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Uncovering Carl Sagan's Science Communication in "Pale Blue Dot" Through Ricoeur's Hermeneutics

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Abstract: *Science communication is a very important but often overlooked field in Indonesia, resulting in very low levels of scientific literacy among its citizens. The goal of science communication is to inform the public about scientific discoveries and developments and to serve as the basis for decision-making and influence societal attitudes. In his book titled "Pale Blue Dot," (named after earth's first "selfie" ever taken by Voyager spacecraft). Carl Sagan employs various compelling methods to persuade his readers to accept his arguments and ideas regarding scientific research. This research attempts to uncover Carl Sagan's style of science's communication through Paul Ricoeur's hermeneutic analysis (semantic autonomy and hermeneutic arcs) of his iconic and popular work, "Pale Blue Dot." The benefit of this study is to inspire Indonesian society—especially the younger generations—to become more aware of the importance of scientific literacy and science communication. The results of this research are Sagan's way of communicating science to general public.*

Keywords: *hermeneutics, ricoeur's semantic autonomy, scientific communication, scientific literacy*

I. Introduction

Science communication can be defined as the communication between various experts with the general public, encompassing various activities that connect science with society. Modern science communication developed in the early 20th century as a field of study, a collection of practices, and also as a profession (Gascoigne, et al., 2020). The primary goals of scientific communication include: informing the public of important scientific developments and discoveries, increasing awareness and interest in science among the public, serving as a basis for public decision-making, and influencing societal attitudes and behaviors in addressing social issues(National Academies of Sciences, Engineering, and Medicine, 2017).

In Indonesia, scientific literacy is often neglected, evident from its low ranking in the Programme for International Student Assessment (PISA). Indonesian students were ranked 74th out of 80 countries in 2018, or ranked sixth from the bottom (Fuadi, Robbia, Jamaluddin, & Jufri, 2020). This poses a serioys problem because without a strong foundation in scientific literacy for decision-making, future generations will struggle to face the challenges of the modern world and compete globally in the scientific areas.

Science communication is critically important because without effective ways to communicate science to the public, we risk having a generation who are unable to think critically and logically in decision-making processes. Ideally, every member of society must have access to factual and high-quality scientific information, which can be achieved through effective scientific communication (Holford, Tapper, Fasce, & Lewandowsky, 2022). This way, people can make an informed decision to vote for candidates that have real commitment to tackle issues such as global warming, rising sea levels, climate change, etc.

Carl Sagan, as one of if not the most popular science communicators, can serve as a reference to improve our understanding of how to communicate science to a wider public. This research will explore Carl Sagan's science communication principles through the lens of hermeneutics, focusing on the narratives found within his book "Pale Blue Dot." Applying hermeneutics as a method to interpret scientific texts is not unfounded, although it is typically employed for interpreting religious texts. This approach is based on the fact that both religious and scientific texts convey knowledge or ideas that are mediated through language(Billingsley, Chappel, & Reiss, 2019). Moreover, hermeneutics has been applied in communication studies in order to understand texts as communication involves constructing meaning to create representations of reality (Sulistyanto, 2019).

The novelty of this research lies in the fact that scientific texts are rarely examined through the perspective of hermeneutics, which is typically reserved for interpreting religious texts. "Pale Blue Dot," written in a fluid style with narratives rich in metaphors and analogies, makes it suitable for analysis from a hermeneutical standpoint.

1. Science Communication

In "Communicating Science", it is stated that science communication involves interactions between science communicators and the general public, encompassing activities that connect science with society(Gascoigne, et al., 2020). Therefore, science communication is important and influential in educational development in schools and societal progress. It can be said that science communication bridges the gap between scientific discoveries and developments and the general public(Akhter, Siddique, Shabbir, & Akram, 2021).

Science communication aims to enhance awareness and understanding among the general public about scientific knowledge, which subsequently affects how society behaves and makes decisions. Science communication strives for the public to make decisions based on scientific facts (National Academies of Sciences, Engineering, and Medicine, 2017). Challenges in science communication in Indonesia include the low trust in science among its population (Supratmn & Zakki, 2020)and the proliferation of misinformation on social media(Sugiono, 2023).

2. Scientific Literacy

Scientific literacy is defined as the ability to explain scientific phenomena and articulate them by presenting scientific evidence(Rodger, Barry, & Robert, 2009). Low understanding of science has broad consequences because in this era, science is intertwined with various fields directly relevant to society, such as science journalism(Anderson & Dudo, 2023), health (Brossard, Wood, Cialdini, & M, 2020), politics, morals, and law(Scheufele, 2014).

3. Science

Science is not merely a collection of facts about the world. A collection of facts about the world is called "knowledge," whereas science, according to Al-Khalil, is a way of thinking and understanding the world, which can lead us to new knowledge(Al-Khalili, 2023). In science, although it is nearly impossible for scientists to remain neutral and value-free, scientific knowledge must be neutral. Here are the characteristics of the scientific methods according Al-Khalili(Al-Khalili, 2023):

1. Self-correction;
2. Replicability;
3. Falsifiability;
4. Importance of uncertainty;
5. Value of acknowledging mistakes.

II. Research Methods

This research utilizes qualitative methods, specifically by conducting a literature review to collect data.The research is done through textual analysis guided by hermeneutical principles. The theoretical framework employed in this paper is Paul Riceour's Hermeneutics to uncover deeper meaning of a text and the interconnectedness between the interpreter's background and that of the author's.

Hermeneutics sees understanding and interpretation as a whole, consisting of language, objects, events, and context. These elements enable humans to understand texts, books, novels, songs, dramas, poetry, scriptures, and so on. In the hermeneutical view, humans are interpretive creatures who always link objects into a unity of meaning. From this process, humans gain all knowledge. (Zimmerman, 2015)

Hermeneutics seeks to understand a text as a whole. This means that not only interpreting the meaning of words founf in a text, but also tries to understand the social, cultural, economical, and political context of a text. (Fabianus, 2016)

According to Ricoeur, a text must be understood through the interconnectedness between the author, background, and with other texts (intertextualization). Interpretation must be understood as a kind of dialogue between the interpreter/reader and the text being read. According to Ricoeur, interpretation of the text, or conversation, and so on, is also a kind of interpretation of oneself. Ricoeur believes that the author no longer has control over the original meaning of the text when the book Pale Blue Dot is written. This means that readers or interpreters can interpret the contents of a book differently and produce new interpretations and understanding. This can lead to a phenomenon known as text distortion(Fensi, Liliweri, & Ronda, 2022). This shift often occurs when various factors such as social changes, cultural shifts, and societal developments influence how people understand and interpret a text(Susilo & Fensi, 2023).

Paul Ricoeur also discusses the concept of semantic autonomy. Ricoeur argues that a written work can acquire meanings different from those intended by the author. Semantic autonomy consists of three dimensions: semantic autonomy regarding the author's intention; semantic autonomy concerning the original cultural context; and semantic autonomy towards the original readers or public(Kleden, 2020).

1. Semantic autonomy regarding the author's intention

The author is considered to no longer have control over the original meaning intended when a text is written. This means that readers or interpreters can interpret the content of a book like "Pale Blue Dot" differently and generate new interpretations and understandings. This happens partly because we cannot realistically “know” what the original author intends to convey, and partly because of cultural differences between the author and the reader.

Ricoeur suggests that while we might in theory try to reconstruct the original idea. Nevertheless, these reconstructed ideas inevitably reflect the context and realities of our own time. Therefore, according to Ricoeur, the text can be interpreted creatively as long as the interpretation remains tethered to the original meaning and context to some extent. Ricoeur's view allows for a dynamic and productive interpretation where readers or interpreters can bring their own perspectives and insights into the understanding of a text, but they are also bound by the intention and cultural backdrop embedded in the original work. This balance ensures that interpretations can be innovative and enriching while still maintaining a connection to the foundational ideas and contexts established by the author.

2. Semantic autonomy concerning the original cultural context

The meaning of a text also depends on the cultural and temporal context when the text was written. When a text is brought into another cultural and temporal context, the original meaning of the text often changes. However, the original meaning can still be reconstructed and not completely lost. Regarding the reconstruction of the original meaning, Ricoeur believes that the original cultural context we refer to is often also a result of reconstruction in our time(Kleden, 2020).

Furthermore, Ricoeur also emphasizes that in the process of interpretation, interpreters cannot detach from our own understanding horizon, so what happens is our interpretation cannot detach from the subjectivity and context of the present time(Kleden, 2020).

3. Semantic autonomy towards the original readers or public

According to Ricoeur, because of the change in time and place, the context of texts will somewhat change. The intended audiences or readers would not still be the same.Therefore, Ricoeur argues that the interpretation of a text will vary among individuals with different cultural and temporal backgrounds. As a result, a text can live beyond its author and his time. The interpretation of the text then is not only reproductive

(returning to the author's intention and original cultural context), but can also be productive because of the blending of horizons between the interpreter and the interpreted(Kleden, 2020).

III. Findings and Discussions

In interpreting texts, researchers base their interpretations on the concept of semantic autonomy and produce creative interpretations that result from the fusion of American and Indonesian cultural perspectives. Carl Sagan's book "Pale Blue Dot" was written in the 1990s in the United States. American culture is unique in that, despite being a secular nation, its citizens are among the most religious in the Western world. Sagan's ideologies, both implicit and explicit throughout the book, endorse space programs, advocate for the protection of planet Earth and exploration of other planets, and support liberal democracy. These contexts are interpreted by researchers with an Indonesian cultural background, which is more religious and less secular (Tamir, Connaughton, & Salazar, 2020).

The Indonesian version of Sagan's book was only published and translated in 2021, thus attracting a very different readership compared to the original audience of the 1990s. While Sagan in his works often tackles pseudoscience of his times (for example: aliens and new age movements in his book Cosmos)(Sagan & Druyan, The Demon Haunted World, 1995), Indonesian readers are much more likely to believe in genie (53%) or witchcraft (69%)(Pew Rresearch Center, 2012)**,** while regarding religion and faith as foremost in life.

Sagan chooses to refrain from writing confrontational critiques on faith and religious dogmas, unlike other authors such as Dawkins and Hitchens. As a result, Sagan's works are more easily accepted and popularized across various demographics, and are highly persuasive. Especially to religious readers, as it would be considered less “offensive” to faith.

Below are the discussions of the text interpretation:

"... astronomy is a humbling experience that builds character."(Sagan, 2021, p. 6)

"Perhaps there is no better demonstration of the folly of human conceits than this distant image of our tiny world." According to me, it underscores our responsibility to deal more kindly with one another, and to preserve and cherish the pale blue dot, the only home we've ever known."(Sagan, 2021, p. 7)

Sagan communicates science by constructing an inspirational narrative and even drawing moral conclusions from scientific discoveries. The photo of Earth taken from a distance is named the pale blue dot and accompanied by a narrative reflecting on the human condition by Sagan. This is in part, a unique take on science, since science is usually more concerned with deriving facts instead of values.

"Modern science is a voyage into the unknown with lessons in humility waiting at every stop. Many passengers choose to stay at home."(Sagan, 2021, p. 19)

"The standards of scientific proof are rigorous and, when adhered to, allow us to see a very bright light even in pitch darkness."(Sagan, 2021, p. 300)

Sagan communicates science without a patronizing or elitist tone. He highlights the distinctiveness of science from many other aspects, such as humility in acknowledging new discoveries even when they do not always align with commonly held assumptions and ideologies. "A very bright light" becomes a metaphor for science, and "pitch darkness" symbolizes things we still do not know.

In communicating science, Carl Sagan incorporates quotations from books, scriptures, and poetry from various cultures of the past. These quotations typically relate to the themes discussed by Sagan in each chapter. For instance, in the sixth chapter which explores the Voyager spacecraft mission, Sagan quotes Psalm 107:23:

"Some went out on the sea in ships; they were merchants on the mighty waters. They saw the works of the Lord, his wonderful deeds in the deep."

The purpose of using this kind of quotation is to provide historical context to his discussions so that readers can link new scientific discoveries with ideas from the past. Sagan's choice of this quote parallels the discoveries of today. He employs a Biblical verse to liken the Voyager spacecraft's journey to merchant ships sailing the seas. In this verse, merchants who traversed the seas witnessed the wonders of nature as creations of God, while the Voyager spacecraft unveils the "wonders" of the Solar System.

Sagan adopted the idea used by Voltaire in his book that criticizes civilization and Western culture through the perspective of alien explorers from Saturn and a planet orbiting Sirius. The viewpoint of "aliens" in Voltaire's novella is adopted by Sagan to communicate science and to criticize human activity that brings about ecological disasters. With his unique writing style, Sagan blends science fiction narrative with that of scientific facts along with critiques wrapped in humorous writing.

Sagan quoted Voltaire's work titled "Micromegas" (1752), stating, "They traveled for a long time and found nothing. After some time, they saw a small light, which was the Earth… [But] they couldn't find the simplest reason to doubt that we and our fellow Earthlings have the honor to exist and evolve."(Sagan, 2021, p. 53)

"Besides the thin layer of life on Earth, brave spacecraft occasionally seen and the sound of static radio, our impact in the universe is zero. The universe knows nothing about us."(Sagan, 2021, p. 54)

"Imagine you are an Alien explorer entering the Solar System after a long journey through the darkness of interstellar space."(Sagan, 2021, p. 54)

Sagan uses thought experiments as a method to communicate science. Readers are invited to withhold assumptions about Earth and humanity's position in the universe. On the bigger scale, humans have zero impact on the universe as our activity went undetected from outer space. Only some signs of life can be observed including the trace amount of methane in earth's atmosphere. This way, Sagan combined an explanation of how science works, the methods commonly used to detect life in outer space, while at the same time providing readers with information about the characteristics of Earth. This sense of "smallness" and "unimportance" also serve as a lesson of humility and to protect life on earth, as it is precious and vulnerable.

"When looking at the visible light spectrum and near-infrared to determine chemical composition patterns, you will definitely find water ice in the ice caps, and water vapor in the air explains the presence of clouds…"(Sagan, 2021, p. 55)

"The spectrometer also reveals that one-fifth of the planet's atmosphere consists of oxygen, O2."(Sagan, 2021, p. 55)

Sagan blends scientific discoveries, introducing methods and scientific instruments in a narrative style akin to a novel.

"You notice the amount of these gases in the atmosphere continues to increase, year after year… The same applies to methane and other greenhouse gases."(Sagan, 2021, p. 61)

"Over the years, across the entire planet Earth, you see fewer forests and more scrublands." (Sagan, 2021, p. 61)

"… at such a rate that in a few decades there will be no humus left." (Sagan, 2021, p. 61)

"From your orbit perspective, you can see that clearly there has been a mistake."(Sagan, 2021, p. 62)

Sagan criticizes human lifestyles that harm the environment, emphasizing the vulnerability of life on Earth. Sagan also criticized the lack of awareness about the damage that is done to the environment, "Don't they notice what's happening? Don't they realize their fate? Can't they work together for an environment that supports them all?"(Sagan, 2021, p. 62)

"In the 1980s and early 1990s, many people viewed the US space program as a series of disasters."(Sagan, 2021, p. 64) In addition, manned space programs were also considered to be very costly with little benefit. All these criticisms seem familiar today, with many feeling that funds would be better spent on addressing Earth's climate crisis rather than discovering a "new world" or making Mars habitable. In Indonesia, issues like that are not addressed much since we don't have our own space programs.

Sagan also explains to readers who might still be skeptical about arguments that space science programs bring significant benefits by providing proofs such as communication satellites, meteorological satellites, reconnaissance satellites, etc. He also mentions various observation satellites used to monitor the environment from soil erosion to holes in the ozone layer and the GPS (Global Positioning System).(Sagan, 2021, p. 65)

Sagan uses science communication to persuade readers but always provides arguments for and against as a basis for readers to participate in discussions on science-related issues.

"Images are the only way to show the excitement of robotic missions to the public—however, they have also funded them."(Sagan, 2021, p. 133)Sagan was involved in the Mariner mission and suggested bringing a camera to showcase it to the public. According to Sagan, expensive missions funded by the public should provide a "result" to be shown to the public. Sagan also supports science communication methods that directly involve the public.

Sagan's science communication is highly persuasive and contains many calls for action. For Sagan, the role of a science communicator is to educate the public and to provide scientifically accurate informations so that people can make their own decisions about scientific issues.

IV. Conclusions

This research concludes Carl Sagan's approach and strategy in popularizing science to the general readership includes:

1. Narrating scientific discoveries with a literary style akin to a novel, using metaphors or analogies to enhance understanding.
2. Quoting literature from other genres (novels, scriptures, poetry) and linking them to the context of the themes discussed. Often, the quotes used involve speculation or are related to the theme of the chapter.
3. Integrating advice, wisdom, and critique within scientific writings.
4. Employing thought experiments to construct narratives around new discoveries from fresh perspectives.
5. Presenting arguments for and against to provide balanced writing and encourage critical thinking.
6. Engaging the public directly so readers feel like stakeholders in scientific research and issues.

It can be concluded that Sagan's works are highly adaptable to various cultural contexts and diverse audiences; they remain relevant and capable of effectively communicating and inspiring readers. Sagan's writing and his approach to communicating science can be applied across different media to disseminate scientific knowledge in Indonesia. Sagan's ideas enrich the readers' horizon, with his key message being timeless.

Further research in science communication is necessary to improve the way we can communicate science to public for the greater good of society.

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