what science has discovered about), the research method of science (how science operated; how hypotheses are generated and revised), and the sociology of science (refers to how the scientific community conducted; how to secure funding; how theories come into vogue, are judged and are accepted or rejected).

Theoretical Framework

Research on science communication has been around for a long time, starting around 60 years ago, and is mostly carried out in countries that have strong-rooted scientific traditions and are categorized as developed countries (Hin and Subramaniam, 2014; Guenther and Joubert, 2017; Trench and Bucchi, 2010).

In the last twenty years, researchers in countries in the Asia Pacific Region have begun to pay attention to science communication research (Hin and Subramaniam, 2014). The existence of science communication research is supported by the publication of science communication journals in several developed countries.

The oldest science communication journal to date is *Science Communication*, which was published in the late 1970s, followed by the publication of the *Public Understanding of Science* and the *Journal of Science Communication*. Interesting developments in science communication research are also evidenced by the increase in the frequency of publication of these journals.

In the early stage of publication, they were published only four times a year, now these journals are published up to six times a year (Guenther and Joubert, 2017; Horning Priest, 2012; Trench & Bucchi, 2010).

Articles of science communication research results can also be found in various other journals that pay attention to the issue of science communication. In addition, several books and handbooks on science communication have been published (Buchi & Trench, 2014; Gascoigne, 2020; Hin and Subramaniam, 2014; Leßmöllmann, Dascal and Gloning, 2019; Newman, 2019).

Of the various existing studies, scientific communication research that has been published in the form of journal articles is still dominated by researchers from developed countries such as the United States, Canada, Western European countries, and Australia. Only a small proportion, less than 10 articles come from Asian, African and Latin American countries (Guenther and Joubert, 2017; Trench and Bucchi, 2010).

The development of science communication research is now expanding to various countries in the world (Mulder, Longnecker, and Davis, 2008) such as countries in Latin America (Massarani and Oliveira, 2022), a number of countries in Asia such as Japan, China (Xu, Huang, and Wu (2015) and the Philippines (Navarro and McKinnon, 2020). But this development does not make Indonesia part of it.

In general, science communication in Asia is not as developed as in western countries (Davis, 2010). In Indonesia, research on science communication is still a rare item.

From a search of the accredited communication journal Sinta 2 with the keyword "science communication", only a few articles use abstract science communication, but with content that does not specifically examine how science communication in Indonesia. (Note: some of the journals that were searched were the *Jurnal Ilmu Komunikasi* published by Atmajaya University Yogyakarta, *Jurnal Studi Komunikasi* published by Unitomo Surabaya, *Jurnal Komunikasi* published by the Islamic University of Indonesia Yogyakarta, *Jurnal Komunikasi* published by the Association of Indonesian Communication Scholars, *Jurnal Ilmu Komuinikasi* published by UPN Veteran Yogyakarta).

The underdevelopment of research on science communication in Indonesia is possibly due partly to the fact that science communication has so far not received sufficient attention either as a practice or as an academic study or discipline.

While the development of science communication research in several countries is an important part of the development of science communication as an academic discipline in various universities both at the undergraduate level, and many of them are in postgraduate programs (Trench and Bucchi, 2010), science communication in Indonesia has not yet become an academic study as part of communication disciplines as well as in the field of science, as has happened in various developed countries (See for example Friedman, et.al 1979; Mulder, et.al, 2008; Trench and Bucchi, 2010).

The phenomenon of science communication itself has been occurring in Indonesia for a long time, although in forms that are still limited to science communication for the environment itself, such as communication between scientists and their colleagues, and communication between scientists and the public through various mass media.

In addition, there are also various forms of science communication such as writing about science through the mass media. *Tempo* Magazine, for example, has a science section in almost every issue. Later, the *Conversation* also appeared which became a new development in science communication in Indonesia. Research on the phenomenon of science communication in Indonesia has not been as developed as in developed countries.

Science Communication in Various Perspectives

There is an interesting phrase put forward by Leßmöllmann & Gloning (2019: XIII), which states, "knowledge itself is worthless in science if it is not communicated to anyone in that field of science." They further stated:

> "For science, not communicating with the scientific population would mean not acting scientifically. The flip side of this coin is, no science can be done without taking other people's work into account and referring back to it. The creation –through language and visualization, or, today, all the multimodal tools available – and the dissemination of findings and insights have always been part of

> the science, linked to different communicative actions"

The editor of the Handbook of Communication emphasizes the importance of science being communicated both to experts in the same field, especially to the wider public. Science communication is an important part of the development of a scientific discipline, especially for the advancement of society. The results of scientific findings that are as great as anything will not be useful for many people if the findings are not communicated to the public.

Now there are still various views and opinions about scientific communication so this gives birth to various definitions of scientific communication. Kappel and Holmen (2019) note that there is general agreement in the literature that models for communication science can be divided into two paradigms.

Some models see science communication in a one-way model as conveying information about science from experts to the public as the right way to communicate knowledge. Other models instead see dialogue and deliberation between communities, experts, and decision-makers as the way to engage in science communication. Burns defines science communication as the "use of appropriate skills, various media activities, and dialogue to produce one or more personal responses to science: awareness, enjoyment, interest, opinion, and understanding of science" (Burns, O'Connor, and Stocklmayer, 2003).

Davis (2010) states science communication in concise language as being able to popularize science. Here there is a process of filtering the results of scientific research (which are usually published in papers or books in accordance with the rules and habits of scientific writing) into a form that is easily understood by the public.

The discussion about how science article writers write articles is in the area of science communication. According to Kappel & Holmen (2019), referring to the latest report of The National Academy of Sciences, Engineering and Medicine, there are five general goals of science communication, namely (1) sharing the latest findings and excitement for science, (2) increasing public appreciation of science, (3) increasing knowledge and understanding of science, (4) influencing people's opinions, policy preferences, or people behavior, and (5) ensuring that the diverse perspectives on science held by various groups are taken into account when solutions to social problems are to be sought.

Meanwhile, it is acknowledged, so far, the starting point for science article writers is from conveying the knowledge they have obtained to the public. From here they learn how to write science articles that are acceptable to the public. However, they do not study and capture the changes that occur in the public when interpreting science articles. They just keep writing according to what they understand and master.

This does not mean that the public rejects the writings of the authors of these science articles. They do not use it optimally to form an information society. Even though they really wanted to put the 2003 World Summit on Information Society declaration into practice in Geneva. In the declaration it was agreed that the position of scientific articles was as follows:

> ….people who have the opportunity to create, access, use information and science, so that every society and nation can develop fully according to their potential (Soehendro, 2006).

The desire to create an information society also needs to be considered by science article writers when writing science articles. This is their challenge to write science articles. The problem is, did they succeed in overcoming this challenge?

This is the question that this research wants to answer by using a prescriptive theory. The theory in question is a statement stating how something should be done in practice. Theory like this can be seen in materials and methods.

Material and Methodology

The purpose of this research is to develop standards for writing science articles in scientific journals and online media such as The Conversation Indonesia. This research uses qualitative and quantitative approaches to obtain comprehensive data.

A qualitative approach based on case study methods is designed to obtain specific data. According to Yin, case study is empirical research that examines contemporary phenomena with in real contexts (Yin, 2009).

This research used in-depth interviews as a data collection technique. The in-depth interviews involved three prominent professors from Gadjah Mada University to elaborate their experience of writing articles in reputable journals. The three prominent professors from Gadjah Mada University are: (1). Adi Utarini, professor of medicine and 1 of the 100 most influential people in 2021; (2). Wisnu Nurcahyo, professor of the Faculty of Veterinary Medicine, and (3). Rimawan Pradiptyo, criminal economist specialist and the Dean of the Department of Economics, Faculty of Economics and Business.

Meanwhile, quantitative approach with a quantitative content analysis method is designed to obtain general data. The purpose of quantitative content analysis is to analyze trends in science articles published by The Conversation Indonesia during December 2021. According to Neuendorf, quantitative content analysis is a systematic and objective analysis of messages (Neuendorf, 2002: From another perspective, content analysis is a research technique for drawing replicable and valid conclusions from texts in the context of their use (Krippendorf, 2004).

This research uses observation, interviews and secondary data documentation as data collection techniques. Researchers made observations of reputable journal manuscripts from three prominent professors from Gadjah Mada University and, in the next stage, researchers interviewed the authors.

This study also uses documentation of science articles as material for quantitative content analysis. Researchers collected The Conversation Indonesia science articles during December 2021.

There are 41 science articles analyzed. In the next step, the researcher inputs the data into the coding sheet and processes it using the SPSS software.

Researchers analysed the results of in-depth interviews and quantitative content analysis into a model and standard of science articles. The process of this research can be seen from the following flowchart.

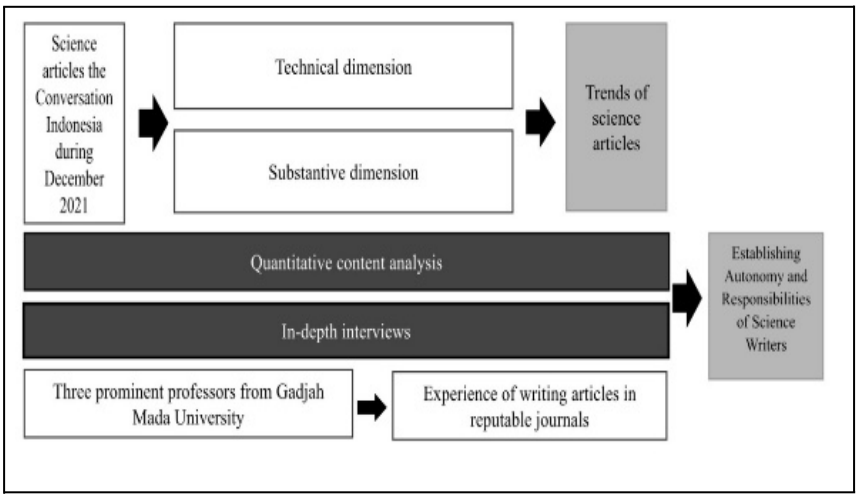

Figure 1. Research flow chart

Result and Discussion

Article quality

What is it about how the article quality is portrayed in this study? Five explanations are offered in this article. Each has a content and an effect facet.

The first explanation is the dimensions of consistency. Actually, the dimensions of consistency starting from the title, content and illustrations. These dimensions have a positive contribution to the technical construction of article writing.

Two of these three aspects (the title aspect and the content aspect) have clear (consistent) linkages and relationships. The title and content aspects respectively have an optimal level of suitability. While the illustration aspect is divided into two assessments, where the illustration is seen as a tool that supports the article and does not support the articles.

Table 1. Examples of articles consistency

Articles title	Link	Provide Illustrations	Not Provide Illustrations
Is Your Child Afraid on the Syringe? Following How to Prepare They are for Vaccines COVID	https://theconversation.com/apakah-anak-anda-takut-pada-jarum-suntik-berikut-cara-mempersiapkan-mereka-untuk-vaksin-covid-173838	√	-
In Big Data Leaks Why Human Factors Often Forgotten	https://theconversation.com/dalam-kebocoran-big-data-mengapa-faktor-manusia-kerap-terlupakan-172870	-	√

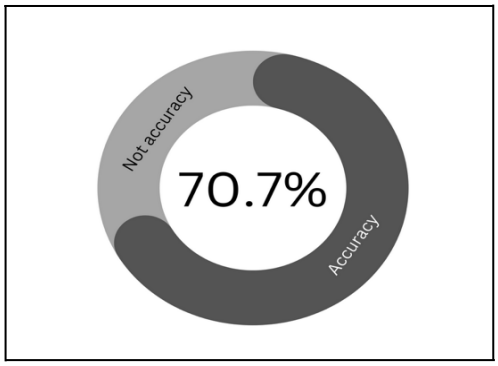

Figure 2. Tendency for accuracy

The second explanation focuses on the degree of to which extent the dimension of accuracy appears in the articles. In fact, this dimension of accuracy is closely related to the thoroughness in writing articles in writing their articles.

The Conversation's science articles are quite high, reaching 70.7%. Most of the articles do not suffer from typing problems or in other words, typographical errors only occur in a small number of science articles.

Table 2. Examples of writing errors

Article Title	Link	Examples of Writing Erroes
Understanding the political side of the Jemaah Islamiyah Movement	https://theconversation.com/memahami-sisi-gerakan-politik-jemaah-islamiyah-172496	The form of the organization Hierarchical-bureaucratic means that JI must have a leader who is in charge of directing and controlling the group's operations. Para Wijayanto filled this position the period 2008 to 2018.
Research shows that it is very difficult to track misinformation and Political Disinformation on Tiktok	https://theconversation.com/riset-menunjukkan-susahnya-melacak-misinformasi-dan-disinformasi-politik-di-tiktok-173918	-These comments considered unverifiable, due to emotional factors and what users think about the problem. -Users must also be able to sort by the number of views and/or engagements and upload date accordingly

Evidence based policy is the best? Not necessarily	https://theconversation.com/kebijakan-berbasis-bukti-adalah-yang-terbaik-belum-tentu-173065	-Qualitative research with samples more limited women often do considered more feminine, less trusted, -Evidence is often contextual

The third explanation is that the theorizing dimension in the articles. The theorizing dimension covers three main indicators, namely the use of theory, the suitability of theory and the arguments for using theory. The indicator of the use of theory observes the use of theory in articles.

The use of theory is considered to be a fundamental factor in research publications that explain the framework of research publications. Thereafter, the observation moved on to the theory suitability indicator. The focus of observation is positioned on the suitability of using the theory in the science article.

Table 3. Examples of theory usage

Articles Title	Link	Example of Theory Usage
Warga Memaknai dan Menaati Pembatasan Sosial Pandemi secara 'berbeda': Temuan dari Malang (Public Interpret and Adhere to Pandemic Social Restrictions 'Differently': Findings from Malang).	https://theconversation.com/warga-memaknai-dan-menaati-pembatasan-sosial-pandemi-secara-berbeda-temuan-dari-malang-172779	Space convergence theory by Henri Lefebvre, namely space is not inseparable from social relations. For him, space is formed by capitalism and neo-capitalism which are reflected in the business world.
Pemerintahan yang 'Cukup Baik": Mengevaluasi Upaya Anti-Korupsi Secara Realistis ('Good Enough' Governance: Evaluating Anti-Corruption Efforts Realistically).	https://theconversation.com/pemerintahan-yang-cukup-baik-mengevaluasi-upaya-anti-korupsi-secara-realistis-173596	The Good Enough Approach Governance, namely (government which is good enough") - instead of "Good Governance" which involve an agenda that does not realistic in the long term and difficult.

The fourth explanation for dimension of data completeness. The data completeness dimension is based on two indicators, namely the inclusion of primary data and secondary data. Based on these two indicators, all the articles studied included primary data in the contents of the article.

As for the inclusion of secondary data, most of The Conversation's articles have included secondary data. Furthermore, the inclusion of secondary data can help the writer to sharpen the analysis.

Table 4. Examples of secondary data usage

Articles Title	Link	Examples of Secondary Data Usage
Banyak Pekerja Salah Jurusan: Apa yang Harus Diperbaiki di Sistem Pendidikan Indonesia? (Many Workers Have Wrong Majors: What Needs to be Improved in	https://theconversation.com/banyak-pekerja-salah-jurusan-apa-yang-harus-diperbaiki-di-sistem-pendidikan-indonesia-173662	In 2019 research from Vietnam shows that mismatched educational backgrounds can make it more difficult for people in developing countries to move up economically.

Indonesia's Education System?)		Recent research in Indonesia states that the potential difference in this income can reach more than 5%. studies in Bosnia-Herzegovina put the figure at 13% -15%.
Halaman Opini pada Koran Lokal Membantu Mengurangi Polarisasi Politik: Temuan dari Amerika (Opinion Pages in Local Newspapers Help Reduce Political Polarization: Findings from America)	https://theconversation.com/halaman-opini-pada-koran-lokal-membantu-mengurangi-polarisasi-politik-temuan-dari-amerika-170867	According to a survey by Gallup in 2017, two-thirds of respondents think the news media does not distinguish between facts and opinions. This related opinion increased from around 42% of respondents in 1984. In another poll, only 43% of Americans said they could easily tell the difference between online news and opinion). Half of Americans are not familiar with the term "op-ed".

The data above shows that the articles reported by The Conversation Indonesia are not ideal. There are still parts that need to be improved. This improvement certainly depends on the creativity of the writer. Creativity requires freedom to determine oneself. He points to the writer's autonomy.

The existence of this autonomy implies a responsibility for her/his choice. Growing awareness and recognition of the rights and freedoms of the readers of the articles. This generates the desire that the articles must be optimally useful for them.

The writer's view on science article

The challenge for science writers is to make the writing useful for their readers. This awareness will determine their attitude and actions in writing science articles. An explanation of the benefits of scientific writing needs to be clarified, why? For Budi Darma (In Sularto, 2016), the benefits are related to the next generation. He says:

> Writing is a source of learning for the next generation. Without writing, culture will not progress. We can learn because there is writing (in Sularto, 2016: 156).

In order to produce science articles that can serve as guidelines for the next generation, of course there are conditions. These conditions, as called by Budi Darma (In Sularto, 2016), include: (i) presenting the problem explicitly, (ii) explaining the core of the problem, (iii) discussing it comprehensively, and (iv) finding a solution.

The writer's position in writing science article

A writer is not enough just to be a scholar, but also an intellectual. By taking up an undergraduate position, her/his writings were only serving her/himself a benefit. On the other hand, by taking an intellectual position, her/his writing is also beneficial to society. It is at this point that the science writer actually needs to ask about the values she/he adheres to when writing the paper.

The value in question is her/his concern and humanity that goes far beyond the boundaries of her/his profession. Such values, said Daoed Joesoef (2006), are only possessed by those who feel called upon and are always ready to criticize the government and are persistent in seeking the truth for their writings.

It seems that it can be concluded that a wise writer is an intellectual who still adheres to the guidelines for scientific writing originating from the journal that will contain his/her writings and who has a concern and humanity that goes far beyond his/her profession. He/she did, at least: first, seeking the truth through his/her research. Second, write it according to the rules set by the journal. Third, orienting her/his writing for the benefit of science for readers.

Cultural tension

There is a cultural tension within the readers of science articles. So far, science problems are considered to be problems of scientists only. Now, however, the problem includes their response to science articles. The response depends on the quality of the article. The article must be strong. The strength of the article, said Rimawan Pradiptya, is that it has a societal impact. He contributes to changing values in society (personal communication, August 29th, 2022).

In writing science articles, the writers use language that is understood by the public. Language becomes an instrument for expressing their worries. According to Adi Utarini, through language they talk about their testimonies and expressions about the themes they write about (personal communication, October 4th, 2022). They also convey their experiences through language. Naturally, language plays an important role in conveying the expression of science article writers.

Can the public catch that expression? According to Budi Darma (2006), the public will be able to understand this expression if the writing: (1) presents the problem explicitly, (2) explains the essence of the problem, (3) discusses it comprehensively, and (4) finds a solution. For this reason, science article writers must fulfill these requirements humbly.

This is where the nobleness of the tasks and challenges faced by science article writers. He/she formulates his/her desires, imagines the needs of the public and expresses his/her expression as a combination of these two things (personal interview with Wisnu Nurcahyo, August 16th, 2022). It is the writer of science articles who unites the sparks of his feelings, sews and connects them with the needs of the public towards. a precise understanding of the theme elaborated by the science article.

Knowledge development

Science and technology make people's lives easier. The development of science and technology will continue to influence people's lives. The influence is so great that there are groups of people who already feel that they are a science-based society. As a result, people are starting to be demanded to be able to understand and use scientific principles in meeting their daily needs.

To ensure the delivery of information about science to the public, science communication is needed. Above, especially in the Literature Review and Theoretical Framework, it has been explained about science communication in Indonesia. Every activity of communicating science through science articles intends to fulfill the purpose of science communication.

These goals, according to Howard F. Fehr (1978), include, first, intellectual goals. So that the public knows the thoughts of the owner of the science article. Second, to see the truth about science. So that the reader will love the truth of science and see it more clearly. Third, helping the community meet the scientific needs of the community. This last one in particular, is a strong foundation for fulfilling science literacy, for the present and the future.

This explanation shows that the purpose of science communication is very noble. It is not surprising that science communication is developing rapidly. It was so fast that various scientific articles were published in various scientific journals and popular media. How to write science articles will always be a topic of discussion. The technical aspect will also always develop, in accordance with the development of knowledge that occurs. So that, a wise science article writer is needed.

For the time being, this is acknowledged, wise science article writers are those who adhere to the guidelines for scientific writing originating from the journals that will contain their writings and who have a concern and humanity that goes far beyond their profession. He/she did, at least: first, seek the truth through his/her research. Second, write it according to the rules set by the journal. Third, orienting his/her writing for the benefit of science for readers.

Conclusion

If we think deeply about it, the real issue that this paper raises whether the technical skills of science writing are capable of producing science writing in accordance with the characteristics of the information society above? The answer would be "yes", if the writing is of good quality and the writer has a reputation as an intellectual. An intellectual is a person who dares to oppose the opinion of many people. As long as her/his opinion is right according to common sense, she/he will defend her/his opinion. She/he doesn't care whether her/his opinion contradicts the opinion of the crowd. The problem is she/he only wants to convey scientific information that is important

and useful for society. She/he doesn't want to be popular among the people.

At this point, one can imagine the challenges that science article writers face. These challenges include, first, the autonomy to write science articles according to their expertise. Second, being responsible for the movement and change in public awareness about science. If they have successfully passed the challenge, in fact they have contributed to managing this nation according to their expertise.

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