

The Power of Fake News: Big Data Analysis of Discourse about COVID-19–Related Fake News in South Korea

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The study investigated people’s perceptions and reactions to fake news by evaluating trends in online comments sections. First, fact-checked newspaper articles were identified using an online fact-checker provided by the Korea Disease Control and Prevention Agency. Only 2 of 98 pieces of fake news were found to be revised. A Word2Vec analysis of 38,057 comments posted to 98 articles about public health, education, and the economy that contained fake news revealed readers’ perceptions about fake news, government policy, and criticism and praise for the government. The findings of this study highlight the speed of messaging in modern society and short media attention spans, reflected in the fact that the public ultimately does not appear to be interested in correcting fake news. It is necessary to increase public awareness of the importance of correcting fake news as an essential part of media literacy to prevent the delivery of fake news.

Keywords: COVID-19, fake news, misinformation, social media, fact-checking, big data, Word2Vec, South Korea

Since December 2020, not only has the novel coronavirus spread worldwide but also misinformation and fake news during the COVID-19 pandemic. The World Health Organization (WHO) emphasized the seriousness of this issue, stating that fake news spreads faster and more easily than the virus itself (Xie et al., 2020). Misinformation, defined as false information with or without misleading intentions, and fake news, which is fabricated information with misleading intentions in mainstream news (referred to as disinformation), have been disseminated through both traditional media sources like TV and newspapers as well as social media platforms such as Twitter (University of Washington Bothell & Cascadia College Campus Library, 2023).

Efforts to combat misinformation and fake news have been made in South Korea, a country with relatively low COVID-19 cases and fatality rates. The Korea Disease Control and Prevention Agency (KDCA), previously known as Korea Centers for Disease Control and Prevention, actively fact-checks news items

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through its website. A study analyzing fact-check posts on the KDCA website revealed that policy-related misinformation was more frequently checked than health-care-related misinformation, often identifying specific newspaper articles as sources of fake news (Song, Ko, & Jang, 2021).

During the COVID-19 pandemic, there have been attempts to detect fake news and classify various topics through big data analysis (Ceron, de-Lima-Santos, & Quiles, 2021; Madani, Erritali, & Bouikhalene, 2021). Studies analyzing the sentiment surrounding fake news during the pandemic have found that anger, fear, and negative emotions are more prevalent in fake news compared with real news (Iwendi, Mohan, Ibeke, Ahmadian, & Ciano, 2022). Furthermore, research has categorized COVID-19-related fake news and identified that conspiracy and the virus elicit more negative emotions, while topics like cures, vaccines, and politics generate different sentiments (Charquero-Ballester, Walter, Nissen, & Bechmann, 2021).

However, despite these earlier studies using big data analysis to examine fake news, they have not addressed strategies to deal with confirmed fake news. By analyzing comments on fake news items in the present study, we examine how fact-checking has affected the behavior of fake news providers and public perceptions of fake news.

Literature Review

Fake Social Media News Regarding COVID-19

The unrestricted nature of social media allows for the rapid and extensive dissemination of misinformation (Waszak, Kasprzycka-Waszak, & Kubanek, 2018; WHO, 2022a). Studies have shown that a significant portion of COVID-19-related information on platforms like YouTube and Facebook is inaccurate and unverified (Iwendi et al., 2022; WHO, 2022a). Users often share such information due to trust in online sources and feeling overwhelmed by information overload (Laato, Islam, Islam, & Whelan, 2020).

One of the reasons people rely on social media for information is the perception that it provides timely updates that official authorities may lack (Signorini, Segre, & Polgreen, 2011). Hence, the belief in fake news shared on social media often surpasses the trust in government-provided information, leading to the adoption of false precautionary measures (Huynh, 2020). The spread of disinformation through social media can have severe health consequences and contribute to the threats posed by the COVID-19 pandemic (Pulido, Villarejo-Carballido, Redondo-Sama, & Gómez, 2020).

Social Media Comments on Fake News

Social media comments serve as user responses, expressing opinions, sentiments, questions, rumors, personal experiences, or calls to action (Chin & Zauddin, 2022; Erzikova & McLean, 2020). Examining these comments in different contexts is important for several reasons. First, it helps understand user attitudes and opinions, providing insights into their perceptions of and responses to various topics, events, or organizations (Whiting, Olufowote, Cravens-Pickens, & Witting, 2019). Additionally, social media comments provide valuable insights into user behavior, engagement patterns, and the dynamics of discussions within online communities (Jenkins & Moreno, 2020). Analyzing comments aids in detecting and combating fake news and misinformation (Sabeeh, Zohdy, Mollah, & Al Bashaireh, 2020).

Furthermore, studying social media comments improves user experiences by gained insights into preferences, needs, and engagement patterns, which can be used to enhance platform design and tailor content recommendations (Meldrum et al., 2017). Overall, examining social media comments in diverse contexts offers valuable insights into user attitudes, behaviors, and the impact of online content, contributing to decision making and interventions in the complex dynamics of social media ecosystems.

Fact-Checking Endeavors for Fake News

Fact-checking plays a crucial role in addressing fake news and misinformation. First, it enables journalists to investigate the sources of fake news and make necessary corrections (Zhou & Zafarani, 2020). Second, it helps inform consumers about errors and false information, increasing their likelihood of having accurate information (Amazeen, 2015). Consumers exposed to fact-checking are more likely to perceive the seriousness of fake news and have correct information compared with those who are not (Brandtzaeg, Følstad, & Chaparro Domínguez, 2018).

The WHO combats COVID-19 misinformation by emphasizing reliance on trustworthy sources like itself, Centers for Disease Control and Prevention (CDC), and health authorities and raising awareness through campaigns like "Stop the Spread." In Korea, a limited number of fact-checking sites combat misinformation. Notable examples include the Seoul National University Fact-Check website (<https://factcheck.snu.ac.kr/>), which evaluates news from more than 30 Korean sources, and the AFP Fact-Check Korea (<https://factcheckkorea.afp.com/list>), which corrects widely disseminated misinformation.

Studies have shown that fact-checking efforts by users, platform providers, and government interventions, such as policy guidelines and algorithmic verification, help to mitigate the spread of fake news (Schuetz, Sykes, & Venkatesh, 2021). Platforms like Facebook also aim to correct misinformation and raise awareness about the risks of sharing unchecked information (Jennings & Stroud, 2023). Engaging the public in cross-checking information with authoritative health organizations is essential for combating fake news (Hartley & Vu, 2020).

Discrepancy Between Fact-Checking and Correction

During the COVID-19 pandemic, Krause, Freiling, Beets, and Brossard (2020) expanded the meaning of fact-checking to include "myth-busting efforts by institutions and scientific agencies" (p. 1053). Supporting this definition, new websites (e.g., <https://www.covid19factcheck.com/>) appeared. Factcheck.org, the pioneer fact-checking website that led the early fact-checking movement, created a new archive specific to COVID-19 (<https://www.factcheck.org/issue/covid-19/>), and the WHO (2022) created a Web page called "Coronavirus Disease (COVID-19) Advice for the Public: Mythbusters." The CDC (2020) also acted against fake news by posting a document titled "Stop the Spread of Rumors."

Efforts to fact-check fake news on social media platforms have been made, but a considerable portion of misinformation remains uncorrected. Research by Brennen, Simon, Howard, and Nielsen (2020) indicates that significant proportions of fake news on platforms like Twitter (59%), YouTube (27%), and Facebook (24%) go uncorrected. Ahmed and colleagues (2020) found that only around 27.5% of Facebook posts contained correct information verified by reputable sources like the CDC or the WHO, while approximately 22.3% contained fake news, and 19.6% were unverifiable.

Data and Methods

Data Collection

In this study, we aimed to understand reactions to fake news over time by analyzing trends in replies and comments on news items based on their publication dates. We focused on the Daum and Naver news websites, which are the two major Web portals in Korea (Jun & Chung, 2016). To ensure a balanced representation of political viewpoints/orientations, we included both portals as Daum leans toward liberal, while Naver leans toward conservative (Na, An, Lee, Kim, & Kim, 2021). We collected the data in Korean because both portals did not provide English translation features.

Figure 1 depicts the flowchart illustrating the included comments. Initially, between February 2020 and November 2022, we collected all available data for issue-checking posts ($n = 33$) and fact-checking posts ($n = 64$) from the KCDA (<http://ncov.mohw.go.kr/factBoardList.do>). These posts were independently reviewed by two researchers, who excluded those that were not based on news articles or were unrelated to COVID-19 ($n = 45$). This process resulted in 45 posts comprising COVID-19 fact-checked articles and corrections to newspaper articles.

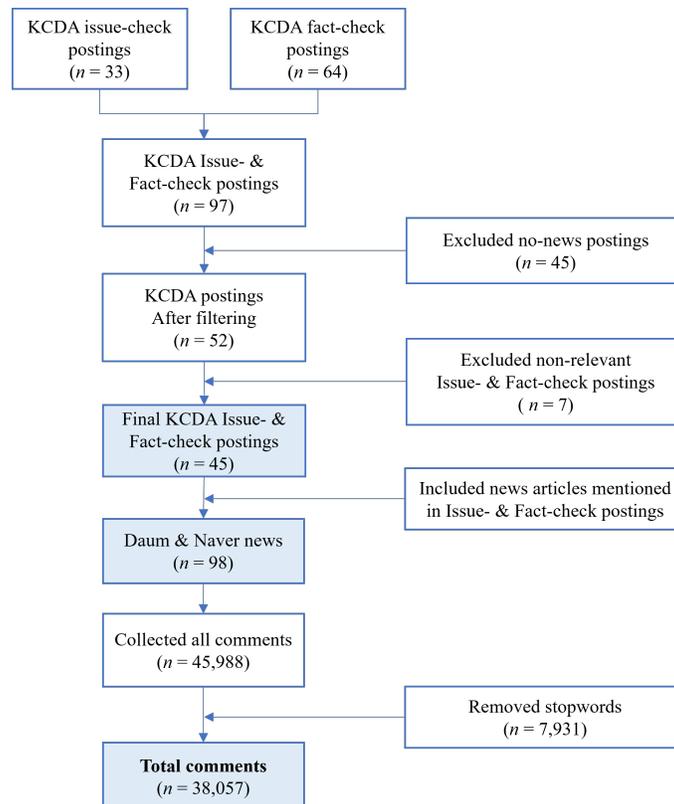


Figure 1. Flowchart of comments.

Next, we conducted a search to find news articles that referenced any of these 45 Daum and Naver posts: 98 news articles were identified. These news articles covered a range of topics, including public health, education, economy, and society. The inclusion of multiple categories allowed for a comprehensive analysis of various domains affected by fake news.

We then proceeded to collect responses to these 98 news postings, resulting in a total of 45,988 comments. To ensure data quality, we removed stop words, such as special characters, emoticons, numbers, consonants, and vowels, from the collected comments. After this preprocessing step, we retained 38,057 comments for further analysis.

Analysis

To analyze the collected comments, we employed Word2Vec, a widely used machine learning technique for natural language processing (NLP). Word2Vec is an effective model for capturing semantic relationships among words in a large corpus of text data, allowing us to understand contextual meaning and word associations (Mikolov, Sutskever, Chen, Corrado, & Dean, 2013). Through Word2Vec, words are represented as dense vectors in a high-dimensional space, with similar vectors indicating semantic similarity based on their appearance in similar contexts (Suh, 2020).

First, we conducted a morpheme analysis on the comment units using the *kkma* module of KoNLPy, a Korean morphological analysis tool for NLP (Park & Cho, 2014). This step allowed us to extract meaningful nouns from the comments and form a basis for subsequent analysis. Next, Word2Vec was applied to the comments of each category. We analyzed the data in Korean and translated the findings into English. This was not only because Word2Vec is widely used for Korean analysis (Jeong et al., 2018) but also because incorporating the original text by using the users' native language helps to capture the contextual meaning of vocabulary as accurately as possible.

In this study, we employed the Continuous Bag of Words (CBOW) algorithm for Word2Vec. The CBOW model predicts a target word given the context words surrounding it. The model uses a neural network architecture, typically a shallow feedforward neural network with a hidden layer, and trains by adjusting the network weights through techniques like backpropagation and gradient descent (Mikolov, Chen, Corrado, & Dean, 2013). The CBOW model was chosen as it has shown effectiveness in capturing word relationships and associations.

To form the word clusters, we conducted training using context words based on predefined topics such as public health, economy, and education. During training, we extracted the vector values of the words and visualized them in two dimensions to identify clusters of semantically similar words. The vector size varied depending on the topic, with 300 dimensions for the topics with a larger number of collected comments (health and education) and 200 dimensions for the topic with fewer comments (economy). The window size, which determines the number of words considered for context, was set to five, and 200 iterations (epochs) were performed for training. For visualization, we used the t-stochastic neighbor embedding algorithm (Schubert & Gertz, 2017), which helps reduce the high-dimensional vector space to two dimensions while preserving the relative distances among vectors.

In terms of naming the word clusters, we adopted a descriptive approach. We analyzed the common themes and characteristics of words within each cluster and assigned labels that accurately represented the main topics or concepts conveyed by the words in the cluster. The names of the clusters were derived from the observed word associations and semantic relationships in the data. It is worth noting that the formation and categorization of word clusters involved an iterative process, with multiple independent observers reviewing and comparing the preliminary classifications until a consensus was reached. Table 1 presents the examples and numbers of comments for each category.

Table 1. Examples and Numbers of Comments for Each Category.

| Category | Example of Article Title | Number of Comments | |
|---------------|---|-----------------------|------------------------|
| | | Daum ($n = 19,349$) | Naver ($n = 18,708$) |
| Public health | <ul style="list-style-type: none"> Controversy over the reliability of Korean diagnostic kits: U.S. lawmakers “inappropriate (the U.S. lawmakers)” vs. “a diagnostic method recognized by the WHO (KDCA)” (Cho, 2020). | 13,255 | 5,147 |
| Education | <ul style="list-style-type: none"> The Ministry of Education plans to implement “online schooling” without any preparation (J. M. Park, 2020). | 2,219 | 10,915 |
| Economy | <ul style="list-style-type: none"> 5 trillion won from “unclaimed assets” allocated for disaster management . . . remains unused amidst COVID-19 crisis (S. Y. Park, 2020). | 3,871 | 2,633 |
| Society | <ul style="list-style-type: none"> Government should learn from local authorities after one week of the mask “five-day rotation” policy (<i>Joongang Sunday</i>, 2020). | 4 | 13 |

Note. Since the society category had only a few comments, we excluded this category in the current study.

Findings

Figure 2 depicts how reactions to fake news (focusing on news articles with the most comments on Daum and Naver) evolve over time. We discovered that people react immediately after fake news is published online, but their interest in fake news, on the other hand, fades within one day. For example, 7,113 comments were posted on a fake news item (Cho, 2020) on the day of publication, but only 175 the next day, and two during the following two days (Figure 2, left). Similarly, the number of comments on the most commented-on Naver fake news item (Ahn & Heo, 2020), which was about the Korean government’s financial policy during the COVID-19 pandemic, was high immediately after publication ($n = 2,139$) but rapidly declined only days later (Figure 2, right). Regardless of the news platform, there were no reactions to or comments on revised articles (even though there were only two revised articles), implying that there is no effective way to correct misinformation that has already been widely disseminated.

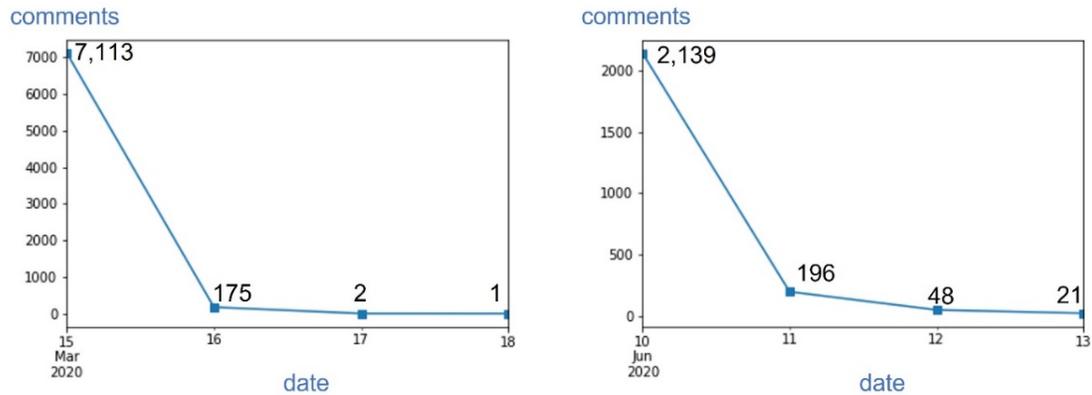


Figure 2. Changes in the number of comments on fake news items over time.

Source: Cho (2020) and Ahn & Heo (2020).

Figures 3 to 5 present reactions to fake news by analyzing the comments using the Word2Vec technique with regard to three different categories (i.e., public health, education, and economy). First, Figure 3 depicts people's reactions to fake news about public health on the Internet news media (Daum on the top and Naver on the bottom). Among the replies on Daum, three major word clusters emerged: (1) contempt for fake news, (2) praise for COVID-19 test kits made in Korea, and (3) symptoms and treatment of COVID-19. The Naver Word2Vec results also reveal three major word clusters, two of which are similar to Daum: (1) praise for the Korean COVID-19 testing kit and (2) contempt for fake news. In addition, we discovered a new cluster: (3) incompetent government and criticism of policy.

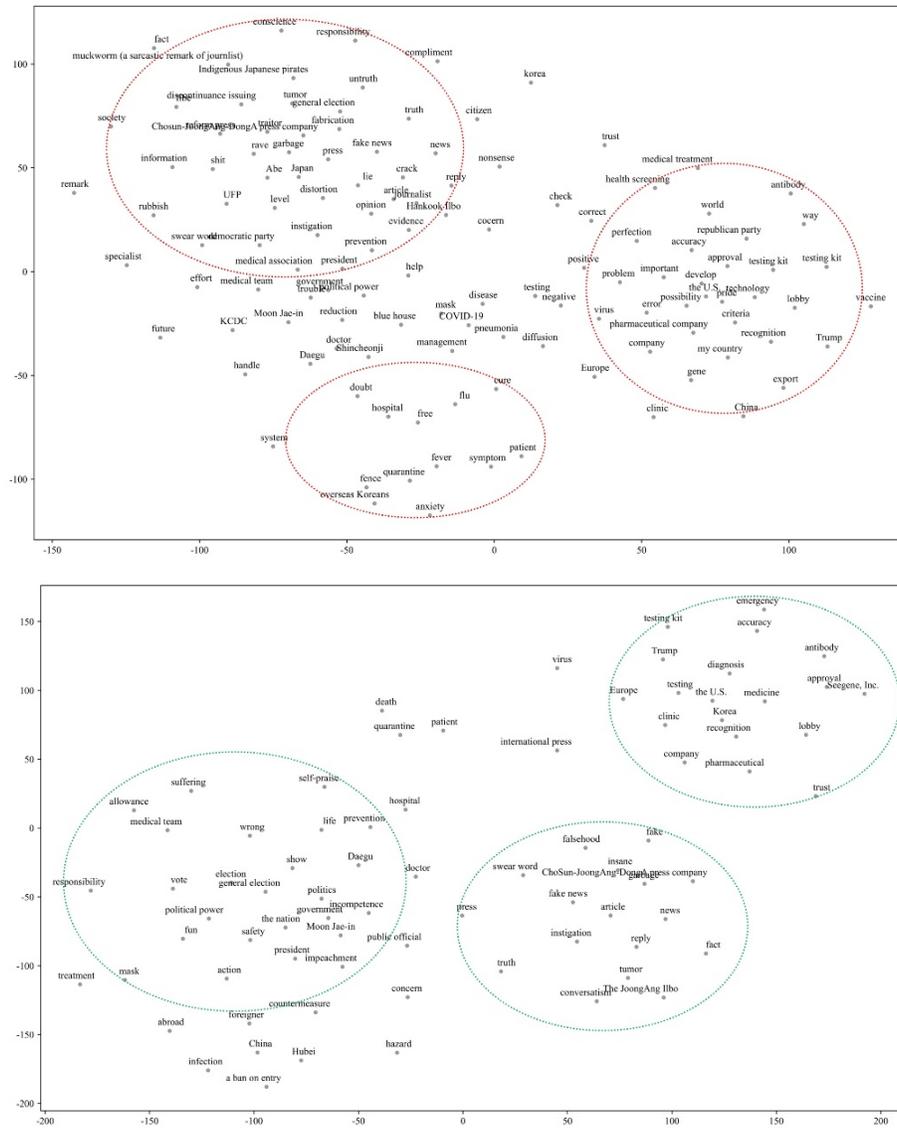


Figure 3. Word2Vec analysis: Public health category comparison between Daum (top) and Naver (bottom).

Table 2 provides specific information about each word cluster by analyzing comments about public health-related fake news on Daum and Naver. We found few differences between Daum and Naver with regard to the first two clusters, which expressed disdain for fake news and appreciation for Korea-made COVID-19 test kits. The comments on the third cluster on Daum, regarding symptoms and COVID-19 treatment, reveal curiosity about symptoms and treatment methods as well as fears of being diagnosed with COVID-19. On the other hand, the last word cluster on Naver, regarding incompetent government and

policy criticism, reveals negative attitudes toward the Korean government, which users claim does not adequately support health-care professionals, allows foreigners to enter Korea, promotes the faster and wider spread of the coronavirus, and uses the COVID-19 pandemic situation for political purposes.

Table 2. Word Clusters, Example Words, and Comments About Public Health–Related Fake News on Daum and Naver.

| | Example Words | Examples of Comments |
|---|---|---|
| Daum | | |
| Cluster 1: Contempt for fake news | Rumor, fabrication, garbage, fake news, responsibility, fact, Chosun-JoongAng-DongA, information, shit, distortion, swear word, opinion, lie, article, trust, journalist | <ul style="list-style-type: none"> • Why can't a reporter who produces such dreadful articles be kicked out? Those who would sell the nation to make their own money. (personal communication, March 15, 2020) • How much longer do we have to put up with these worthless pieces of trash trying to sabotage the current administration? (personal communication, March 15, 2020) |
| Cluster 2: Praise for COVID-19 test kits made in Korea | Testing kit, technology, lobby, vaccine, antibody, health screening, perfection, important, the U.S., possibility, pharmaceutical company, gene, my country, export, Europe, China | <ul style="list-style-type: none"> • Officials from the U.S. Food and Drug Administration (FDA) are currently developing . . . There is a shortage of diagnostic kits among American hospitals and medical associations. Giregi [Reporter+trash in Korean], the above is true. Be unbiased when writing an article. (personal communication, March 15, 2020) • Foreign media are now criticizing the government by fabricating an argument that Korean goods are inferior because foreigners praise Korea. (personal communication, March 15, 2020) |
| Cluster 3: Symptoms and treatment of COVID-19 | Hospital, free, cure, flu, patient, symptom, fever, quarantine, fence, overseas Koreans, anxiety | <ul style="list-style-type: none"> • What the hell are you talking about? A worker in the same building (11 Lakes) vehemently pleaded that he was worried even though he was asymptomatic, so he gave me a free test because there were confirmed cases throughout the company. What an elaborate lie! (personal communication, April 13, 2020) • Juniors in college tested negative for fever and mild cold symptoms. Due to his immigration status, my nephew was tested within three days. However, he claimed to have a headache and requested another test, leading him to claim that he was tested twice weekly. It doesn't seem like reporters are covering it. (personal communication, April 13, 2020) |

| Naver | | |
|---|--|---|
| Cluster 1: Contempt for fake news | Falsehood, fake, Chosun-JoongAng-DongA, a press company, article, news, reply, fact, rumor, truth, swear word, press | <ul style="list-style-type: none"> • The Korean test currently in use finds the virus gene itself (takes at least 3 hours). I am aware that the 30-minute rapid diagnostic kit mentioned in the article as the antibody detection method has not yet been adopted in clinical practice in Korea. There are variations among tests. This is fake news that falsely portrays unused kits, like those not being used in the United States, as if they were criticized in the United States. (personal communication, March 15, 2020) • I still haven't deleted this garbage false article. The media reporting fake news should be fined 1 billion per case. (personal communication, April 14, 2020) |
| Cluster 2: Praise for COVID-19 test kits made in Korea | Testing kit, accuracy, diagnosis, approval, medicine, Trump, the U.S., Europe, lobby, pharmaceutical, trust | <ul style="list-style-type: none"> • The government should take pride in Korean-style diagnostic kits. A kit that can diagnose in 4 hours is the most effective kit to prevent the spread of infectious diseases. Infected people travel by high-speed rail, travel by plane, and spread pathogens in all directions. How do you stop the spread if it takes 2 days to inspect 1 person?? If you just pile up Korean-style diagnostic kits in a warehouse and control exports and give the situation, orders from around the world will rush out and shout for Korean-style diagnostic kits to be sent. You will soon face a situation where you will have a headache about which country to give it to first. (personal communication, March 15, 2020) • Hey, writer. Read the article and comment. You are so stupid. "It is not that our diagnostic kits are defective; rather, the US position is that it will only use kits that meet its own standards because confusion will arise when diagnostic kits from two countries with different standards are used together." (personal communication, March 15, 2020) |
| Cluster 3: Incompetent government and criticism of policy | Self-praise, show, politics, government, the nation, election, vote, political power, president, impeachment, foreigner, a | <ul style="list-style-type: none"> • Students from China: They're rushing in because they don't want to be barred from entering the country. Therefore, a nationwide entry ban from China should be implemented immediately |

ban on entry,
responsibility, suffering,
medical team

starting from this moment. (personal
communication, February 3, 2020)

- Do you notice China or the government that is still oblivious to the gravity of the situation? An inept government with public safety as a byproduct. (personal communication, February 3, 2020)

Figure 4 and Table 3 depict emerging word clusters about education on Daum and Naver. On Daum, we discovered five distinct word clusters: (1) contempt for fake news, (2) criticism of the Korean government for not prohibiting international students from entering the country, (3) burden on the health-care system, (4) criticism of education policy, and (5) safety and health concerns.

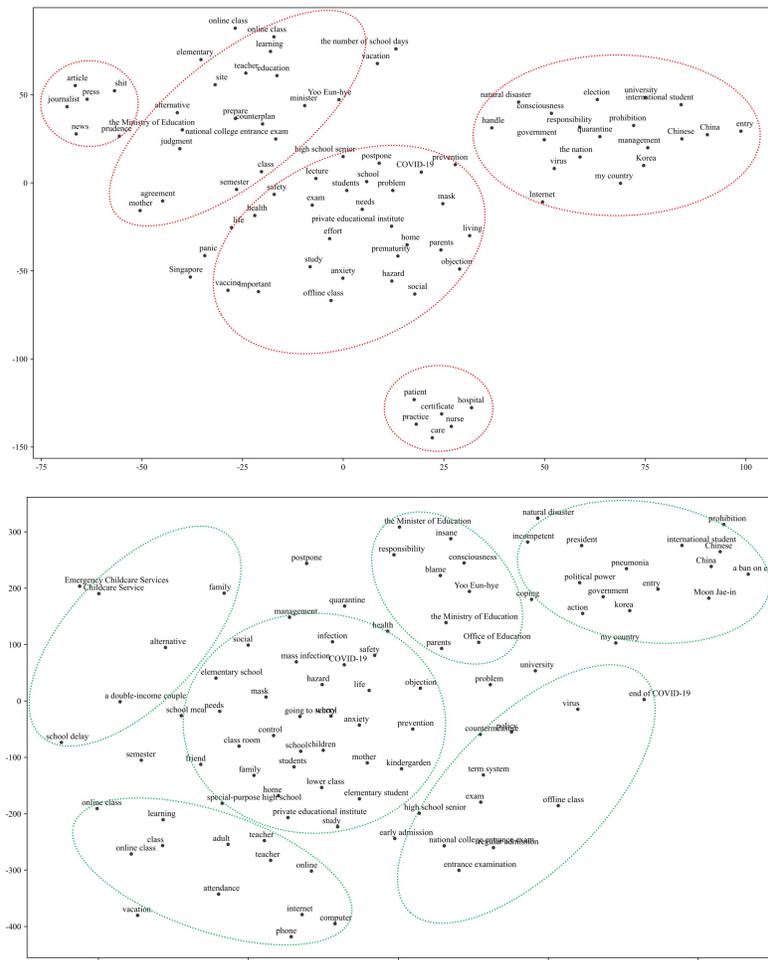


Figure 4. Word2Vec analysis: Education category comparison between Daum (top) and Naver (bottom).

There were six distinct word clusters on Naver. In addition to the first cluster, which criticizes the Korean government for not prohibiting international students from entering the country, the second word cluster on Naver depicts the difficulties of online education faced by families during the pandemic, with a focus on family structure (e.g., mother, a double-income couple) and the devices necessary for online classes (e.g., Internet, WiFi, phone, computer). The third cluster was about blame placed on the Ministry of Education. Cluster 4 contained words related to safety and health concerns, such as hazard, life, anxiety, prevention, and infection. The last two clusters were about online education and college entrance examinations during the pandemic.

Table 3. Cluster Names, Example Words, and Comments About Education-Related Fake News on Daum and Naver.

| Example Words | | Examples of Comments |
|--|---|---|
| Daum | | |
| Cluster 1: Contempt for fake news | Journalist, press, article, shit, news, prudence | <ul style="list-style-type: none"> You giregi [reporter+trash in Korean]. Naver Band [a mobile community application] made it easy to give online lectures. Lectures are easy, classes are easy, and do you write articles like this because you're just a giregi who manipulates distortion? (personal communication, March 26, 2020) I want to filter out untrustworthy news articles. I'm just going to take the Ministry of Education's word for it. What's the problem with the press? (personal communication, April 19, 2020) |
| Cluster 2: Criticism of the Korean government for not prohibiting the entrance of international students | Prohibition, international students, Chinese, China, entry, Korea, my country, the nation, quarantine, government, responsibility | <ul style="list-style-type: none"> Confirmed cases are coming in from all over the world. International students, in particular, who went abroad to study early must be reconsidering . . . It's far too risky. (personal communication, March 26, 2020) This government is truly problematic. I asked you to restrict Chinese entry into the country, but now that you're a Chinese student, do you want me to handle it at school? Is the immigration exam administered by the school? COVID-19 management is so lax . . . The Internet media appears to be blocking reports right now. (personal communication, February 12, 2020) |
| Cluster 3: Burden on the health-care system | Patient, hospital, nurse, certificate, practice, care | <ul style="list-style-type: none"> Isn't this labor exploitation disguised as practical training? It does not appear to be professional medical practice to me. Time is limited, and I believe this should be revised to reflect reality. (personal communication, February 18, 2020) |

| | | |
|---|--|---|
| | | <ul style="list-style-type: none"> • Trainees in blind spots . . . I think the system needs to be improved. I only learn professional theory first (because I have practical training at academies/schools) and take only theoretical tests. How about a system that gives certificates only to those who pass the theoretical test after 3 months of practice? If you did well in practice for three months after passing the theoretical test, it would be easier to get a job at the hospital. Wouldn't it be more efficient? I think the current system is definitely problematic. (personal communication, February 18, 2020) |
| <p>Cluster 4: Criticism of education policy</p> | <p>Online class, elementary, online learning, teacher, prepare, counterplan, alternative, Ministry of Education, national college entrance exam, semester, class</p> | <ul style="list-style-type: none"> • Without a plan, the Ministry of Education is really bad. (personal communication, April 13, 2020) • If you're going to do this, why did you spend money to make an online class? Is going to school more important than life? (personal communication, April 14, 2020) |
| <p>Cluster 5: Safety and health concerns</p> | <p>Safety, health, life, panic, vaccine, offline class, anxiety, hazard, needs, problem, COVID-19, prevention mask, objection, private educational institute, effort</p> | <ul style="list-style-type: none"> • I don't think you're weighing your life. Safety comes first. (personal communication, April 13, 2020) • Reporters, trash, and children's safety is important. School starts are important. Don't write trash articles about online lectures without preparation. (personal communication, March 27, 2020) |

Naver

| | | |
|---|--|---|
| <p>Cluster 1: Criticism of the Korean government for not prohibiting the entrance of international students</p> | <p>International student, prohibition, Chinese, China, a ban on entry, Korea, government, political power, president, Korea, action, my country, incompetent</p> | <ul style="list-style-type: none"> • The government is messing around with no countermeasures on what could be a ban on Chinese entry. While the ruling party's approval rating is falling, the Democratic Party will be wiped out in the general election if the coronavirus spreads in universities due to Chinese students. (personal communication, February 18, 2020) • You should've banned Chinese from entering the country earlier. You still haven't. Crazy regime. (personal communication, April 1, 2020) |
| <p>Cluster 2: Difficulties of online education faced by families during the pandemic</p> | <p>Emergency childcare services, childcare service, family, alternative, a double-income couple, school delay</p> | <ul style="list-style-type: none"> • I hope school starts, there are so many people in the park at the restaurant. Is it a problem that can be solved just by delaying the start of school? Online start of school? Double-income couples are going crazy. (personal communication, April 19, 2020) |

- | | | |
|--|--|--|
| Cluster 3: Blaming the Ministry of Education | The Ministry of Education, insane, responsibility, blame, Yoo Eun-hye, Office of education, parents | <ul style="list-style-type: none"> • However, I believe that going to school is still dangerous. Of course, it's beneficial for children who require care to attend school, and I'm also good at working less, but I can't help but worry about becoming infected. (personal communication, April 19, 2020) • Is the Ministry of Education out of its mind? It is not enough to ban Chinese students from entering the country right away, so why should our country's money be used to provide residence and meals? And if students start school, they can get infected in a bunch, but the number of days of classes is more important than that? Please come up with realistic measures. If we continue like this, what's the plan if we end up facing a situation like Wuhan? (personal communication, February 22, 2020) • School starts in 10 days . . . What the hell are you doing? There's no place to buy a mask. School is just around the corner. The number of confirmed cases is increasing . . . There's nothing the government does . . . All I can say is swear words. (personal communication, February 21, 2020) |
| Cluster 4: Safety and health concerns | Hazard, life, anxiety, prevention, infection, quarantine, health, going to school, mask, kindergarten, elementary school | <ul style="list-style-type: none"> • I don't even have an elementary school mask. There's no disposable children's mask. School starts in April? We have to deal with it online. (personal communication, March 25, 2020) • Don't you know that middle school and elementary school students have weaker immune systems? (personal communication, April 19, 2020) • The evaluation will be postponed until next year. Discuss how to enter the student record. For administrative convenience, we cannot abandon quarantine and put children at risk. Go to school when COVID-19 ends, and you can go to school without a mask. (personal communication, April 14, 2020) |
| Cluster 5: Online education | Online class, learning, teacher, online, I, attendance, phone, computer | <ul style="list-style-type: none"> • I'm concerned . . . There must be some very poor children who do not have access to a computer or laptop at home. Will Internet and device costs cover the costs of children who do not even have Internet access? It's going to break my heart. (personal communication, March 25, 2020) |

Cluster 6: A college entrance examination during the pandemic

Term system, policy, exam, high school senior, early admission, national college exam, regular admission, entrance examination, virus, end of COVID-19, university

- How do students who do not have access to computers or phones learn? (personal communication, March 25, 2020)
- Top students in general high schools are already studying for the college entrance exam on their own, even at home. Do you know that individual study skills are more important for the college entrance exam than school classes if you are a high school senior? (personal communication, March 25, 2020)
- Be cautious, Ministry of Education. It is the same as ending social distancing if you actually start school. When school begins, it will be accepted that closed spaces such as clubs and bars can reopen, and everyone will accept that there is no longer a need to distance themselves from home. That is why the start of the school year is so significant. The French college entrance exam has been cancelled. We do not need to cancel the college entrance exam, but we do require some coordination in accordance with world order. (personal communication, April 18, 2020)

In the economy category, there were five-word clusters on Daum and three on Naver (Figure 5 and Table 4). We discovered five clusters on Daum: (1) government policy regarding the extra budget, (2) contempt for fake news, (3) Criticism of the Korean government and claims of compensation for damages to Shincheonji church, (4) face masks, and (5) private sector financial policy.

Table 4. Cluster Name, Example Words, and Comments About Economy-Related Fake News on Daum and Naver.

| | Example Words | Examples of Comments |
|---|--|---|
| Daum | | |
| Cluster 1: Government policy about the extra budget (public sector) | Budget, blaming the government, Daegu, local government, payment, wage, allowance, public official, grant aid, price, supplementary budget, funding, tax | <ul style="list-style-type: none"> • Inconsistent policies. Moment by moment. (personal communication, June 10, 2020) • If there is something that has not been received, you can receive it with the money when the supplementary budget is processed at the 21st National Assembly. Stop exposing without alternatives, Chosun-Joongang-DongA Ilbo. (personal communication, June 10, 2020) |
| Cluster 2: Contempt for fake news | Journalist, reply, article, newspaper, report, newspaper company, fabrication, swear word, fake news, Chosun-JoongAng-DongA press company | <ul style="list-style-type: none"> • Chosun-Joongang-DongA is a source of information that blames others. (personal communication, June 10, 2020) • Giregi [news reporter+trash in Korean]. (personal communication, June 10, 2020) • Fake news spreaders should be punished. (personal communication, June 10, 2020) |
| Cluster 3: Criticism of the Korean government and claims of compensation for damages to Shincheonji | Moon's government, charge, damage, Shincheonji, COVID-19, nation, crisis, president, the nation, needs, worry | <ul style="list-style-type: none"> • Tell Shincheonji to pay for it. The news articles are getting worse. (personal communication, March 19, 2020) • Let's claim the right to indemnity from Shincheonji in the government!! In addition to compensation for the people's mental fatigue!! (personal communication, February 26, 2020) |
| Cluster 4: Face masks | Mask, filter, nano(fiber), production, export, safety, technology, China, Korea | <ul style="list-style-type: none"> • The Ministry of Food and Drug Safety will have to thoroughly inspect it. If you approach it roughly as a mask crisis, you may encounter more issues than COVID-19. The company claims there is no issue because it was used for sanitary pads, but sanitary pads and masks are not the same thing. Sanitary pads are at best skin irritations, whereas masks can be directly related to life, but they are not the same. I sincerely hope you believe there is a problem and continue with the test. Even if it appears, I will not use it. Safety is untrustworthy. (personal communication, March 18, 2020) • I heard that there are definitely harmful and dangerous nanofibers (in the face mask). I've heard that nanoscience as a whole is bad for the |

| | | |
|---|--|---|
| Cluster 5: Financial policy (private sector) | Periodic deposit, credit card, loan, bank, application, performance, credit | <p>environment. It is urgent, but we ask you to make sure that you are sure and safe. (personal communication, March 18, 2020)</p> <ul style="list-style-type: none"> • Declare a disaster area in Daegu, lend interest-free loans to small business owners, and provide support for living expenses. (personal communication, February 25, 2020) • Such desk administration. What is the Financial Supervisory Service doing? (personal communication, April 23, 2020) |
| Naver | | |
| Cluster 1: Government policy about the extra budget | Payment, wage, supplementary budget, government, government employee, disaster, grant aid, allowance, budget, medical team, mayor | <ul style="list-style-type: none"> • Among the huge supplementary budget, the COVID-19 supplementary budget is only 2%. (personal communication, June 18, 2020) • You can make an emergency payment for those who are working hard and take care of it later. Do they dig in the ground? Civil servants, you've never been pushed back, have you? If this happens later, who's going to do it? (personal communication, June 10, 2020) |
| Cluster 2: Contempt for fake news | The Chosun Ilbo, press, news, garbage | <ul style="list-style-type: none"> • It's a fake article even if it's dealt with . . . Dedicated fact check required . . . Trash. (personal communication, June 11, 2020) • Do you write an article after correctly checking the facts??!! If you make fake news in this style, you will now pay a fine. Pay a lot of fines hahaha. (personal communication, June 10, 2020) |
| Cluster 3: Criticism of the Moon government | Moon Jae-in, democratic party, show, political power, North Korea, election, citizen, company, show off, tax, president, corporation, support, problem | <ul style="list-style-type: none"> • A government that is only interested in pork-barrel policies that are politically beneficial without spending money where it should be. This is also one aspect of incompetence. (personal communication, June 10, 2020) • Before the election, he sprayed disaster support funds a lot, but he only showed off his administration, and this kind of place is not worth the money. (personal communication, June 10, 2020) |

Despite active reactions to fake news by users, of the 98 fake news pieces on Naver and Daum, only two were revised due to KDCA fact-checking. Both articles focused on the treatment of medical personnel by the Korean government during the pandemic. The first news piece (JoongAng Ilbo, 2020a) remained unchanged, but a note was added at the end of the revised article:

Regarding JoongAng Ilbo's April 1st editorial <Is it okay to neglect the medical staff of "Corona Heroes" so much?>, the government said, "The monthly remuneration paid to the medical staff at the temporary screening clinic includes risk allowance, and the elderly, etc. who are vulnerable to infection. It is a guide limited to many nursing hospitals, they may be liable for damages due to additional quarantine measures if an administrative order is violated and a group infection occurs or spreads." This report is in accordance with the mediation of the Press Arbitration Commission. (JoongAng Ilbo, 2020a, p. 30)

For the other article titled, "As Election Day Approaches, Patient Numbers Drastically Decrease as if by 'Magic'. . . Experts Urge 'Aggressive Testing'" (JoongAng Ilbo, 2020b), only a few sentences were changed—primarily in tone—and some were added (Table 5). In addition to these changes, several sentences about the announcement from the Central Disease Control Headquarters were added.

Table 5. Fake News Articles Before and After Fact-Checking.

| Changes | Before Fact-Checking | After Fact-Checking |
|----------------|---|---|
| <i>Revised</i> | <ul style="list-style-type: none"> • However, protective clothing did not arrive at any of the 11 screening clinics in Daegu. • As the Korea Centers for Disease Control and Prevention revised the test guidelines from the 6th edition to the 7th edition, the number of tests decreased somewhat, and on April 11, it dropped sharply to 14,070. | <ul style="list-style-type: none"> • However, protective clothing did not arrive at any of the 11 screening clinics in Daegu, which lacked protective clothing. • As the Korea Centers for Disease Control and Prevention revised the test guidelines from the 6th edition to the 7th edition, the number of tests decreased somewhat, and on April 11, it decreased to 14,070. |
| <i>Added</i> | <ul style="list-style-type: none"> • When I first went to Daegu, I felt a sense of shame as a doctor as I experienced the collapsing local economy, the suffering of citizens, and the deaths of patients. • The Central Disease Control Headquarters explained on the 13th about the suspicion of reduced testing by doctor B at a hospital in Incheon ("Corona 19 diagnostic tests are not allowed at medical sites, so the number of tests and confirmations is unlikely to increase until the general election"). The Quarantine Countermeasures Headquarters said, "The government respects the judgment of doctors on diagnostic tests and has actually acknowledged all requests for tests from medical institutions without any cases of reduction due to medical judgment. No. Our diagnostic testing system provides an opportunity for citizens to receive diagnostic tests if they pay their own expenses, even if doctors determine that they are not eligible for COVID-19 diagnostic tests. It is not possible to intervene in the doctor's judgment." • In response, the Central Disease Control Headquarters issued a press release on the 13th and refuted that "statistical exaggeration is not true." The Central Defense Countermeasures Headquarters explained that the 510,000 previously announced | |

was based on the number of inspectors, and that 860,000 cases were tested if duplicate tests were included.

- It's not that difficult, and I have enough inspection capabilities now. We still haven't done anything that could have been done by conducting a random sample survey of about 20,000 people nationwide for about a week.

Note. Due to the length of news articles (JoongAng Ilbo, 2020b), this table contains only revised sentences.

As shown in Table 6, Koreans are aware when news articles are not based on fact and tend to blame the government as well as the mass media for failing to thoroughly investigate facts before dissemination. Comments against fake news such as "Fiction of fiction. Shame on you [the news reporter]" (personal communication, April 22, 2020) exemplify Korean citizens' awareness and condemnation of newspaper reporters who publish fake news.

Table 6. Newspaper Articles Before and After Fact-Checking, and Relevant Comments.

| Title | Number of Comments After Revision of the Article | Example of Comments (After Revision) |
|---|--|--|
| Can We Neglect the "COVID-19 Hero" Medical Staff Like This? (KDCA checked on April 2, 2020) | Daum: $n = 1$ | Daum: <ul style="list-style-type: none"> • I want you to adequately compensate the medical staff. Regardless of whether or not JoongAng Ilbo writes a novel. (personal communication, April 6, 2020) |
| | Naver: $n = 27$ | Naver: <ul style="list-style-type: none"> • Is this a kind of editorial? Is it fact-checking and writing? You're not a journalist, but a novelist. (personal communication, April 14, 2020) • You guys who pretend to be misinformed and spread fake news should pay a fine and shut down your business, just like in Germany (personal communication, April 14, 2020) |
| [Editorial] As the Voting Day Approaches, the Number of Patients Plunged Like Magic, Raising Suspicions of "Reduction of COVID-19 Tests" by Active Doctors. "We | Daum: $n = 263$ | Daum: <ul style="list-style-type: none"> • Fiction of fiction. Shame on you [the news reporter] (personal communication, April 22, 2020) • Even though you are old enough to report the facts, you distort the facts. Isn't it embarrassing |

Need To Do an Aggressive Test.”

(KDCA checked on April 13, 2020)

Naver: $n = 188$

Naver:

to see your child? (personal communication, April 14, 2020)

- How come he is an editorial writer? Go write a third-rate essay somewhere. Stupid. Don't be a disgrace to the doctors and nurses who are fighting for their lives (personal communication, April 15, 2020)
- I hope we can punish fake news like this after the general election. (personal communication, April 15, 2020)

Discussion

In our study, we examined the Korean government's fact-checking efforts against COVID-19 fake news and the responses. Surprisingly, only a few fact-checked articles were revised. Comments on revised articles showed fake news led to false perceptions, criticism, and distrust of the government. We also found word clusters reflecting contempt for fake news across various categories, indicating public awareness.

Our findings shed light on the rapid dissemination of information and the overwhelming volume of messages today. Users are exposed to a substantial amount of information daily, making it challenging for them to critically evaluate every piece of it. Thus, previous studies suggest that state-of-the-art technologies using deep learning algorithms and crowdsourcing can be employed by social media platforms to effectively filter through fake news (Hartley & Vu, 2020; Sabeeh et al., 2020).

Moreover, the media can exploit "loopholes" where the public initially reacts fervently to fake news, but as time passes, the significance of addressing fake news diminishes in the wake of other news stories. Nonetheless, it is crucial for the public to actively combat such deception as they are the ones most likely to be adversely affected by misinformation. Therefore, raising public awareness about the importance of correcting fake news should be an integral part of media literacy initiatives.

To effectively combat the infodemic of fake news, it is crucial to propose specific practices for media literacy. These practices should include promoting critical thinking skills, enhancing fact-checking abilities, fostering digital literacy, encouraging information source verification, and cultivating a healthy skepticism toward information encountered online (Chambers, Notley, Dezuanni, & Park, 2022; Mason, Krutka, & Stoddard, 2018; Tully & Vraga, 2018). Individuals equipped with these essential media literacy skills can be empowered to discern and counter the spread of fake news in today's information-rich landscape.

The present study carries several implications. First, news reporters and media outlets, serving as social institutions that facilitate public access to information and the ability to evaluate its authenticity (Hwang & Kwon, 2017), bear the responsibility of meticulously verifying factual accuracy in their news

articles. Second, there is a need to strengthen the accountability of the Press Arbitration Commission. In the event of a dispute caused by media reports, the Media Arbitration Commission, established in Korea as a quasi-judicial institution, can conduct dispute mediation, arbitration, and infringement. The Media Arbitration Commission (2023) classifies false reports as “wrongly recorded reports,” “false reports,” and “exaggerated reports,” and assists parties affected by false reports in being rescued through mediation and arbitration. We absurdly found that only one case of adjustment was disclosed by the Media Arbitration Commission. However, it is difficult for people to recognize corrections because the alteration of news is not explicitly announced, and changes are made without notice.

In light of this, it is recommended that both the public and media arbitration committees adopt a critical stance and take necessary action when encountering news articles, while media companies should conduct thorough internal fact-checking of their news content. Along with their endeavors, the government should consider practical interventions such as regulations, guidelines, and protocols (Hartley & Vu, 2020). Several governments, for example, in Germany and Singapore, have explored the implementation of legislation to address the proliferation of fake news (Thomasson, 2018; Vaswani, 2019). The possibility of anti-fake news legislation by the Korean government is worth considering to prevent and prohibit the dissemination of false information.

This study has limitations that can be addressed in future research. First, we could not determine the individual characteristics of those who commented on revised newspaper articles after fact-checking. Second, although we included prominent websites known for spreading fake news during the pandemic, there may be other routes we did not consider. Despite these limitations, our study contributes theoretically and practically. It adds to public health communication by exploring reactions and perceptions before and after corrections of fake news, an understudied area. It provides critical data on public responses to fake news, emphasizing the importance of information and media literacy. It also highlights the need for policies to combat fake news and promote public health prevention and control. Future research can expand on our findings by examining the dissemination of government-checked fake news on social media platforms and exploring the impact of fact-checking by private organizations.

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