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Mismatching ideas among the experts–Producing science edu-communication media for the citizen

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Abstract
The need to improve the status of the quality and the production efficiency of science news media is urgent. In order to depict the "misunderstanding" among the related personals, the current study interviewed the following members: "science edu-communicators" (those with science education background and worked as the mediators between the journalists and the scientists), "journalists" (those who interviewed the scientists and produced the science news media), and the "scientists" (those who were the knowledge providers explained the scientific contents to the audience). The "misunderstandings" were coded and labelled as "mismatch of frames". Through a series of semi-structural interviews, it was found that these divergent frames led to different interpretations, understandings and expectations to the production of the educational science news media. Thus, these "mismatching of frames" caused their conflicts. A total of 47 conflicts of frames were identified in the process of interviewing protocol. Among them, eight conflicts were about "awareness"; three conflicts were about "enjoyment"; two conflicts were about "opinion formation"; and 34 conflicts were about "understanding". There was no conflict related to "interest". Possible reasons regarding why the three parties held different frames in science communication are analyzed and discussed. Further, recommendations for future development of production model for science news media collaboration were discussed.

Keywords: AEIOU, correspondence analysis, frame theory, science communication, science edu-communication, science news

INTRODUCTION

Among the many channels of science communication, science news has been a frequently researched topic (Chen & Lee, 2017; Clark & Illman, 2006; Knudsen, 2017; Lewis et al., 2015; Molek-Kozakowska, 2016; Pan et al., 2019; Yang, 2017). Wellington argued that science news, like science courses, serves as an intermediary connecting the public (students) with scientific information (Wellington, 1991). Huang and Jian (2010) pointed out that science news is an important medium for the public to continue receiving scientific updates after leaving formal education.

Despite the importance of science news, many scholars have raised concerns about various issues, such as sensationalism, misinformation, oversimplification of scientific knowledge, and difficult terminology (Hartz & Chappell, 1997; Ho et al., 2022; Kim & Kim, 2021). Huang (2014) pointed out that most science news in Taiwan comes from international sources, and after being translated for a second time, it may suffer from double distortion, leading to misunderstandings. Nelkin (1995) argued that journalists often distort content when translating scientific information, filled with academic terms and excessive information, into everyday language. Similarly, Singer (1990) identified three common types of "content inaccuracies" in science news: direct erroneous descriptions, misleading headlines, and omission of important information (e.g., limitations of scientific experiments). Presenting scientific content too deeply or too superficially, or with erroneous information, can hinder public understanding of science.

Therefore, a new form of science news production model needs to be established, integrating theories and practices of science education and science

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Contribution to the literature

- This study delves into the common framework theory in the Science Education and Science Communication community, aiming to uncover new discoveries that will benefit both fields.
- The study's findings establish an academic foundation for developing an education and communication model. This model outlines conflict situations based on the AEIOU framework's three roles: The Science Edu-Communicator, Journalists, and Scientists. It can be used as a reference to reduce conflicts and facilitate future collaboration in science communication.
- Additionally, the study offers a detailed description of science communication cases in Taiwan, which can aid the academic community in developing a better understanding of the current state of science communication, particularly in producing educational science communication media.

communication to address the aforementioned issues (Wu et al., 2019). In addition to scientists and journalists, the team also includes a third-party role with knowledge of media production and a background in science education: science edu-communicators (SEC). They are responsible for selecting science news topics and planning, designing, and explaining news content that is easy for the public to understand and of appropriate difficulty, which is then presented by scientists and filmed by journalists through interviews. All parties have their respective roles, with SEC coordinating in the middle. Science news produced using science edu-communication model incorporates educational design concepts, such as cognitive load theory (Sweller, 1994), multimedia learning theory (Mayer, 2002), and proximity principle (Galtung & Ruge, 1965), and can be referred to as educational science news (Schirrmacher, 2012; Shea, 2015).

Science communicators have emerged as a third party, making the production of science news more educational and attempting to mediate the frequent discord between scientists and journalists (Wu et al., 2015) . Nevertheless, sporadic conflicts still occur among the three roles, such as when a science communicator proposes a topic for a science news story to a journalist, only to be rejected; or when a scientist reviews the actual news product and finds it below expectations. This is the starting point of the current study.

Purpose of the Study

Baram-Tsabari and Osborne (2015) suggest that science education research and science communication research should not be separate but should learn from each other. The researchers believe that the science communication model, as a pioneer in combining the theories and practices of science education and science communication, is essentially suitable as a research subject. In addition, to build an understanding of conflict incidents in the science news production process and to improve science news production in the future, it is necessary to study this series of conflict incidents.

This study examined conflicts in news production under the science communication model based on the research methods (i.e., dynamic framing) adopted by Davis and Russ (2015) and AEIOU vowel model of science communication proposed by Burns et al. (2003). Davis and Russ (2015) used content analysis and found that scientists and journalists employed different frameworks to interpret the same scientific research, resulting in conflict incidents between them. Burns et al. (2003) suggest that science communication activities can produce five different effects: awareness, enjoyment, interest, opinion formation, and understanding, abbreviated as AEIOU. Drawing on two distinct perspectives, this study posits that in the educational science news production process under AEIOU model, participating scientists, journalists, and science communicators hold divergent frameworks regarding the effectiveness of science news. Through their interactions, these distinct frameworks lead to differing interpretations and expectations of science news effectiveness, generating conflicts of opinion among them. In light of this hypothesis, the study aims to address the following research questions:

1. To what extent do differences in frameworks among scientists, journalists, and science communicators in the science communication model account for conflicts of opinion among them?
2. What are the underlying frameworks that shape these conflicts between scientists, journalists, and science communicators in the science communication model?

THEORETICAL FRAMEWORK AND LITERATURE REVIEW

What Conflicts?

There are numerous literatures exploring the interactions and conflicts between scientists and journalists. After reviewing the literature, researchers have identified four possible causes for conflicts between scientists and journalists: cultural differences, language and representation styles, norm differences, and framing differences.

First, in terms of cultural differences, Peters (1995) pointed out that scientists and journalists have different cultures. In other words, they have their own perspectives and values within their communities. When people from different cultures communicate, there may be three situations: difficulty in meaning communication, holding different stereotypes and prejudices about the same thing, and having different definitions and expectations of each other's role responsibilities. Conflicts may arise when expectations do not match reality. The study asked 234 journalists and 448 scientists about their opinions and attitudes towards "the function of journalism," "preferred reporting methods," and "scientist-journalist interaction forms." The results found significant differences between the two groups in many aspects, including whether news should entertain or educate the public, influence public opinion, increase public interest, allow scientists to review news before publication, and whether journalists should translate professional terms into everyday language. The study showed that journalists prefer to provide entertainment to the public, while scientists have a parental attitude towards the public. Scientists and journalists have different preferred reporting styles. Scientists publish scientific literature without the need to attract public attention, while journalists do the opposite. Both scientists and journalists disagree on content control.

Second, regarding language and representation styles, Wellington (1991) compared the science content in school curricula with that in the media, pointing out that science content in the media often has characteristics such as dramatic content, fragmented scientific discoveries, using definitive language (e.g., describing "X is related to Y" directly as "X and Y have a causal relationship"), not based on previous research, and sometimes choosing topics with little relevance to science but with entertainment value. Valenti (2000) noted that the "language" used by scientists and journalists is different, hindering communication between the two. Scientists typically use technical, professional methods to describe science content, convey quantitative, complete, and accurate information, cite existing research as a basis, and do not need to attract public attention. In contrast, journalists use simple everyday language to describe science content, convey qualitative, incomplete (but still understandable) information, rarely cite existing research, and are often influenced by public opinion.

Third, regarding norm differences, Weigold (2001) reviewed the literature and pointed out that the main cause of conflicts between scientists and journalists is the differences in values and norms between them. Journalists need to add subjective judgments and interpretations to science news, while scientists, based on academic norms, take an objective approach to describing science content. Furthermore, the two sides have different requirements for news value. Scientists usually avoid using sensational or misleading science content to attract public attention. Lastly, both parties have different opinions on who should control the right to speak, as scientists have complete control when writing academic literature, but cannot fully control science news content when collaborating with journalists.

Lastly, in terms of framing differences, Davis and Russ (2015) conducted a case study exploring the conflicts between scientists and journalists from a framing theory perspective. The article highlights that scientists and journalists often interpret scientific research through different frames, which can cause conflicts during communication. For example, a medical school professor published an article about drug overuse at a certain veterans' hospital. A campus journalist from the same university then interviewed the scientist and wrote a science news report. Upon content analysis, it was discovered that the professor repeatedly used an "uncertainty" frame to describe the research, focusing on the study of the veteran population, which had never been researched before. On the other hand, the journalist viewed the research through an "economic" frame, emphasizing that the over-prescription of drugs would increase expenses for veterans and taxpayers. These different interpretations caused conflicts between the two parties, highlighting the importance of considering different frames when communicating about science.

Frame Theory

Frame research can be divided into two categories: how frames are formed in the media and the impact of frames in the media on the audience. The former is called "frame building," and the latter is called "frame setting" (Davis & Russ, 2015; Lin, 2017). Davis and Russ (2015) point out that frame theory is a common theoretical foundation for both science education and science communication research. They analyze different frames held by participants in conflicting events to identify the causes of conflicts between scientists and journalists. According to the perspective of constructivist psychology, frames are the internal structures of an individual's mind (Kinder & Sanders, 1990) or the individual's prior knowledge or stereotypes (Feinstein, 2015). Frames guide individuals processing through various information processes, such as understanding meanings and interpreting concepts (Hammer et al., 2005; Pan & Kosicki, 1993). Goffman (1974) notes that frames, also known as "interpretive schemata," help individuals locate, perceive, identify, and classify external things. Entman (1993) believes that individuals use frames to define problems, diagnose causes, make moral judgments, and propose solutions.

On the other hand, according to Hammer et al. (2005), students use their frames to perform causal reasoning, understand class content, and express meaning. Therefore, frames are closely related to the mental models in science education research. Mental models are constructed by individuals to explain and predict scientific phenomena (Quinn et al., 2012). Mental models are usually composed of incomplete facts, past experiences, and intuitive experiences, and they affect individuals' understanding, behavior, and decision-making regarding certain things (Center for Research on Environmental Decisions, 2009). In addition to representing the internal structure of an individual's mind, communication research suggests that the verb form of "framing" implies the behavior of "interpreting and representing something," that is, expressing mental concepts through language, text, or images (Entman, 1993; Hammer et al., 2005; Li et al., 2017; Pan & Kosicki, 1993).

Since the framing process is related to media, frames are also a subject of interest in communication research (Lu & Cheng, 2017). Different studies have used different frames as the basis for analyzing conflicts. For example, Nisbet and Mooney (2007) described how supporters and opponents of embryonic stem cell research adopted different frames in the news media. Supporters used "social progress" or "economic competitiveness" frames in their messages, describing stem cell research as a medical hope for millions of Americans. In contrast, opponents used frames like "playing God" and "destroying human life" to criticize the research.

Vowel Analog "AEIOU" for Science-Edu-Communication

The field of science communication has gradually shifted towards the topic of "public understanding of science," and the combination of science education research and these two fields has become increasingly important (Wu et al., 2020). Based on this interdisciplinary perspective, this study uses the wide-adopted AEIOU framework proposed by Burns et al. (2003) as the viewpoint, interpretation, or anticipated outcomes of science news producers on science news. That is, using AEIOU as the "frames" held by the three parties (e.g., science edu-communication model: scientists, journalists, and SEC) for analyzing the effectiveness of science news, and to identify those "mismatch of frames" during the science news production process.

The five aspects of AEIOU adopted in this study are defined, as follows:

(1) awareness of science–not feeling alienated from science, recognizing the relevance of science to the public,

(2) enjoyment of science–an affective motivational aspect, a positive experience of science, feeling entertained or engaged,

(3) interest in science–a cognitive motivational aspect, making the public willing to actively participate in science communication activities,

(4) opinion formation on science–forming or reshaping public attitudes or views on science and society, which includes three aspects: cognitive (i.e., whether the emerging view is considered true by the individuals), affective (i.e., whether the emerging view aligns with personal values or beliefs), and conative (i.e., whether the emerging view enables individuals to make more useful, influential actions and decisions), and

(5) understanding science–the public's understanding of science content, processes, and the relationship between science and society, which could be recognized as the prerequisite for scientific literacy (Wu et al., 2019).

Specifically, as in a formal educational settings (i.e., school science class) and an informal settings (i.e., science communication among the public settings), the five aspects covered by AEIOU seemed a sound structure covering the scientific literacy of the audiences/students/citizen.

MATERIALS AND METHODS

This study adopts a qualitative research approach, using semi-structured interviews to collect conflict events from the past collaboration experiences of scientists, SEC, and journalists who have participated in one production of educational science news series. Content analysis is then performed (An & Gower, 2009; Jörg, 2009; Lin & Hsu, 2015; Shea, 2015), adapting the five aspects of science edu-communication AEIOU framework as coding categories, to analyze which frames the conflicts in the data stem from (Lewis et al., 2015; Semetko & Valkenburg, 2000). From the perspective of these frames, this study aims to identify the incompatible frames behind the opinion conflicts that occur between the two interacting parties (Davis & Russ, 2015).

A team that produces educational science TV news series using science edu-communication model are the interviewees in this study. The team consists of three types of people: scientists, SEC, and journalists. The scientists interviewed in this study are mainly current teachers or researchers in Taiwanese research institutions or higher education institutions, serving as interviewees in the production process of educational science news, with few having been interviewed for television news before. As representatives of the mass media, journalist and the filming team are responsible for filming, interviewing scientists, post-production editing, and scheduling. The team have never experienced a production of educational science news before. SEC serve as the third-party role in coordinating scientists and journalists during the production of educational science news. In addition to having a background in science teaching, they plan and select topics for production, and gradually becoming familiar

Table 1. Backgrounds of the participants to be interviewed

Participants	Gender	Background/expertise	Topics participated
Scientist 1	Male	Researcher from an earth science research institute. His expertise is in monitoring and interpreting earthquake data for such as Seismological Center at Central Weather Bureau in Taiwan.	Earthquake monitoring network
Scientist 2	Male	Professor from a biomedical chemistry research institute. His research is about the mechanism of telomere recombination.	Telomere
Scientist 3	Male	Professor from a sports science research institute. His research is about how human body exercise can promote health and etc.	Sport science
Scientist 4	Male	Professor from a civil and disaster prevention engineering research institute. His research is about how earthquake engineering & seismic design can help prevent damage when an earthquake occurs.	Forensic seismology
Scientist 5	Male	Professor from a food science research institute. His expertise is about effective techniques and risk management for developing food processing strategies.	Molecular gastronomy
SEC 1	Female	Master student majors in science education	Telomere & molecular gastronomy
SEC 2	Male	Doctoral student majors in science education	Sport science
SEC 3	Male	Post-doctoral researcher in science education	Cloud classroom, earthquake monitoring network, & forensic seismology
SEC 4	Female	Master student majors in science education	Non-Newtonian fluid, health bracelet, earthquake park, & Hualien indigenous people
Journalist 1	Female	A domestic TV news journalist who holds a bachelor's degree in communication	Telomere, exercise, cloud classroom, earthquake monitoring network, & forensic seismology
Journalist 2	Female	A domestic TV news journalist who holds a master's degree in communication	Molecular gastronomy, earthquake park, Hualien indigenous people, & non-Newtonian fluid

with the news media's production processes during this work.

This study uses purposive sampling to select multiple interviewees from these three roles who have experienced opinion conflicts during the science news production process for interviews. In total, the researchers interviewed five scientists, four SEC, and two journalists (please see **Table 1**).

11 semi-structured interviews were conducted through face-to-face or telephone to elicit interviewees' experiences of conflict during past collaborations. Before the interviews, the interviewees were informed that the interviews were for research purposes and would be recorded as data for analysis. After the interviews, the researchers transcribed the audio files into verbatim transcripts for subsequent analysis.

The interview questions were structured based on different stages regarding the news media production process (please see **Figure 1**). Interviewees (i.e., SEC, journalists, and scientists) were asked two~four questions for each stage depicting their experience and reflections. Please note that scientists did not receive questions regarding stage 1 since they did not participate in such stage. In addition, similar question items were

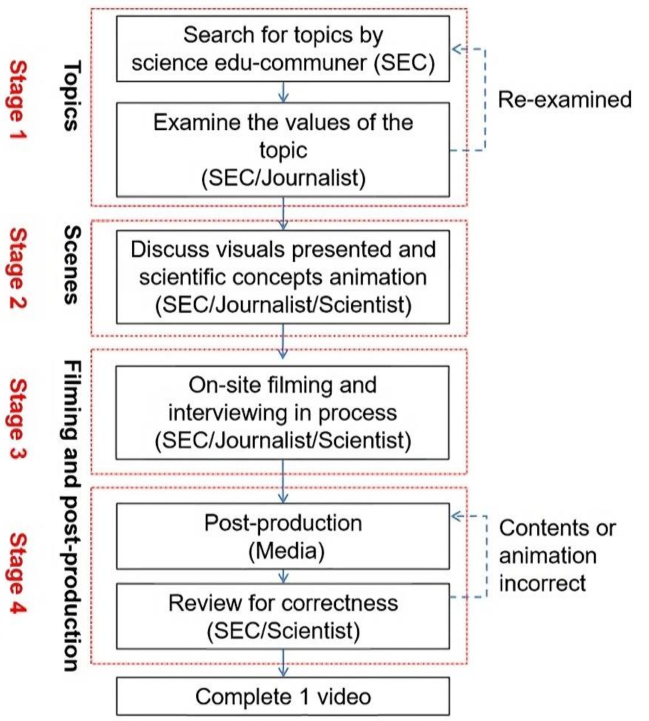

Figure 1. Stages regarding production process of science news media (Source: Author's own elaboration)

Table 2. Definitions of AEIOU frames to be coded

Categories of "opposing" frames	Code as	Descriptions of coding definition	Examples of key term	Scope for coding
Awareness	A	Conflict content is related to the selection of topics and their connection to people's lives, such as "making people feel the presence of science" and "helping people broaden their knowledge of science".	ADHD, IRS, & relevance	Paragraph
Enjoyment	E	Conflict content is related to the "entertainment elements associated with science," such as mentioning positive and negative emotional experiences.	Interesting, cool, & boring	Paragraph
Interest	I	The conflict content is related to "motivating people for self-directed learning," such as mentioning the willingness and motivation to engage with science news.	Further & do not want to watch anymore	Paragraph
Opinion formation	O	The conflict content is related to "forming attitudes or opinions on scientific topics," such as influencing people's consumption behaviors through scientific concepts.	Commercialized advertising	Paragraph
Understanding	U	Conflict content is related to "helping people construct scientific knowledge," for example, mentioning learning outcomes.	Myths & misconceptions	Paragraph

asked in a similar tone/fashion via the same interviewer among the same group of the interviewees for same stages to ensure a better reliability. All the interview questions were developed by a team of two science education professors and one researcher who were familiar with the process of survey items development and validation. Thus, the validity and reliability of the interview questions were confirmed. Please see below for sample question items.

Stage 1 for SEC: *Without a reporter/journalist, what story would you tell about this topic? What elements would you add to complete this news story? (video production)*

Stage 2 for journalists: *Have you encountered any issues with capturing the screen? If so, how did you resolve them? If not, why do you think everything went smoothly? Additionally, can you explain the logic behind screen editing? For example, why was a particular shot used for a specific scene?*

Stage 3 for SEC: *Have there been any interesting incidents during the on-site filming? How were unexpected situations handled? Such as the actual footage prepared by the scientists was very different from what you had imagined. Or, the scientists' explanations were too lengthy, etc.*

Stage 4 for scientists: *Do you have any modifications to the document? What issues did the document have? Did the journalist accept your modifications at the end?/Why did you not modify the document?*

Next, an inductive content analysis approach was utilized to analyze the mismatching frames in the conflict events. Inductive content analysis does not define clear classification criteria in advance; instead, the frames themselves emerge gradually during the analysis process (De Vreese, 2005). In other words, the frames are the result of inductive content analysis (Jörg, 2009). The purpose of inductive content analysis is to identify any possible frames in the interview transcripts and preliminarily depict the different perspectives and interpretations (i.e., frame mismatching) held by both parties during the interaction (Pan et al., 2019). However, inductive content analysis has disadvantages, such as being extremely labor-intensive, only able to handle small samples, and difficult to reproduce (Semetko & Valkenburg, 2000). As an exploratory study, it is hoped to condense a wide and diverse range of interview data into a concise set of results and develop theories and models of conflicting frames in the science news production process (Thomas, 2006). Therefore, using an inductive content analysis to explore the frame opposition behind the conflict events in the interviews was then confirmed.

To order to make the induction structured and supported by the literature, AEIOU five aspects is adapted as the preliminary coding categories for the inductive content analysis and preliminarily define the related coding criteria, as shown in **Table 2**. The actual coding (frames) were gradually adjusted and modified during the analysis process.

In addition to the above five dimensions of AEIOU in science communication, the conflicts events according to the parties involved, with three combinations: scientists and SEC, scientists and journalists, and SECs and journalists. To ensure the reliability of the coding process, the researcher constantly discussed with another science education researcher to reach a consensus on each of the coding themes. Furthermore, the researcher utilized qualitative data analysis software, Nvivo 9, for coding. Quantitative data analysis software, SAS university edition, was employed to conduct correspondence analysis on the coding results, enabling visualization of the characteristics of these conflict events (Lorenzo-Seva et al., 2009).

RESULTS

The following outcomes of the current study are presented aligned with the research questions.

Table 3. Frequency statistics of conflict frameworks & participants identified from the interview transcripts

Categories of "mismatch" frames	Mismatch sum (times)	Mismatch between scientists & journalists (times)	Mismatch between scientists & SEC (times)	Mismatch between SEC & journalists (times)
Awareness	8	1	0	7
Enjoyment	3	0	0	3
Interest	0	0	0	0
Opinion formation	2	0	0	2
Understanding	34	14	5	15
Total mismatch sum (times)	47	15	5	27

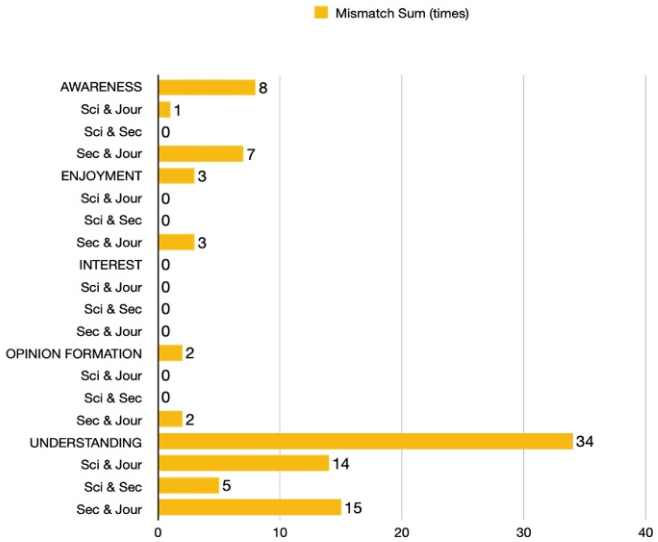

Figure 2. An overlook of total mismatch frames frequencies (Source: Author's own elaboration)

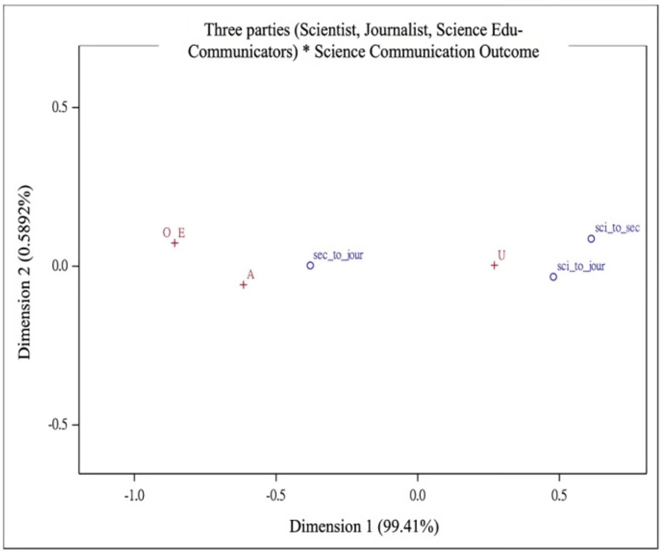

Figure 3. Conflicts outcome analysis among three parties (Source: Author's own elaboration)

To What Extent Do Differences in Frameworks Among Scientists, Journalists, and Science Communicators in the Science Communication Model Account for Conflicts of Opinion Among Them?

47 conflict events were identified from the interview transcripts. The first dimension of the coding was AEIOU frameworks. Among these conflicts, eight (about 17.0%) were related to the "awareness of science" framing, three (about 6.3%) to the "enjoyment of science" framing, zero to the "interest in science" framing, two (about 4.2%) to the "opinion formation on science" framing, and the largest proportion, 34 (about 72.3%), were related to the "understanding science" framing.

In addition to AEIOU framework, the conflict events as the second dimension according to the parties involved were recorded as the following: five mismatches occurred between scientists and SECs, 15 mismatches between scientists and journalists, and the highest number of mismatches, 27, occurred between SECs and journalists. The data of both dimensions are summed up in **Table 3**.

Figure 2 shows an overlook of the total mismatch frames frequencies.

Also, SAS was used to perform correspondence analysis on the 47 conflict events obtained from coding and presented the distribution of framework mismatch and the proximity of the participants in a two-dimensional chart, as shown in **Figure 3**.

According to the results of the correspondence analysis, the conflicts between scientists and journalists, and SEC mainly revolve around the "understanding science (U)" category of framework opposition. Meanwhile, the conflicts between SEC and journalists are mostly related to the "awareness of science (A)", "forming scientific views (O)", and "enjoyment of science (I)" categories of frame mismatches.

What Are Underlying Frameworks That Shape These Conflicts Between Scientists, Journalists, and Science Communicators in the Science Communication Model? (i.e., Mismatching of AEIOU Frames)

"Awareness" mismatch

The research findings indicate that there are eight conflicts related to the "public understanding of science" framework within the interview cases. The "public understanding of science" framework is concerned with "what scientific topics should be known to the public." As the producers of scientific news can decide which scientific topics to report, the significance of the "public understanding of science" framework lies in determining the perspectives and expectations of scientific news producers regarding topic selection and influencing the themes of scientific news. The research findings reveal that the "public understanding of science" framework in conflict incidents is related to "which topics have a higher relevance to people's lives." As mentioned earlier, the relevance to people's lives is an essential indicator of news value. This study's findings also show that this indicator has an impact on the choice of scientific news topics, and science communicators and journalists have different perspectives on "which topics have a higher relevance to people's lives."

In addition, the methods of presenting scientific news content also belong to the "public understanding of science" framework. The study's findings further point out that journalists and scientists have differing opinions on how to introduce scientific topics. Finally, the discrepancy in views on local news values is also a cause of conflict. Journalists believe that significant scientific discoveries have more news value than local research achievements, while science communicators are dedicated to presenting local research achievements to the public.

Relevance of the scientific topics to daily life?: From the conflict incidents, the researchers identified the first aspect of the "public understanding of science" framework opposition as differing views on the "relevance of topics to people's lives." This type of conflict accounted for 75% of all "public understanding of science" framework conflicts, mainly occurring between science communicators and journalists. Science communicators are well-versed in scientific knowledge in the educational domain, so they believe that scientific topics related to school teaching activities are suitable for scientific news. For instance, science communicator 2 considers that in the context of school education, there are many scientific principles suitable for the general public to understand, such as the psychological mechanisms behind learning activities or the causes of attention deficit hyperactivity disorder (ADHD), which is commonly seen in today's educational settings. Science communicator 3 believes that educational technology can benefit teachers and students in the classroom. Therefore, they chose the "instant response system (IRS)" as the theme for an episode of scientific news, and they believe that the scientific knowledge behind this type of topic is essential for the public to know.

> Science communicator 2: Topics related to education, I think, are highly relevant to our lives. We once considered filming a piece on the causes of ADHD because we often encounter such children in educational settings.

> Science communicator 3: I think this topic (IRS) is very much worth reporting. The connection between education and life is significant, and for the public, education is always an excellent entry point for discussion. I believe this is a good angle that can make the audience feel that it is interesting and valuable.

However, journalists hold a different view. Journalist 2 believes that the target audience for scientific news is not only school-aged children but also adults. Most of these adults have been away from school education for some time, so education-related scientific topics are almost irrelevant to them, and they naturally do not want to pay attention. Therefore, journalists think that these topics are not suitable for scientific news.

> Journalist 2: Our (news) audience is broader, ranging from young children to the elderly. We hope that when they watch this, they might have some basic understanding. But for those who have generally left school life, they would think, "OK ... So? What does this have to do with my life?"

However, journalist 2 does not completely reject such topics. They believe that if these topics can be closely related to the public's life situations, such as changing the theme to "IRS can also be used in the office," it would resonate more with the public.

> Journalist 2: But if you say that IRS can be used in the office (during meetings) for responses, would not it be more appealing to the general public? You not only know what happened, but you can also see how it is being used. Is not that very clear?

Attracting the audiences by sensational language?: The second aspect of the "public understanding of science" framework conflict is whether to use enticing methods to draw public attention to scientific news topics even if it might lead to misinformation or loss of focus. In order to increase the public's willingness to watch the news, sensational language is sometimes used in the introduction or headline to "catch the eye." Scientific news faces similar situations. However, sensational language aimed at attracting public attention is less accepted by scientists. Scientist 4 commented on the scientific news he participated in filming: the introductions or subtitles in the news anchor's speech and the news footage are designed and selected. These introductions and subtitles draw public attention to scientific topics by emphasizing certain words or concepts, but scientists believe that they may not necessarily align with the main points they want to convey.

> Scientist 4: When the (scientific news) program starts, it's when the anchor is talking. The emphasis at that moment or the logic and subtitles spoken at that time might draw the public's attention or be more comprehensible. But it's not

> the essence of what we want to convey; instead, it will startle the viewers and make them pay attention for a moment.

The importance of local scientific research when selecting topics?: The last aspect of the "public understanding of science" framework conflict is related to the "news value of local scientific research." Journalists believe that if significant foreign scientific achievements have more news value than local scientific achievements, they should prioritize reporting on those foreign achievements. In contrast, science communicators argue that it is precisely because they are local scientific achievements that they should be reported:

> Journalist 1: So, I asked, is Taiwan's space (research) development rapid? Is it ranked in the top 100 worldwide? Because the news is not only about Taiwan, we also do international news and mainland China news. Mainland China's space development is more advanced than ours, so why should we watch Taiwan's news? That was my point at the time. I could not find a reason to convince myself or the viewers to watch this news story.

"Enjoyment" mismatch

Should it be entertaining? The research results show that there are three conflicts related to the "enjoying science" framework conflict in the interview cases. Science communicators and journalists have different views on whether scientific news should allow the public to enjoy science. Science communicators believe that journalists overemphasize the entertainment value of scientific news.

Science communicators point out that journalists prefer science content with entertaining effects or novelty. Science communicator 2 describes that science topics related to education are usually more easily accepted by journalists if they are about educational technology. Popular educational technologies, such as using augmented reality or virtual reality for teaching activities, are mostly novel and interesting to the public, so they are well-liked by journalists.

> Science communicator 2: Journalists think that if they want to (film) something related to education (in scientific news), it must be about educational technology. Maybe (it's) inventing a certain type of toy, something cool and dazzling. They may care more about whether the audience is interested or not, rather than whether they (the public) need to know. Because when we discuss with her, she might ask in the first few sentences, would the audience find this interesting?

> Science communicator 4 mentioned that she found an interesting video in which people were jumping on a cloudy liquid, and surprisingly, they did not sink into the water but continued to jump on the surface. This unexpected phenomenon caused by "non-Newtonian fluid" was also well-received by journalists and was quickly included in the filming list.

> Science communicator 4: I originally posted a YouTube advertisement for them (journalists) to see, and everyone was jumping on it. They thought it could be filmed and was related to science. They might think from the audience's perspective that this could attract viewers and then explore what scientific principles it has.

"Opinion Formation" mismatch

Based on the interview cases, the researcher found that science communicators and journalists have different views on "enabling the public to form attitudes or views on scientific topics."

The research results show that there were two conflicts related to the "forming views on science" framework conflict in the interview cases. Science communicator 3 believes that scientific news should report on some controversial topics, such as products and services that use pseudoscience for advertising content. By reporting the correct concepts, the public can change their views on these issues, make more useful and influential behaviors and decisions, in other words, no longer be deceived and refuse to buy these products. However, journalists do not seem to have this idea.

> Science communicator 3: Which is useful, L-carnitine or D-carnitine? Is collagen useful? They are afraid that doing these topics would lead to lawsuits from cosmetic companies. Stem cell (topics) were considered, but the final direction was completely different from the original idea, a bit commercialized, only talking about the benefits of stem cells. The reason for wanting to do it was because stem cells were flooding the market, and companies or advertisements that distort the effects of stem cells appeared. There were even advertisements for immune cell banks at that time. This not only distorts the public's understanding of the functions of science but may also lower their scientific literacy.

"Understanding" mismatch

The research results show that there are 32 conflicts related to the "understanding science" framework conflict in the interview cases. Based on these conflicts, the researcher has summarized the details of the "understanding science" framework conflict, including:

(1) requirements for the accuracy and precision of scientific content and sources,
(2) requirements for explaining the principles, mechanisms, and scientific values, and
(3) what kind of scientific content is easy to understand.

These points are explained in order below.

Scientific content and sources must be accurate: The first aspect of the conflict arising from the "understanding science" framework conflict is the requirement for "accurate scientific content and sources." According to the researcher's summary, this aspect can be further divided into four sub-points. The first category is the different requirements for content accuracy. Although all three parties believe that the content of scientific news must be accurate, scientists and science communicators still think that sometimes journalists introduce incorrect content in the news. One obvious example of a conflict occurs in the production of computer animations in scientific news produced using the science communication model. Most scientific news produced with this model includes a computer animation explaining scientific principles and mechanisms. Scientists and science communicators are particularly strict about the content conveyed by the computer animation, fearing the transmission of incorrect information. For example, science communicator 4 commented that she often encountered situations, where the journalist's understanding differed from her own when planning computer animation scripts.

> Science communicator 4: In the (production stage) backend, when illustrating those scientific principles, there would actually be arguments. Sometimes the CG (computer animation) images they draw were different from what we think, and then you had to find a way, like drawing a CG image for them. Or, when the entire animation was completed, you found that some parts were drawn incorrectly. When you asked them to change it, it could be very troublesome. So, you must be more careful when reviewing. You must check the words, like looking for typos and finding, where the problem was.

Scientist 1 believes that when promoting science, a central rule is "better not to provide information than to provide incorrect information." Based on this concept, he would suggest modifications to the computer animations explaining scientific principles.

> Scientist 1: When we were in science popularizing events, there is a very important saying: It is better not to provide information than to provide incorrect information. This means that we place great emphasis on whether the content of the information being transmitted is consistent with the facts. For the animations, I have insisted on some chronological order, and it was not completely followed due to haste. But it's not wrong, just that the timeline has some minor flaws.

The second sub-point of this aspect is *the sensitivity of scientists to numbers*. In the scientific news "can playing basketball help you grow taller?", the scientist questioned the data cited by the journalist in the manuscript and asked whether these numbers had a scientific basis during the revision process.

> Scientist 3: When you talk about science, it should be based on accurate data. You cannot just make things up. You can say he is 201 cm, but he is only 168 cm. This will make the audience, the viewers think, wow, is there really such a big difference?

Science communicators believe that scientific news should select suitable sources as interviewees. Science communicator 1 mentioned that in one episode of scientific news, a journalist asked a scientist who studies squid how to determine whether the fish in the market are fresh, but this question is not related to that person's research expertise.

> Science communicator 1: I feel that the teacher is a bit distressed. If I remember correctly, this teacher's specialty is neither about determining the freshness of fish nor about researching global warming. I remember he is researching squid.

The third sub-point of this aspect comes from science communicators and scientists who unanimously believe that scientific news must report scientific content in a logical manner. Science communicators and scientists believe that journalists have not met their expectations in terms of the order of concepts and the reasoning between cause and effect. Scientist 2 mentioned that the final edited scientific news product presented by the journalist lacks a logical sequence between the steps.

> Scientist 2: Because his (the journalist's) thinking is a bit jumpy, they will talk about things they like. There is no problem with telomeres controlling aging, but how telomeres and aging are related to cancer was not explained in that video. He just mentioned that he used a car analogy, but there were a few sentences missing before that. I think, in terms of understanding (the order), it jumped too quickly.

Science communicator 1 also believes that in another scientific news story about "antibiotics and chicken," there is a lack of some necessary elements between the content presented and the final conclusion, and the conclusion may mislead the public.

> Science communicator 1: The conclusion of this news is strange, as if it's a bit of a leap (in thinking). Only those who know about this matter will find it reasonable. But if I do not know about this, or if I have a prejudice against it, I probably still will not understand what he (the journalist) is talking about, especially with the headline he used. The logic is a bit odd.

Scientists believe that science news should not only help the public construct accurate scientific knowledge but also aid in *dispelling misconceptions*. Scientist 3 argues that the majority of the public may hold the misconception that "playing basketball can make one as tall as professional players" due to observing the predominantly tall stature of basketball players. However, in reality, basketball players undergo rigorous selection processes, and human height is ultimately limited by genetic factors. No amount of training can surpass these inherent limitations. The scientist hopes that science news can help change this misconception, but he comments that the reporter seems to have missed his main point:

> Scientist 5: The reporter did not seem to emphasize the correct concept very much. They did mention that as long as you exercise, you can still reach your genetic height potential.

The need to explain the underlying principles, mechanisms, and their value: Science educators believe that science news is a form of mass media for teaching and therefore emphasize the importance of using science news to help the public construct an understanding of scientific mechanisms. They argue that "understanding" science involves building mental models of scientific concepts. Individuals who understand science can use mental models to explain and predict real-world phenomena (Greca & Moreira, 2002). Mental models of specific scientific content describe cause-and-effect relationships and the mechanisms underlying scientific phenomena (Quinn et al., 2012). Therefore, science educator 1 and science educator 2 believe that science news content should not merely describe superficial, macroscopic scientific phenomena but should also help the public understand the underlying microscopic, abstract principles and mechanisms (Taber, 2013).

For example, science educator 1 believes that the science news story "how to determine if a fish is fresh" discusses how to discern the freshness of fish but fails to explain the underlying microscopic mechanisms, which is a missed opportunity. On the other hand, science educator 2 notes that the proposed "osteoporosis" science news story only discusses macroscopic phenomena without addressing the underlying principles and mechanisms, diverging from their original intention when producing science news.

> Science educator 1: The reporter roughly explained how to tell if a fish is fresh or not but did not explain why. If it were us, it seems like we should not stop there.

> Science educator 2: At the time, everyone thought the interview outline for that science news episode was like health education; it just told people about osteoporosis. We felt it went against our initial intention to produce science news because it only informed people that bone density decreases as gaps between bones increase, and that's called osteoporosis.

Furthermore, science educators believe that the ***value of science*** should also be understood by the public. Science is not just about cause and effect; it enables humans to explain and predict natural phenomena and, ultimately, to solve problems. Science educator 3 mentions that the scientific principle behind the "IRS" is key to solving problems in teaching environments. Thus, science news should not only report phenomena like "using smartphones in class" but should also emphasize the problem-solving value of scientific principles.

> Science educator 3: I would first film the scene of a class without IRS, where the teacher is asking questions to a group of students, like talking to a group of tombstones. This represents the actual dilemma. So, if using mobile phones during class can help with teaching, it means that mobile phones are essential, and only then we discuss the comparison between having an IRS and not having one. When the journalist asks about the scientific principles, I would talk to them about learning theories and learning science, for example, how learners process information in their brains, and how they acquire knowledge through cognitive processes. I might present the cognitive processes using animations... Because they [journalists] are not scientists, they will not necessarily feel the scientific value.

What type of scientific content is easier to understand: The last aspect of the "understanding science" framework is about what kind of scientific content is easier to understand, in other words, to what extent scientific knowledge should be simplified. Science news is not an academic journal, and its audience consists of the general public. Discussing scientific principles and mechanisms in science news is challenging and requires striking the right balance between depth and complexity. Scientist 2 recalls their experience in filming science news, where they were reminded by the journalist to avoid overly academic explanations.

> Scientist 4: Since they [journalists] told me they were coming, I tried to prepare some material.

Table 4. A sum-up table of mismatch AEIOU (conflict) frames with issues for science communication

Mismatch in AEIOU	Issues	Scientist	SCE	Journalist
Awareness	Relevance to daily life		X	X
	Sensational language for attraction	X		X
	Domestic (science) topics		X	X
Enjoyment	Entertaining		X	X
Opinion formation	Forming attitudes or views		X	X
Understanding	Accuracy of content	X	X	X
	Explain underlying principles		X	X
	Simplicity for understanding	X	X	X

Note. X implies conflicts occurred in the corresponding frames

> Later, I realized that what I had prepared was not particularly useful because I was still approaching it from a very academic standpoint. So, frankly speaking, it was not useful.

On the other hand, journalist 2 believes that science news content should be easily understood by anyone. Moreover, given the limited time available for news, scientific principles should be simplified.

> Journalist 2: But why did I write that piece? I wanted it to be accessible to the general public. From a professional perspective, it might not be professional. However, my goal is not to delve deeply into the subject for the audience, but to make it simple and easy to understand. So, our perspectives are different. They stand from a researcher's point of view, but how can you finish explaining it within 30 seconds?

Table 4 shows a sum-up table of mismatch AEIOU (conflict) frames with issues for science communication.

DISCUSSION

Based on the analysis of conflict frequency, researchers found that different science news producers participate in science news production with opposing frameworks. In their interactions, these opposing frameworks lead to different interpretations and expectations for science news, resulting in conflicts (Davis & Russ, 2015). Conflicts between science communicators and journalists are more frequent than those between scientists and journalists. Researchers speculate that in the science communication model, science communicators negotiate with journalists, reducing the conflicts between scientists and journalists. However, conflicts between science communicators and journalists are more extensive, involving four aspects: awareness of science, enjoyment, perspective formation, and understanding. This suggests that science communicators have more diverse frameworks for science news, which may differ from journalists' frameworks.

Scientists and science communicators have higher demands for scientific content than journalists, leading to most conflicts being related to the understanding framework. In conflicts between scientists and journalists, 93.3% of the overall conflicts are related to the opposition within the understanding framework. However, conflicts between scientists and science communicators are less frequent, possibly because both parties have a scientific background, making collaboration smoother. Even though conflicts between science communicators and journalists are more frequent, the production of science news requires negotiation and adjustments. This process of negotiation allows science news to become more diverse rather than being dominated by one perspective or framework. Peters argues that conflicts between scientists and journalists represent a "creative tension" that, despite appearing tense, stimulates innovation in science news (Peters, 2013).

Mismatch in the "Awareness of Science" Framework

The first finding of this study is the opposition within the "awareness of science" framework, with conflicts mainly occurring between science communicators and journalists. The relevance of science news topics to people's lives (proximity, or relevance) is an important indicator of news value (Spinks, 2001). According to the principle of proximity, domestic news topics are more attractive to the public than international news (Galtung & Ruge, 1965). In addition to geographical proximity, the degree of relevance to individual experiences is also an indicator. Shauli and Baram-Tsabari (2018) point out that parents of children with hearing impairments need to search and read a lot of relevant scientific knowledge, such as the structure of the human ear, the mechanism of hearing, and children's language development. For these parents, due to their children's hearing impairments, such scientific knowledge is no longer remote but directly relevant to their lives. In this context, frameworks are indeed influenced by individual experiences (Feinstein, 2015). Since the perspectives on "relevance to life" are related to the past experiences of science news producers, the framework conflicts between science communicators and journalists are easily understood. SEC, who are familiar with the theories and practices of educational settings, naturally consider science topics in educational settings to be "accessible." In contrast, journalists hold the opposite view, showing little interest in education-related science topics, leading to differences in the selection of science news topics. Even though a few education-related science topics are chosen for science news, journalists often reluctantly agree to cover them.

This section may be divided by subheadings. It should provide a concise and precise description of the experimental results, their interpretation, as well as the experimental conclusions that can be drawn. Moreover, the public's awareness of scientific issues is also influenced by the way news is reported. Whether it's the anchor's introduction or the subtitles appearing on the news screen, these are all ways they represent scientific content, and the process of representation is called "framing." Entman (1993) pointed out that framing includes two factors: selection and emphasis. When people represent scientific content, they choose some partial, one-sided facts and emphasize their importance. Scientists may think that the anchor's introduction and the subtitles on the news screen are "specially selected" because they are the products of journalists' framing, which means selecting the parts of the facts and content that they think are important and representing them in the form of introductions or subtitles. The focus chosen by journalists and anchors differs from the focus chosen by scientists (Singer, 1990), leading to scientists' confusion and misunderstanding.

The third connotation of the opposing awareness of science framework is related to whether local research results have news value worth of reporting. The more significant the scientific discovery or event, the more likely it is to be accepted by science journalists. Spinks (2001) listed ten factors that make it easier for science news to be published smoothly, the first being the importance or impact of the subject matter of the science news. This means that the topics of science news are usually "scientific breakthroughs," such as major scientific applications that can change people's lives or significant discoveries that can change human understanding of the natural world. In some cases, Taiwan's local research achievements may not be particularly eye-catching compared to Europe and the United States, and therefore are less favored by journalists. However, this perspective differs from that of science educators. According to science educators, it is precisely because these are domestic research achievements that they should be made known to the Taiwanese public. Since most of Taiwan's science news is translated from foreign media, there is a relative lack of coverage on domestic scientific progress. As a result, science educators believe that science news should be committed to reporting on domestic scientific topics (Wu et al., 2015).

Mismatch in the "Enjoyment of Science" Framework

This study also found that members involved in the production of science education news have an opposing "enjoying science" framework. For example, two science educators mentioned that journalists prefer cool and interesting scientific content because these entertaining contents can more easily attract the public's attention. Should science news allow the public to enjoy science? The answer is yes. Taking the science news about "non-Newtonian fluids" as an example, people bouncing on the liquid surface without sinking is indeed a very novel phenomenon. Indeed, the interesting and novel aspects of science news can make readers and listeners more willing to engage with science. Baram-Tsabari and Osborne (2015) also believe that science communication activities should not only educate the public about science but also entertain them. On the other hand, for informal science learning through watching science news, positive experiences and enjoyment are considered important learning outcomes (Alsop, 1999). Chen (2011) used a self-rating scale to ask Taiwanese scientists and journalists about their views on media functions. One of the scale items was "media can entertain the public." The average score for scientists (n=1,046) was 3.90, and for journalists (n=67), it was 4.04. After a two-tailed t-test, there was no statistically significant difference between the two groups' average scores. This shows that the scientists and journalists generally "agree" that the media can entertain the public. In summary, some interesting elements to science news to allow the public to enjoy science may not be inappropriate.

"Interest in Science" framework–The Perspective of Science Amateurs

Although this study did not find an opposing "interest in science" framework among the production members, it is not possible to determine whether the three groups have different frameworks for "interest in science." This may be due to the research question not being mentioned, or they may have no specific views or opinions on whether science news can/should arouse public interest.

However, the researcher found that journalists who are science amateurs, with an increased number of interviews with scientists and exposure to scientific content, gradually increased their interest in science and were willing to discuss more science-related issues with scientists. Journalist 2 mentioned that arousing the public's interest is more important than forcing them to acquire scientific knowledge. She believes that educational science news should not be like attending a class but should stimulate the public's interest and encourage them to search for more knowledge on their own.

> Journalist 1: I used to skip science news, because I did not understand it, I was not interested, and I did not want to read it, and I thought the threshold was high! After doing this for more than

a year, I'm not so resistant to it now. Like when I did food safety news for an online news company, I chatted with a professor for more than an hour and found it very interesting. Only when you work on this topic can you understand it and then come to like it.

Journalist 2: Is not that what education is all about? I give you a hook, and then you go and learn. I pique your interest, allowing you to learn on your own, rather than me forcefully feeding you the information. When you give them a hook, they may not initially think it's much, but the more they search, the deeper they get into it. I think this is a crucial thing, much better than me telling you bluntly what biomimetic theory is today.

Journalist 2's idea of the effectiveness of science news is close to the concept of informal science learning, which does not emphasize the acquisition of scientific knowledge and allows learners to freely choose what they want to learn (Falk et al., 2018). What the public is willing to learn is precisely, where their interests lie.

Mismatch in the "Opinion Formation (Forming a Scientific Perspective)" Framework

The connotation of "forming a scientific perspective" is "enabling the public to form attitudes or opinions on scientific topics." Hollander (1976) pointed out that the three dimensions of attitude are:

(1) cognitive dimension: attitude affects whether an individual "believes something is true",

(2) affective dimension: attitude affects whether an individual "likes something", and

(3) behavioral dimension: an individual's attitude is highly related to their behavior.

Opinion is a concept similar to attitude, but there are differences between the two (Shrigley Robert, 1990). Opinions lean towards the cognitive dimension, i.e., Hollander's (1976) "whether to believe that something is true." However, attitudes include affective and behavioral factors. Moreover, even if the public may have a specific opinion on something, they may not necessarily act. Shrigley and Robert (1990) cited an example, where some Americans held their own opinions on gun control legislation, believing that the government would implement certain mechanisms to monitor gun owners. However, they were not highly concerned about the issue and did not push the legislation to pass the bill. In other words, whether an individual acts for a particular idea is a critical condition for elevating from opinion to attitude.

In the interview case, science educators mentioned that although journalists did not refuse controversial topics due to their opposition to educating the public, their considerations were not unreasonable. In the science education model, the production of science news is a collaboration between scientists, science educators, and journalists. The three parties must coordinate to construct a piece of science news together. Nelkin (1995) pointed out that the news industry is a profit-making business, and they are influenced by advertisers, shareholders, and even other companies, affecting their reporting content.

In another case of conflict in the "forming a scientific perspective" frame, science educators believed that the finished science news product seemed to have an advertising suspicion. Nelkin (1995) pointed out that science news has a "vulnerability to source". Journalists sometimes accept all information from the message provider, but if the information comes from public relations or press conferences with specific commercial positions, the neutrality of the scientific information may be questionable. Therefore, if the message source is a commercial company, the content may be "framed" with advertising purposes. If science news producers overlook this issue, they will not only fail to help the public change their views, but they may also lead the public to develop incorrect opinions or attitudes, preventing them from changing their consumption behavior or making wiser consumption decisions.

Mismatch in the "Understanding of Science" Framework

In this study, the "understanding science" framework accounted for about 72.3% of the overall conflict events, indicating that there are significant differences in the understanding of science among members involved in the production of scientific news. Researchers speculate that these differences may be related to whether they have a scientific background. Rehbein (1994) pointed out that conflicts often arise between two communities with professional gaps (e.g., doctors and patients).

The results of this study echo previous claims that scientists and science educators with a scientific background can accept the rigor, objectivity, and quantitative information of science due to their knowledge, culture, and communication methods within the scientific community. However, the audience of scientific news consists of the general public, and it is worth considering whether the high expectations of scientists may raise the threshold for the public to engage with science.

On the other hand, journalists tend to simplify scientific facts, use qualitative descriptions, be relatively less objective (e.g., adding exaggeration or entertainment), and focus on macroscopic, concrete scientific facts, products, or services, rather than microscopic, abstract scientific mechanisms and explanations. It is undeniable that science news should promote the public's understanding of science, but there seems to be no consensus among scientists, science educators, and journalists on the extent to which scientific content should be simplified.

The results of this study also resonate with the old paradigm in science communication research–the deficit model–which refers to the knowledge gap between scientists and non-scientific public (in this study, represented by journalists). Many science education scholars and science communication scholars have begun to adopt new perspectives on science communication, such as Logan's (2001) interactive science model and Baram-Tsabari and Osborne's (2015) dialogue model. These models emphasize diverse communication methods and public engagement in science, such as participating in science decision-making, science issue discussions, or even directly engaging in scientific research.

Furthermore, science communication activities have shifted from a scientist-centric perspective to an audience-centric one, focusing on informal science learning that considers the audience's prior knowledge and interests. Inspired by Davis and Russ (2015) and Hammer et al. (2005), this study argues that frameworks are diverse rather than having a single, correct truth. Both the production of science news and the construction of understanding in science courses involve people negotiating and coordinating with their frameworks to reach a consensus. Therefore, it is important to respect the public's frameworks, even if they may not be scientific, as this is their way of understanding scientific content.

In conclusion, both science education and science communication research share a common goal: to promote public understanding of science through public science engagement and media representation of science. Research that combines theories and practices from both fields will be increasingly in demand, as they can complement each other in achieving their common goal (Baram-Tsabari & Osborne, 2015).

CONCLUSION AND FUTURE SUGGESTIONS

Conclusions

This study, based on the theories "framework theory as a common language for science education and communication" and "AEIOU of science education and communication," combines perspectives from both science education and communication. It uses inductive content analysis to investigate conflicts of opinions that occur among members during the production of science news. The researchers identified conflicting frameworks behind the events from the interview transcripts of the producers.

The production process of science news itself is a process in which the producers coordinate their frameworks. Conflicts of opinions may arise if two parties hold different frameworks for the same matter. The study results show that scientists, science educators, and journalists involved in the production of educational science news indeed hold different AEIOU frameworks, and incompatible AEIOU frameworks are the cause of their conflicts.

In this study, the researchers identified a total of 47 conflicts. Classified by AEIOU framework, there were eight cases of "awareness of science" framework opposition, three cases of "enjoyment of science" framework opposition, two cases of "formation of science perspectives" framework opposition, and 34 cases of "understanding science" framework opposition. In terms of the combinations of conflicting members, there were 15 conflicts between scientists and journalists, five between scientists and science educators, and 27 between science educators and journalists. Correspondence analysis results further suggest that scientists and science educators with similar backgrounds exhibit similar conflict patterns with journalists, but the conflicts between science educators and journalists cover a broader range of framework oppositions, unlike the majority of conflicts between scientists and journalists, which mostly belong to the "understanding science" framework opposition.

The results of the inductive content analysis present detailed implications of AEIOU framework oppositions. The content of AEIOU framework oppositions found in conflict events is described, as follows: "awareness of science" framework opposition includes

(1) the relevance of science topics to daily life,

(2) the presentation of scientific content, and

(3) the news value of local scientific research;

"enjoyment of science" framework opposition involves the entertainment value of science news; "formation of science perspectives" framework opposition concerns whether the public should change their views on pseudoscientific products or services; "understanding science" framework opposition includes

(1) the accuracy of scientific content and sources,

(2) the need to explain underlying principles and mechanisms and their value, and

(3) the type of scientific content that is easy to understand.

This study did not identify any conflicts caused by opposition to the "interest in science" framework and therefore could not determine the framework of producers (other than journalists).

From the framework opposition situations, the researchers deduced AEIOU framework outlines for the three parties involved. For scientists, they are concerned about whether science news can enhance public understanding of science, as they have high standards for content accuracy and logic. In addition to helping the public understand science, scientists also hope to debunk misconceptions through science news. In this regard, scientists' framework for science news aligns with the deficit model, which emphasizes one-way information transmission and views media as a means of educating the public. However, this perspective has the following drawbacks:

(1) excessive focus on textbook and laboratory scientific knowledge, rather than science knowledge in the context of people's daily lives and
(2) even if people understand science, it does not mean they will appreciate it.

This is a problem that science communicators need to consider.

Next, the study results show that the science education and communication framework, in addition to requiring an understanding of "science," further narrows the distance between science and the public (awareness of science), adds interesting elements to science news (enjoyment of science), and emphasizes helping people change their views, evaluations, and behaviors (forming opinions about science). In this study, the highest number of conflicts occurred between science educators and journalists, with the broadest range of opposing AEIOU framework dimensions.

Lastly, journalists play a crucial role in media production, and they are skilled at attracting public attention. If science is to become widely known, it needs a storyteller to bring science to the general public. Even though journalists, scientists, and science educators have more apparent conflicts in the "understanding science" framework (about 72.3%), they know how to make people feel that science is close to them (awareness of science) and bring fun content to the public (enjoyment of science).

Suggestions

In future science edu-communication training, it is suggested that members involved in producing educational science news need to:

(1) have a metacognitive awareness of their framework and others',
(2) understand that the cause of opinion conflicts is the presence of diverse and incompatible frameworks, and
(3) understand that media (including educational science news) is the result of members coordinating their frameworks and reaching a consensus, also known as framework construction.

People often unconsciously use their framework to interpret and understand external things, without realizing it. It is only through interaction with others that one may discover their framework due to incompatibilities. In addition, because inconsistent frameworks may lead to opinion conflicts, the researcher suggests that science news producers can adjust their framework for science news based on the results of this study. For scientists, it is suggested they try to expand AEIOU framework from focusing solely on "understanding science" to other diverse aspects. Science educators and journalists need to adjust their "awareness of science," "enjoyment of science," and "understanding science" frameworks, to further reach a consensus on the scope of topics, entertainment, and the degree of simplification of scientific content.

Finally, this study found another type of conflict that does not belong to AEIOU framework opposition. These conflicts are related to media production methods, and their number is as high as 35, close to the total number of AEIOU framework conflicts. Therefore, it is suggested that science communication practioners and scientists collaborating with the media need to understand the functions and limitations of the media and familiarize themselves with their production methods and specifications to avoid conflicts.

This study is a preliminary exploration of the science edu-communication model combining science education and science communication perspectives. More research is needed to construct a more comprehensive discourse and framework in the future. For subsequent studies, this study suggests:

(1) In terms of research methods, this exploratory study only uses inductive content analysis with low reproducibility to process research data. However, a more robust research method is needed for a complete theoretical basis of the science edu-communication model, such as Pan et al. (Pan et al., 2019), which combines inductive and deductive content analysis to process data and categorize complex data into several categories with inductive content analysis and then identify differences between frameworks using deductive content analysis.
(2) In terms of research subjects, it is suggested that including the production of general science news(videos) for comparison, in order to identify AEIOU framework and conflicts between members producing educational science news and those producing general science news.

In conclusion, this preliminary study on the science education and communication model highlights the importance of understanding and addressing the conflicts and differences in frameworks among scientists, science educators, and journalists involved in producing science news. By enhancing metacognitive awareness, respecting diverse frameworks, and adjusting their own frameworks, these individuals can work together more effectively to create engaging and accessible science news for the public. Future research should build on these findings to develop a more comprehensive understanding of the science education and communication model and its implications for science news production and dissemination.

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