A Visual Exploration of Bias in Covid-19 Coverage

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ABSTRACT:

During the Covid-19 pandemic, news outlets used information visualizations to convey noteworthy data about different facets of the crisis in a short period of time. Despite claims of neutrality, an information visualization also conveys bias. Exploring bias in visualizations allows us to understand the bias that some news outlets hold. I chose to explore how news outlets conveyed political bias in a visualization. In this study, using the AllSides scale, I first identified ten news outlets of varying political bias. I then collected five Covid-19 visualizations from each news outlet. I analyzed each visualization's use of information visualization techniques and topics in order to explore the ways political bias manifests visually. It is unsurprising that I found that news outlets were concerned about Covid-19, discussing the spread and number of Covid-19 cases. News outlets were also similar in the types of colors and graphs they used. The news outlets explored the pandemic on both a national and international level. We see that the bias manifests into either accurately exploring the severity of the pandemic or downplaying the severity of the pandemic. No news outlet overstates the concern of Covid-19. By understanding how media bias manifests in information visualizations, we can further understand how to decrease these biases and truly understand what a visualization is trying to convey. Information literacy is one underused method that can help us understand bias in information visualizations. Specifically, visual literacy is essential to determining which visualizations to believe.

INTRODUCTION:

Information visualization research is a still-evolving field. Researchers have explored the bias in visualizations, as well as viewers' interpretations of information visualizations. Similarly, this research has emerged in the public sphere: the New York Times has a weekly "What's Going on with this Graph?" column in which experts analyze a graph. Unfortunately, while graphs and other visualizations are commonplace, many still do not understand how to interpret graphs, or visual literacy. In the past year, Covid-19 has presented a unique challenge: because the pandemic affected was global and affected all aspects of life, including business, travel and academia, media outlets often could not explore all the issues. Therefore, choosing what to discuss meant prioritizing some information above others. Understanding the information visualizations that accompanied these articles is an often-overlooked method of visual information literacy. Although information visualizations are traditionally viewed beside an article, they are excellent vehicles for information when viewed on their own, using different visual elements to explain the data presented. Information visualizations may show a different type of bias

through color or title. In this article, I explored Covid-19 information visualizations that accompanied news articles. I chose fifty information visualizations, comparing the themes, biases and methods used to convey their information. I found that overall, news outlets discussed the spread of Covid-19 and the number of news cases per day. Similarly, news outlets opted to use similar colors and graphs. While none of the news outlets contained blatant misinformation, some of the news outlets showed a preference for different facets of Covid-19 information. Further research is necessary to understand information visualizations and the political biases they may show.

LITERATURE REVIEW:

I chose to examine current visualization research, bias in visualizations and bias in news organizations since my research is an intersection of the three. While understanding visualizations and their use by news outlets is important, it is equally important to understand them within the realm of information science. I first explore research regarding bias in information visualization. Next, I explore visual information literacy and finally I discuss the use of information visualizations in news media.

One common form of bias can be found in visualizations. People typically believe evidence provided by visualizations. Elizabeth Kersten van-Dijk found that even when people hold their own beliefs about their stress levels, "participants were susceptible to value interpretations of their data suggested by the visualization" (Kersten van-Dijk, 2016). Visualizations can override common knowledge. Because of this, bias is also a concerning trend in visualization analysis. Wall et al explained that "While bias typically has a negative connotation, it is not always undesirable" (Wall, 2017). Although bias can be both positive and negative, it is still important to minimize so that viewers may receive neutral information. People's beliefs may be changed by a visualization. However, confirmation bias may also affect someone's response to a graph. Yanai and Lercher found that "the extremely isolated act of interpreting a plot can be strongly influenced by confirmation bias" (Yanai, 2021). Viewers' preconceived notions may result in them believing data that they agree with. Cognitive bias is another type of bias found in visualizations. Using Covid-19 visualizations as an example, Trajkova et al explained that "designers of data visualizations that are crafted to support a political point should carefully separate the data from their interpretation of the results (e.g., by adding a clear, objective description of the represented data before they add their personal claims), to minimize the change of accidentally introducing cognitive bias in their own designs or, vice versa, triggering cognitive bias in the readers"(Trajkova, 2021). This is coupled with another issue: that of analysis ability. People often overestimate their ability to understand a visualization, making them even more susceptible to believing biased visualizations. Formal evaluations have emerged as an important method of analyzing a visualization's effectiveness. Isenberg et al explained that "Reports of formal evaluations of information

visualization contexts can not only be extremely beneficial during the design phase but also offer valuable information on how to evaluate and measure the successes or failures of information visualization tools" (Isenberg, 2008). Borner et al found that when asking participants to evaluate an information visualization, "participants were interested in the visualizations...presented to them,but had significant limitations in identifying and understanding them" (Borner, 2015). Wesslen et al used analysis to explore the bias in interactive visualizations, arguing that "resource-rational analysis can provide a framework for many cognitive biases in data visualizations while providing a quantitative theoretical framework, or "research roadmap," that enables a feedback loop to add realism through further constraints" (Wesslen, 2020). While visualizations are important tools, we must also understand the elements used when building them.

A number of graphical elements may contribute to the bias of its designer. Szafir explained that "everyone has the same visual system, is subject to the same visual biases, and can be fooled by the same visual illusions" (Szafir, 2019). Color can be used to convey messages regarding data. Colors may correspond to emotion: "Calm, Playful, Positive and to a lesser extent Trustworthy are lightest" (Bartram, 2017). Silverman et al found that dark colors were correlated with higher quantities in visualizations (Silverman, 2016). Schloss et al found that in heat maps, "it is easiest for people to interpret colormaps that are designed such that the dark-is-more and opaque-is-more bias result in congruent inferred mappings" (2019). Colors can be effective in certain uses. For example, Lin et al found that "semantically-resonant colors can lower response times, but do not establish the cause(s) of this improvement" (Lin, 2013). By using colors that may correspond to the subject discussed, such as using red when representing apples, or green when representing trees, designers of visualizations communicate concepts more effectively. Bartam et al found that "any color set intended for use in expressing these affects must provide enough variation in both lightness and chroma" (Bartram, 2017). When evaluating users' performance with a tool, Colorlogical, Gramazio et al found that "Colorgorical palettes and industry standards revealed that our model-derived palettes are as effective as, and sometimes better than, current categorical color palette standards...the number of colors may alter the effectiveness of pair-based discriminability and preference scores" (Gramazio, 2016). This model allowed participants to aid the color selection process; however, it did not give total control to potential graph viewers. Participants appreciated using color to explore data, and were able to gain a deeper understanding of color selection. Visualizations often have a title meant to introduce their message. Similarly, these titles may show bias. However, unlike color, subtlety in titles can sway viewers to the designer's side: "In the case of data visualization titles, a slanted title only mentioning a data variable may be the most dangerous as it appears to be most neutral but cues the viewers to connect the dots and infer the trends." (Kong, 2018). Therefore, the titles may provide viewers with an incorrect perception of the information. Many visualizations

contain bias, often expressed through their elements. However, understanding the ways in which viewers interpret this visual bias is still an emerging field of study.

Because information visualizations require a different type of literacy, we must discuss research on visual information literacy, also known as visual literacy. Borner et al found that "individuals are willing to spend time attempting to make meaning in representations depending on their personal interest in the topic." (Borner, 2016). Therefore, when people are interested in a topic, this may motivate them to focus on visualizations discussing the topic. Mansoor and Harrison explain that understanding visualization bias and visualization literacy go together: "Merging the data visualization literacy and visualization bias threads may also bring implications for visualization design, such as highlighting pitfalls for using more complex visualization types to mitigate biases" (Mansoor, 2018). Many believe that education is necessary for visual information literacy. Womack argued that there should be a set of guidelines for exploring visualizations similar to the ACRL framework. Specifically, people must learn about visualizations at a young age: "Students should be introduced to a basic range of visualization types (bar, line, scatterplots, box and whiskers plots, etc.) and learn appropriate uses for each" (Womack, 2015). A lack of elementary visual literacy education can result in misinterpretation of visualizations. Boy et al explored visual literacy through Amazon MTurk, finding that the participants, "while somewhat below average in visualization literacy for line graphs, have fairly standard abilities" (Boy, 2014). Similarly, they explained that their assessment may have been affected by the graphs proper: "these low levels of difficulty reflect the general simplicity of, and massive exposure to, line graphs" (Boy, 2014). Researchers also think that information literacy must be introduced for people to better understand visual literacy. Borner proposed a specific framework that focuses on both information literacy and the theory behind a visualization that "promotes both the reading and construction of data visualizations, a pairing analogous to that of both reading and writing in textual literacy and understanding and applying in mathematical literacy" (Borner, 2016). People are more effective when viewing a visualization if they have experience viewing and analyzing that type of visualization. Lee et al designed a tool called "VLAT," or Visual Literacy Assessment Test, to help assess people's visualization analysis abilities. They explained that "relationship between users' visualization literacy and aptitude for learning an unfamiliar visualization...had a fairly high positive relationship" (Lee, 2017). Basic visual literacy skills can result in the ability to understand newer visualizations. Once again, however, visual information literacy is still an emerging field and is underexplored.

Researchers have previously explored visual literacy as both a facet of information literacy and its own discipline. Kedra (2018) collected 11 definitions of visual literacy from its conception in 1969 to 2013, and found that among other types of visual literacy, "visually literate individuals know how to cite visuals, with respect to ethical and copyright issues and can spot a need for visual material, for example,

in a presentation, followed by search strategies for relevant images" (Kedra, 2018, p.13). This literacy can result in less people being fooled by a duplicitous image. When teaching, Lundy and Stephens (2015) explained that the "visually literate student situates the image in cultural, asocial and historical contexts; describes the intended audience for an image; validates interpretation and analysis of images through discourse with others; critiques persuasive or manipulative strategies that may have been used in image production to influence interpretation; evaluates the use of visual signs, symbols; and conventions to convey meaning" (Lundy and Stephens, 2015, p.1058). Visual literacy means understanding the importance of both the visual proper and the potential implicit messages of the visualization. Unfortunately, Arneson and Offerdale (2018) noted that visual literacy is still underexplored, stating that "providing students with more practice using visual representations and improving alignment between practice and assessment would lead to increased performance" (Arneson and Offerdale, 2018, p.6). Conversely, visual literacy is also undertaught at many levels. Nygren et al (2020) also argued that "it could be constructive for teachers to show and discuss the design of news pages, since many students have difficulty understanding labeling and layout" (Nygren, 2020, p.78). Matusiak and Heinbach(2018) conducted a literature review of studies that used information literacy. They found that "the high number of studies that relied on informal observations as opposed to a systematic data collection found in this study is unusual" (Matsukiat and Heinbach, 2018, p.6) Specifically, visual literacy has emerged as a solution to believing misinformation "By incorporating…visual literacy into information literacy lessons…the new generation of librarians can position themselves at the front lines of the battle against misinformation." (Thompson, 2018, p.385). Helping students analyze information bias in the news requires an understanding of both information literacy and visual literacy.

Media bias affects information presentation. Similarly, when someone only reads from conservative news outlets or only liberal news outlets, they may not obtain all the information. Domke et al. (2006) found a "dynamic relationship between political elites and journalists during a presidential campaign" in the 1988, 1992 and 1996 Presidential elections. As the number of news sources exploded, this relationship continued. Dellavigna and Kaplan (2007) defined a term known as the Fox News effect, arguing that in the 2000 election, "Fox News convinced 3 to 28 percent of its viewers to vote Republican, depending on the audience measure" (Dellavigne, 2007). Specifically, many researchers have explored bias in journalism and its manifestation in articles and companies. Lavery (2013) explored gender-based difference in news coverage, determining that it had the same frequency. Lee explained that "the general public and a significant number of politicians are convinced the U.S. news media have a liberal and pro-Democratic bias" Eisinger et al (2007) found that in the cases of politicians, "newspapers often label liberals, at times more than they do conservatives." Unfortunately, fake news often results in a distrust of

news outlets. Many information users who distrust news outlets are conservatives. Van der Linden et al (2020) found that "conservatives are especially likely to associate the mainstream media with the term fake news and these perceptions are generally linked to lower trust in media" (Van der Linden, 2020). This distrust could result in a potential information user only seeking out news outlets that confirm previously held beliefs. Similarly, Lachlan et al (2021) found that people who had polarized, low search interest were more likely to explore only sources that confirmed their information. However, they also found that both conservative and liberal high information seekers are open to information that is contradictory for their beliefs. Focusing on credibility of a source rather than its party preference must be done when reading information. Some research has explored images that a news outlet presents. For example, Barrett and Barrington found that images of political candidates can influence a voter's opinion of the candidate. Specifically, they concluded that "candidates endorsed by a particular newspaper—or whose political leanings match the political atmosphere of a given paper—generally have more favorable photographs of them published than their opponents" (Barrett, 2005). Conversely, Shor et al(2014) found that both conservative and liberal news outlets favor photographs of male politicians over photographs of female politicians. However, news outlets' graphs are typically not analyzed.

Visualization studies are often academia-based and focus on images designed specifically for analysis. Visual information literacy is a field that is still underexplored in the context of news outlets. Since news outlets present visual additions meant to enhance their stories, we must also examine these images. Although there is research regarding partisan bias in news outlets, the Covid-19 pandemic was an extraordinary event, and therefore, it was difficult to predict how news outlets react based on their party alliance. Based on the present literature, I formulated the following research questions: How does partisan skew affect the visualizations explaining an event? What do news outlets prioritize? How do news outlets use color and type of graph to convey their message in a visual manner?

METHODOLOGY:

I chose to use Covid-19 as a search topic as the Covid-19 pandemic prompted a wide variety of news coverage. Some news outlets stated that the government was overreacting in its response, while others explained that the pandemic's severity was downplayed. Unlike other crises, which often affect only one country or continent, the Covid-19 pandemic was worldwide. Similarly, the Covid-19 pandemic affected all facets of life: government stay-at-home orders resulted in people working from home and attending class from their couch. Similarly, restaurants and stores implemented either delivery services or integrated delivery apps to allow for their survival during the pandemic. Therefore, any news outlet would no doubt be overwhelmed by the number of stories about Covid-19 for any day. Furthermore, since 2020 was an election year, newspapers were reporting on stories other than Covid-19.

I then determined which bias chart to use to help me begin my selection process. Using the AllSides Media Bias Chart, I selected ten news outlets to search: two from each column. The AllSides Media Bias Chart is a chart that focuses on political bias. Founded by and run by people on both sides of the political spectrum, the AllSides organization provides resources and unbiased news, collecting information regarding bias from a variety of sources (Allsides, 2021). While there are other charts, such as the Adfontes Media Chart, I chose to explore how political bias can affect the information we present and the skew that information may have. Therefore, the AllSides Media Bias Chart allowed me to use the biases without worrying about other aspects of the news outlets such as factualness.

After selecting the news outlets to explore I ranked them from most liberal to most conservative, using a five-point scale. 1 was meant to represent most conservative and least liberal while 5 was meant to represent least conservative and most liberal. The number one represented most liberal, the number three represented neutral and the number five represented most conservative. Rather than evaluating photographs, I chose to evaluate graphs and quantitative visualizations. I then searched Google Images with the keywords "<News Outlet Name> Covid 19 graph." I chose five graphs from the news outlets, totaling 50 graphs. This process was not without its challenges: I had to reselect three news outlets: two conservative and one liberal, as they had an insufficient number of graphs. I then categorized each graph based on the bias of the news outlet, the type of graph, topic, and message conveyed by the graphic. I used qualitative coding to address the topics and themes of the graphs. I also explored the number of graphs used and colors used. This was an iterative process-initial coding was conducted, and as trends emerged, they were also noted.

RESULTS:

I evaluated the graphs on the following: colors used, types of graphs used, and the effect that the bias of the news outlet had on color, type, and topic.

Tables 1 and 2 display the most common colors used in the graphs and the most common charts used in the graphs. The most common colors used were blue, red, orange, green, white and grey. The most common chart used was a line graph: 32 of the graphs were line graphs. There were no specific common color combinations used in graphs.

All the news outlets used a line graph, and the colors blue and red in their visualizations. The most conservative news outlet used exclusively line graphs. The least conservative news outlet was the only one that used an infographic. The second most popular graph was a bar chart that used a line to show a curve: 6 of the graphs were bar charts that used a line to show a curve. The second most conservative, third most conservative and least conservative outlets all used bar charts accompanied by lines.

Table 3 focuses on the bias of the news outlet, the colors used, the type of graph used, the topics explored, and the scope of the locations (district, county, state, country and world). The most conservative

news outlet was the only one that explored mask wearing as a negative experience, while the most liberal news outlet was the only one to compare and contrast Covid-19 cases and complications to the flu. All news outlets discussed the number of Covid-19 cases. Three discussed Covid-19 deaths, while two discussed Covid-19 hospitalizations. The second most conservative news outlet had a graph that explained that many overestimated the risks associated with Covid-19. Geographic scope was also an important aspect of the graphs. All of the news outlets explored Covid-19 on a national and international level in at least one graph. Meanwhile, four of the five news outlets explored Covid-19 on a state level, one explored Covid-19 on a county level and one explored Covid-19 on a district level.

DISCUSSION and ANALYSIS:

RANGE OF TOPICS AND FOCUSES:

The major way in which these news outlets displayed bias was through their focuses. Although all the outlets discussed Covid-19 cases, several used negative slants or biases to explain cases. Similarly, some news outlets were alone in their exploration of different topics: the fourth most conservative news outlet provided an infographic discussing the predominant technology used for office meetings due to Covid-19 shutdowns. Interestingly enough, none of the graphs used political skew to discuss the current leaders: at the time, the United States House of Representatives had a Democrat majority, and the Senate and White House were Republican-led. Therefore, it may have been difficult to identify or blame any singular party for not acting on Covid-19 precautions. Conversely, due to the ever-changing nature of both the information and precautions against Covid-19, it would be difficult to determine whether or not the CDC or other governing members were intentionally creating misinformation, or if they were simply learning more about the virus. For example, although initially the CDC stated that masks would not help stop the spread of Covid-19, within a few months, the CDC had learned that masks would help prevent the spread of Covid-19 and recommended that people should wear masks. Furthermore, because the Covid-19 pandemic took place in an election year, one would expect speculation regarding the candidates' positions on masks, vaccines, or other Covid-19 issues. However, none of the graphs discussed the political candidates' stance on Covid-19. Although one graph presented the idea of protests regarding Covid-19 protection, this was not a partisan graph: only cities and states were mentioned. All of the news outlets explored Covid-19 on a national level as well as on an international level; however, three of them explored Covid-19 on a state level. Only one graph explored the potential correlation between counties' voting preferences in the 2016 election and the number of their Covid-19 cases. This could show that examining Covid-19 on a county level is still underexplored; however, it may have been a result of the news outlets' national focus.

I further explored the topics of the graphs. All of the graphs focused on similar topics including Covid-19 cases. I found that certain topics were seen in a negative light in the most conservative news

outlets and in a positive light in the most liberal news outlets. Mask wearing was one such topic: while the second most conservative news outlet posted a graph explaining that masks did not prevent the spread of Covid-19, the most liberal news outlet posted a graph explaining that masks and other social distancing measures would stop the spread of Covid-19. Other issues explored were the flattening of the curve, a term that was used to describe stopping the spread of coronavirus via an epidemiological curve, and whether or not masks and shutdowns affected this. The second most conservative news outlet explained that the spread of coronavirus was slowed, though the accompanying article did not explore how this occurred. The graph did not state that Covid-19 was no longer a threat. The second and fourth most conservative news outlets were the only two outlets to discuss Covid-19 related economic concerns. Overall, all news outlets seemed relatively concerned about the number of Covid-19 cases, although their opinions on masks and social distancing differed. Some of the news outlets were more interested in the Covid-19 cases in other countries than they were the Covid-19 cases in the United States. This information regarding the topics is valuable, as it shows that the news outlets viewed Covid-19 as a threat rather than arguing about the severity of Covid-19.

Exploring the data sources used to design these graphs in the future could provide further insight. Specifically, there was minimal variance in the types of graphs used and the colors utilized. The colors used were very similar throughout the news outlets: although some news outlets used orange or green, red, black and blue were the majority colors used. Similarly, since the line graph was the most used graph, this showed a definite similarity between all the graphs, regardless of the bias of the news outlet. There are obvious reasons for these graphs: line graphs are known for their data-to-ink ratio, and these graphs are easy to produce. The most conservative news outlet used only line graphs. Conversely, the most liberal news outlet used a variety of graphs: Bar Chart with Line, Line Graph, Heat Map, Infographic. This shows a willingness to try new graphical techniques. The most conservative news outlet used only the colors black, red, green and blue and the most liberal news outlet used a wider variety of colors: green, white, orange, blue, red, gold, yellow, light blue, dark blue, yellow, pink, light red. Once again, this shows that the more liberal news outlets are willing to try using different colors as well as compare many different countries or instances. However, a larger number of colors does not always mean a better graph: too many colors can result in a confusing graph. Similarly, using too many bright colors such as hot pink or yellow would make a graph simply illegible. A future study could analyze line graphs and the number of lines in said graph, as well as the colors utilized.

AN OVERALL LACK OF MISINFORMATION:

Overall, I found that depending on the dataset used, none of the visualizations examined used misinformation. Specifically, none of the visualizations contradicted the dataset used, or focused on

incorrect information. This is a valuable discovery: although some of the visualizations used bias, none of them provided blatantly incorrect information. While there were some flaws with the graphs, such as a truncated y axis or potentially misleading title, none of these graphs convey truly incorrect information.

There were a number of ways to explain that the difference in graphs, especially graphs that discussed the same topic. For example, when discussing COVID-19 deaths, while there were two graphs from two different news outlets, they used different datasets. As a result, the graphs were different. The different datasets used to build the visualizations resulted in different results. Similarly, the use of different topics shows the bias of the news outlets: preferring to explore Italy's COVID-19 transmission rate rather than the United States COVID-19 transmission rate shows a difference in priorities or a willingness to ignore a relevant situation.

However, this does not mean that their accompanying articles did not provide misinformation or that the news outlets that provided these visualizations are not sources for misinformation. Instead, it means that the visualizations were not misinformative. There are other means of bias demonstrated in the set.

INFORMATION LITERACY AS A FIRST STEP:

Understanding images and news articles has a much different depth due to the internet. Rather than simply going to a website and reading an article, images and articles can be shared via social media. This rise of social media can be viewed as a problem. However, when re-evaluating our problems, we must also consider solutions. One cause, echo chambers, has risen over time. Echo chambers occur when everyone in a group believes the same thing, and only information that supports a specific view is shared and discussed. Dissenting opinions or information are not tolerated. In other words, the people who believe this information share it with one another. Since the information is unchallenged, if it is incorrect, then everyone in the group will believe untrue information.

One potential cure for echo chambers is information literacy. Information literacy is defined as "the ability to identify, find, evaluate, and use information effectively" (Information Literacy, 2017). Specifically, information literacy is an important tool when analyzing information's accuracy and truth. Determining whether an image presents true information or skews the story can stop us from spreading a potentially misleading image. Critical thinking is key for information literacy. By understanding a wide range of perspectives, information literacy allows us to determine what to focus on and what to believe. Witeck explains that in the age of social media, "information literacy in the age of social media requires a "meta-literacy": a critical awareness of why we do what we do with information" (Witek, 2012). Vraga found that "news literate…are more skeptical of information quality on social media" (Vraga, 2019).

Unfortunately, false news is often one step ahead of the trends: many don't check what they read on Twitter or Facebook is real. Kiernan found that although students are relatively information literate when compared to older peers, "students are less likely to check what they are reading on their social media networks is real" (Kiernan, 2017). This is concerning-social media texts should be examined, just as news should. The idea that social media is a less informative site is an incorrect assumption. In fact, many consider social media as a form of news: Gallup found that "Social media platforms have become saturated with coronavirus-related news, with 46% of social media users saying "almost all" or "most" of what they see is about the coronavirus situation" (Ritter, 2021). Lachlan et al(2021) alluded to this, explaining that many information users only seek out sources that they know will present information they agree with. This news is biased in a number of directions: if one is in an echo chamber, then they will only see information that they already agree with. Therefore, information literacy is essential when consuming news and expanding one's horizons. Information literacy requires that those who consume information seek it from other reliable sources. Information literacy also means utilizing skepticism of different information sources and finding resources that either confirm or disagree with the original source. Not only does it require that people seek out other sources when consuming information, but it can help people determine which sources are more trustworthy and which are untrustworthy. This in turn can result in people learning how to notice when a news source may be disseminating incorrect information so that they may in turn avoid the news source. Conversely, if a news outlet focuses on certain topics rather than others, this may show a willingness to ignore issues. For example, if a news outlet chooses to explore the importance of ignoring Covid-19 and focusing on gun rights rather than Covid-19 cases, this may show a willingness to ignore a very prevalent problem in favor of another issue.

Unfortunately, although information literacy is explored at the collegiate level, visual literacy is still developing as a discipline. While some students learn how to analyze graphs in elementary school, they do not learn how to understand the biases and intricacies in color theory and titles. This can lead to someone simply examining a graph with a flawed sense of understanding. Visual literacy and information literacy are necessary for any information user. Therefore, these literacies must be taught on both the elementary and collegiate level.

Readers must use visual literacy when analyzing news visualizations. Specifically, they must identify where the data for these visualizations originated. They must also question why the news outlets would share these visualizations. The reader can also examine why the news outlet would choose to focus on this subject rather than another idea. For example, if the news article is comparing COVID-19 rates in Alaska and California, the reader may ask why these two states were selected for comparison. Finally, the viewer must understand the bias that any news outlet has, be it left or right.

However, one concern regarding information literacy is that of doxastic voluntarism. Doxastic voluntarism is defined as "the philosophical doctrine according to which people have voluntary control over their beliefs" (Vitz, 2008). Schuessler explains the personal effects of doxastic voluntarism, explaining that "The will can indirectly maneuver us towards beliefs or opinions by directing our attention to this or that piece of information, thus causing a selective in-take of information" (Schuessler, 2019). Instead of reading from a variety of sources, people may simply ignore any news outlets if they are biased in a certain direction. People will reject media that disagree with their opinions, which can lead them to believe misinformation. By ignoring certain news outlets simply because they are liberal-skewed or conservative-skewed, people are ignoring potential sources of information. Similarly, by discounting these news outlets' content due to their skew can result in people deciding against reading the information and analyzing its integrity. Peoples' prejudices against a news outlet may result in them ignoring very relevant news. Although all the news outlets discussed Covid-19 cases, they each had a unique take on the number of cases. All had a unique subject that none of the other news outlets discussed. Therefore, due to the mere number of news outlets, there is a possibility for a reader to choose only conservative or only liberal news outlets. This strongly supports Yanai and Lercher(2021)'s findings regarding confirmation bias within visualizations. As this research has shown, this can result in an information user missing valuable information. Since the Covid-19 pandemic affected everything, from working style to health, it was impossible for all news outlets to discuss everything. However, reading a variety of sources or examining a variety of visualizations is insufficient if the reader simply chooses to ignore evidence.

A MULTIFACETED APPROACH:

Misinformation is a multifaceted issue, and most solutions are insufficient. Although removing blatantly correct information is beneficial, people must possess the ability to discern what information is true and which is false. Removing bias is an impossible solution. Therefore, we must learn how to analyze information from all sources, including news outlets. Information literacy is an important tool in combatting misinformation. Specifically, determining where to obtain information is one step. However, people should also know which news outlets will cover which issues. Once they understand which news outlets focus on which topics, they can then inform themselves accordingly. They can also examine how different news outlets present this information. Simply choosing to read only the news outlets whose bias aligns with someone's political party is insufficient; oftentimes to examine every issue, someone must consume information from a wide variety of sources. We must also discuss the bias that the information presented displays. While the information visualizations can show us the bias in reporting different aspects of the Covid-19 pandemic, there are a number of aspects that are still underexplored visually. For example, there were no graphs analyzed regarding mental health during the Covid-19 pandemic.

Therefore, it can be assumed that news outlets were unconcerned by this aspect. This shows a bias against some of the less lucrative elements of the Covid-19 pandemic in favor of economic news and the number of cases. Although these are both parts of the Covid-19 pandemic that must be explored, there is a definite lack of exploration on several important elements of the Covid-19 pandemic. Information literacy is one such element. Therefore, it can present a potential partial solution for a discerning reader.

CONCLUSION:

This study has limitations: only fifty visualizations were explored, and the scale to rank the papers from most to least biased may have resulted in a disregard of a source's honesty. However, this scale allowed us to separate the newspapers and present a clear understanding of the various levels of bias. Similarly, news outlets, although excellent at producing visualizations, are inherently a textual medium. Therefore, the number of visualizations is reflective of the number of Covid visualizations online. Focusing on only online print instead of physical copies of a newspaper or television coverage may have limited the research as well. Future work must explore both importance of visual literacy education and the effect of visual literacy on information users' evaluation of news visualizations. Similarly, qualitative studies using both a larger sample size and participant evaluation of visualizations are necessary. I explored the biases in Covid graphs presented by newspapers. I discussed the colors and types of visualizations used to convey information. I found that the majority of news outlets used a similar color scheme as well as a similar graphical format. However, their focuses were different. Although Covid-19 cases were presented in a negative light, some news outlets chose to focus on masks as unnecessary while others explained that masks were insufficient. This exploration is interesting in its mendacity, as news outlets did not focus on blaming anyone or arguing that Covid-19 was a nonissue. Rather, all news outlets differed in both their approach to curtailing the Covid-19 spread, as well as the various side effects. This is optimistic-in times of crisis, we see that news outlets truly focus on providing people with true, unbiased information. However, the information provided is often incomplete and does not detail any potential biases within the selection process. This article shows a definite need for information literacy, as well as exposure to a number of different news outlets. When examining visualizations, information consumers must employ visual literacy to determine which visualizations to believe. Because there was such a wide range of topics, this exposure could allow readers to understand the many facets to a disaster such as the Covid-19 pandemic. Similarly, reading different examples of bias in news media can allow readers to discern which information they choose to believe. However, a wide range of information sources can allow us to understand numerous facets of a situation. Analyzing Covid-19 graphs shows a definite need for more information visualization studies while simultaneously serving

as a case study for future research. However, it is only the first step to understanding the implicit messages conveyed by information visualizations in news media.

TABLES:

TABLE 1: COLORS USED

blue	23
red	22
orange	13
green	12
white	8
grey	8
light blue	6
black	6
yellow	5
dark blue	4
pink	3
light red	3
gold	3
purple	2
light yellow	1
orchid	1
teal	1
burgundy	1
light orange	1
brown	1
light brown	1

TABLE 2:

Type of Graph	Count
Line Graph	32
Bar Chart with Line	6

Heat Map	5
State Map	3
Table	2
Pie Chart	1
Infographic	1

TABLE 3: Table Containing Rank, Subject, Colors Used, Type of Graph and Scope

Bias Rank of News Outlet	Subject of Graph	Colors Used	Type of Graph	Scope of Location
1	Covid Deaths per Capita, Mask Requirements and Rising Cases, Masks Required vs. Masks not required	red, black, green, blue	Line Graph	State, country, world
2	Covid Cases, Flattening the Curve, Protests for Reopening, New Cases Per Day, Social Distancing, Covid Hospitalizations, Low Probability of Dying, Fears vs. Reality, Trade Partners	blue, gold, light blue, dark blue, orange, red, grey, white, green, black	Bar Chart with Line, Line Graph, State Map, Table	County, state, country, world

3	Covid Cases, Covid Hospitalizations, Pro-Restrictions, Flattening of Curve, New Cases Per Day, Covid Testing	red, blue, yellow, orange, teal, burgundy	Bar Chart with Line, Line Graph, Heat Map, State Map, Pie Chart	Country, world
4	Covid Cases, Covid Deaths, Economic Concern, Technology Used	blue, grey, red, yellow, pink, orange, green, white, brown, orchid, light red, light blue, light yellow, light brown, dark blue	Line Graph, Heat Map	District, state, country, world
5	US Covid Cases, Covid Deaths, Covid Cases, Confirmed Covid Cases, Deaths and Complications of Covid vs. Flu	green, white, orange, blue, red, gold, yellow, light blue, dark blue, yellow, pink, light red	Bar Chart with Line, Line Graph, Heat Map, Infographic	State, country, world

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