

# Is Science Effectively Conveyed to the Public? A Case Study of Genetically Modified Mosquito Release

Kailash Vemuri<sup>1</sup>, N. Murti Vemuri<sup>#</sup> and Sita Munukutla<sup>#</sup>

<sup>1</sup>Hunterdon Central Regional High School, Flemington, NJ, USA

<sup>#</sup>Advisor

## ABSTRACT

Science is the driving force behind the advancement of society making public engagement with science vital. With the rapid pace of scientific discoveries, the availability of well-balanced scientific information is possibly the most important it has ever been. This study aims to determine the effectiveness with which scientific information is disseminated to the public. This was done by conducting a survey in which people were given three articles to read about the release of genetically modified mosquitoes. These three articles were adapted from local news coverage, government authorities, and peer-reviewed scientific literature. Survey participants were queried on their relative preferences for these articles. Additionally, the top 100 hits on Google for the search item “Florida mosquito release” were analyzed to assess the availability of the scientific information preferred by survey respondents. The results of this study showed that the public seeks quality, balanced scientific literature but that these types of articles aren’t easily accessible. Articles that prioritize getting clicks are more prevalent than those that present balanced scientific research.

## **Introduction**

Science has far reaching impact on human life and society, from making basic needs such as water and food accessible to improving human health. Science has also expanded our ability to grow economically through new and advancing technologies. Globally, scientific discovery and output has been accelerating at a rate that doubles every nine years (Van Noorden, 2014). It is not surprising then that it is a challenge to be able to keep pace with all the scientific knowledge and information that is being produced or generated around the world.

Public engagement with science is vital if we are to continue to thrive as a society and encourage further scientific progress. This is especially important when decisions related to science affect us as individuals and/or as communities (Pierce, 2013; Zerzan, 2019). Current examples include science related to climate change (Kitcher, 2010), genetic modification (Healthline, 2018), vaccines (Carrillo-Marquez, 2013), autonomous vehicles (Canis, 2021) and other technologies that impact us in our everyday lives. To make wise decisions at an individual level or as a society (through public policy) we need to first close the gap between scientific knowledge and the public. Communication of science is more important now than it has ever been.

There are many challenges in being able to communicate science to the lay public effectively. A first one that comes to mind is the complexity and difficulty in understanding the science. Albert Einstein had once famously said “If you can’t explain it to a six-year-old, you don’t understand it yourself.” If we look at it in another way, it will benefit us all if we are able to hold scientists accountable to explain their science in a simple and less jargon-ridden way. In fact, in the world of medicine, a lot of the medical journals are evolving in this direction and making attempts to reach a lay audience. The British Journal of Medicine, for example, asks patients to review papers that are submitted by medical scientists (The BMJ, 2021).

Beyond simplification of complex scientific information for the benefit of the lay public, there are other even more challenging issues around effective scientific communication to the public. Most notably, the communication of the risks as well as uncertainties around scientific research (Freeman et al., 2019; Freeman et al., 2020). The long-

term costs of not effectively communicating benefits vs risks of a new scientific discovery or advancement can be significant and can include loss of public trust in science and in scientists (Freeman et al., 2020). Recent controversies such as climate change and vaccine hesitancy in the midst of the current COVID-19 pandemic underscore the importance of appropriate communication of science to the public.

Yet another challenge in communication of science to the public is the availability of good sources of scientific information and accessibility of well-written, well-balanced articles in the channels or media that public is most likely to read or hear. A recently published survey by the Pew Research Center found that most Americans get their information on science from news media. Interestingly, the survey also revealed that most agree that science magazines or other specialty science sources such as documentaries or science museums would be more likely to get the facts right (Gottfried & Funk, 2017).

In our research/study we attempted to further understand people's preferences and availability of good science news/articles. Our science topic of interest was genetically modified mosquitoes and their use to control the spread of wild type mosquitoes that carry dangerous diseases such as dengue, Zika virus, and yellow fever. We chose this topic as it involves one that would be of high public interest that has elements of being controversial as well as having high impact on the community. We then set about to understand, via a survey, people's preferences for what level and type of information they would want to read on the topic. Additionally, we explored the accessibility of well-balanced scientific information related to our chosen topic on Google, a widely recognized and popular internet search engine. Our hypothesis was that people would want to be well-informed about science but that it would be hard to come across well balanced articles on the scientific topic when searching for it.

## Methods

### Survey

The survey questions (Appendix A) were designed to understand survey participants' preferences with respect to readability and level of information they like to have when reading about science. We collected information related to these aspects in two separate parts of the survey. The first part surveyed for preferences in general terms (with no particular science topic in mind) while the second part was related specifically to the information provided on the topic of interest (genetically modified mosquito release).

In the general questionnaire section of the survey (Survey-Part 1) we asked participants to rate on a scale of 1-5 (5 being highly important), how important the following aspects were to them when reading about science: easy to read and follow; clear conclusion or expert opinion given; explanation of science; pros/cons or uncertainties related to the scientific advancement discussed.

For Part 2 of the survey, we chose genetically modified mosquito release as the topic of interest based on the following 3 criteria: 1) high complexity of science; 2) impact on community; 3) controversial due to perceived or real risks involved in implementation of the technology. Respondents were asked to read three mock/sample articles on the release of genetically modified mosquitos. The mock/sample articles that were part of the survey were categorized into 3 boxes. The first of these was adapted from various news media coverage. The second was adapted from information provided by local authorities. The third was adapted from peer-reviewed scientific literature. We adapted the information from the various types of sources while noting that the defining focus or key communication point(s) of the different text boxes were as follows: Box 1 focuses on describing the public reaction to the release of the genetically modified mosquitoes. Box 2 aims to provide the rationale behind the project. Box 3 explains science and then goes on to state and evaluate the concerns related to the release of the mosquitoes. We asked the survey participants to select the box they thought best fit each of the following categories: easiest to read, captured attention most, desired depth of information, would help most with decision making, and seems most reliable and/or trustworthy.

## Internet Search

We searched the term “Florida mosquito release” on Google and collated the first 100 hits and analyzed them. Each of the search items was categorized by type of source: local media, national/international media, government authority, scientific magazine, or other. The search date was July 24, 2021. Of the 100 search items 13 were excluded from our analyses due to the following factors: requirement for a paid subscription, no relevance to the topic, duplicate item.

To further assess the level of information found in the search hits, we read through the search items to determine and categorize them to match our sample/mock articles in the survey as described in the previous section. A search hit that focused on public reaction was categorized as Box 1. An article that provided rationale for why a mosquito release was being done was assigned Box 2 and an article that stated and evaluated concerns around mosquito release was assigned Box 3. We then analyzed the internet search results to understand frequency and accessibility of these types of articles when using the search engine to obtain information on the topic.

## Results

### Survey

#### *Demographics*

The survey was sent to 35 people and 29 responded. Of the 29 who responded, 12 were of 51 years of age or older, 4 were 31 to 50 years, and 13 were 30 years or younger. Education level was also collected. 16 had a Master’s and/or PhD, 11 had an undergraduate degree, 1 had a high school diploma, and 1 had none of these.

#### Survey – Part 1

All (100%) respondents reported that it was important for articles to be easy to read and follow (Table 1). A majority (82.7%) thought that scientific reading should have a clear opinion or express and expert opinion. Slightly more than half of the respondents (51.7%) reported that it is highly important for scientific reading to explain the science behind an advancement or technology while the rest felt it was important or were neutral. A vast majority (86.2%) responded with a “highly important” when asked about scientific reading acknowledging pros/cons and uncertainties/gaps in scientific knowledge. The remaining 13.8% responded with an “important” on this question, making this question the one the most skewed towards a rating of 5 (highly important) amongst all the questions related to preference in scientific readings.

Table 1. Survey results on how much respondents value certain aspects of scientific reading.

Question	% Responses by Scale <sup>1</sup>				
	1	2	3	4	5
On a scale of 1-5, how important is it to you for scientific reading to be easy to read and follow?	0	0	0	51.7%	48.3%
On a scale of 1-5, how important is it to you for scientific reading to give a clear conclusion or an expert opinion?	0	10.3%	6.9%	44.8%	37.9%
On a scale of 1-5, how important is it to you for scientific reading to explain the science behind an advancement or technology?	0	0	10.3%	37.9%	51.7%

On a scale of 1-5, how important is it to you for scientific reading to acknowledge pros and cons as well as uncertainties or gaps in scientific knowledge?	0	0	0	13.8%	86.2%
---	---	---	---	-------	-------

<sup>1</sup>Importance rated on a Scale 1-5, with 5 being highly important.  
Some rows may not add up to 100% due to rounding.

## Survey – Part 2

In Part 2 of the survey, participants were asked to answer questions that were designed to assess preferences between three types of mock/sample articles provided to them on the chosen scientific topic of genetically modified mosquitoes. Of the 29 respondents, 55.2% reported that they found Box 1 (public reaction-focused) to be the easiest to read, whereas 31% found Box 3 (focused on evaluation of concerns) to be easiest to read.

Respondents were split in terms of which of the article types captured their attention the most: 51.7% of respondents reported that Box 1 captured their attention the most, while 44.8% said Box 3 captured their attention most.

When asked which of the articles gave them the level or depth of information they would like to have on the subject, 75.9% of the respondents selected Box 3 (Figure 1).

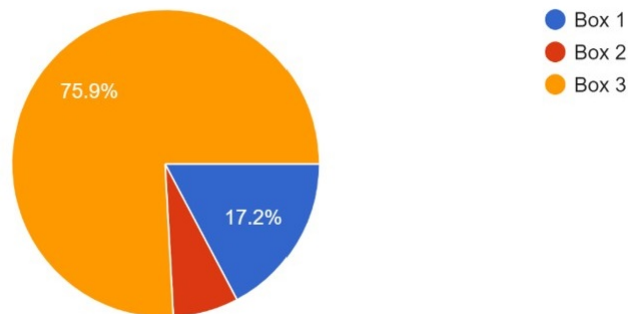
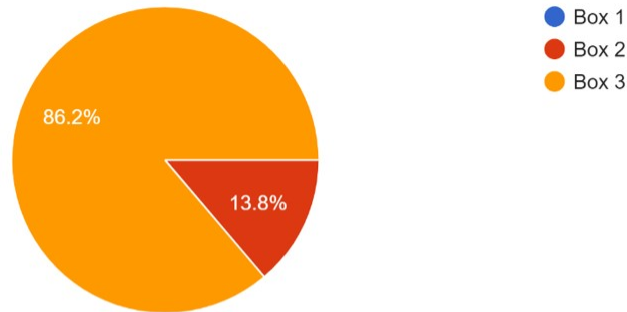


Figure 1. Extent/level of scientific information desired by survey respondents.

Note: Box 1 focuses on describing the public reaction to the release of the genetically modified mosquitoes. Box 2 aims to provide the rationale behind the project. Box 3 explains science and then goes on to state and evaluate the concerns related to the release of the mosquitoes.

As shown in Figure 2, 86.2% of respondents reported that Box 3 (focused on evaluation of concerns) seemed to have the most reliable information, while the rest reported that Box 2 (rationale-focused) seemed to have the most reliable information. None chose Box 1 (public reaction-focused). Furthermore, all but 2 respondents (93.1%) reported that Box 3 would help them the most if they had to vote about this issue in their communities. Of note, 89.7% of respondents reported that the information in Box 3 was not too difficult to understand.

A



B

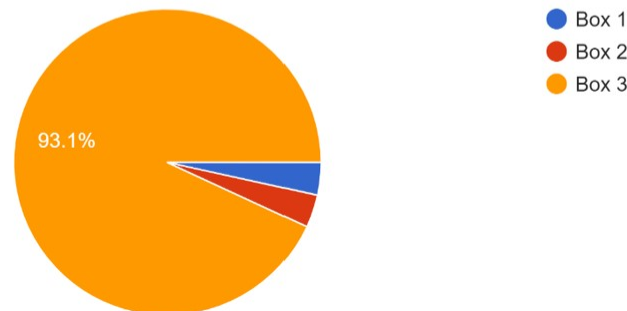


Figure 2. Figure 2A shows which article respondents found most reliable/trustworthy. Figure 2B shows which article respondents thought would be most useful if they had to vote about this issue.

Note: Box 1 focuses on describing the public reaction to the release of the genetically modified mosquitoes. Box 2 aims to provide the rationale behind the project. Box 3 explains science and then goes on to state and evaluate the concerns related to the release of the mosquitoes.

## Internet Search

### *Types of Sources:*

We examined the first 100 hits that came up following a search on Google using the search term “Florida mosquito release” to determine the type of source that was reporting the news or information on the topic. A total of 13 were excluded based on criteria defined in the Methods section which included duplicates or non-relevance.

To match or keep consistent with the survey design, we categorized these into the following source types: Local/National media, Science magazine or specialized scientific source, government or health authority, and other. Figure 3 shows the distribution of the search results by source type. Not surprisingly, a large proportion (55%) of the search hits were from either local or national media or news organizations. Very few (2%) were from government or health authorities. About a fifth of the results were scientific sources (20%), and the remainder were categorized as other (e.g. online magazines, blogs).

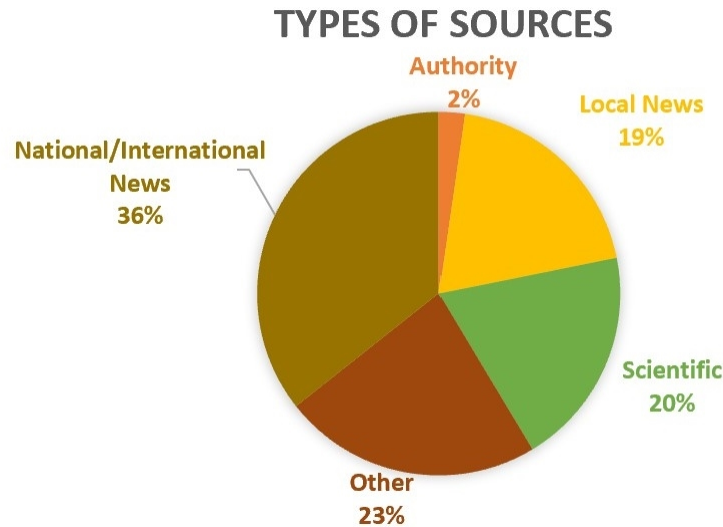


Figure 3. Types of Sources on Google Search

#### Type of information and distribution:

The search items were categorized into type of information based on criteria defined in survey design. As shown in Figure 4, we were able to categorize 45% of the search items to Box 1, 21% to Box 2, and 16% to Box 3. We were unable to categorize the remaining 18% of the articles because they didn't fit the description of any of the boxes. Examples of these types of articles were ones that only described science without any other context or articles that only stated concerns without evaluating them.

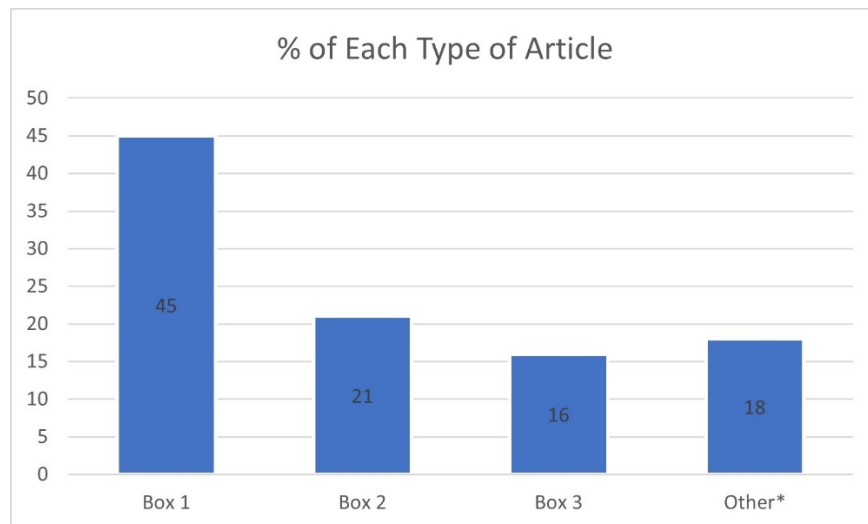


Figure 4. Proportion of Box 1, 2, and 3 in the search results

\*Other category includes articles that only describe science without any other context or articles that only state concerns without evaluating them.

Note: Box 1 focuses on describing the public reaction to the release of the genetically modified mosquitoes. Box 2 aims to provide the rationale behind the project. Box 3 explains science and then goes on to state and evaluate the concerns related to the release of the mosquitoes.

We then examined the distribution of Box 1, 2, or 3 type of articles based on the order in which they come up during the internet search. Relative order was categorized as 1-20, 21-40, 41-60, 61-80, and 81-100 with 1 being the first item that shows up during the search. This was done in order to assess and understand accessibility or ease with which they can be found when searching for information on the topic of interest. It is also worth noting here that to find the 100th item on the search, one would have to scroll through 10 pages of search results (each page of results held 10 search items when we did our search). Figure 5 shows the distribution of article type by search order. Box 1 type articles (public reaction focused) were the most numerous across all categories of search order and was also the most evenly distributed with no particular trend noted. Box 2 had a trend towards showing up earlier in the search order. Box 3 had a more definite trend in that it was easier to find this type of article in the top 40 searches than in latter categories.

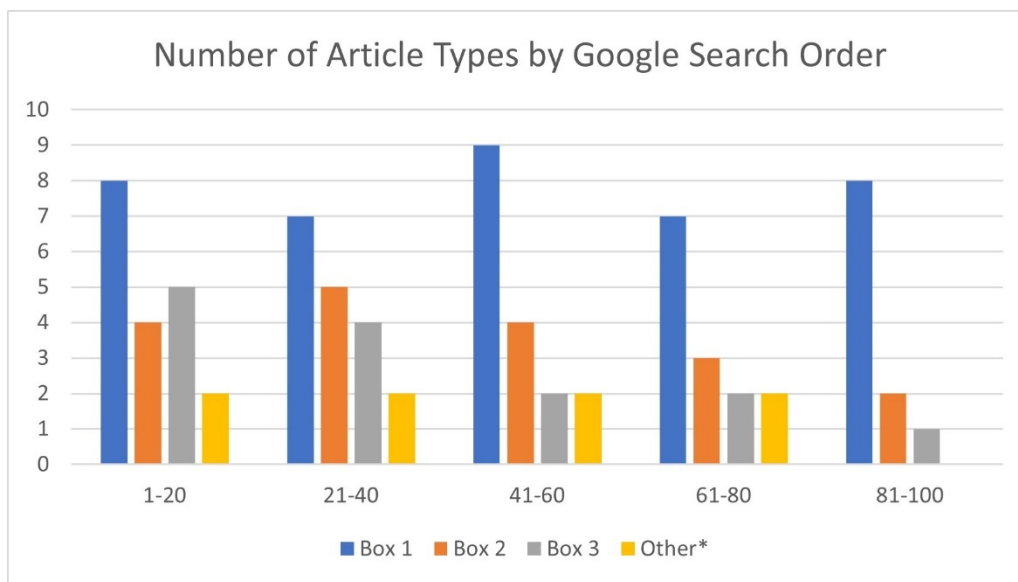


Figure 5. Histogram showing distribution of article types by search order

Note: Box 1 focuses on describing the public reaction to the release of the genetically modified mosquitoes. Box 2 aims to provide the rationale behind the project. Box 3 explains science and then goes on to state and evaluate the concerns related to the release of the mosquitoes.

We further examined the distribution of Box 3 type articles (focused on stating and evaluating concerns) in the various sources of news or media (Figure 6). We found that among Box 3 type articles, 50% were from national or international news sources, 29% were from scientific sources and 21% were from other sources such as online only magazines or blogs. None were found in local news or authorities.

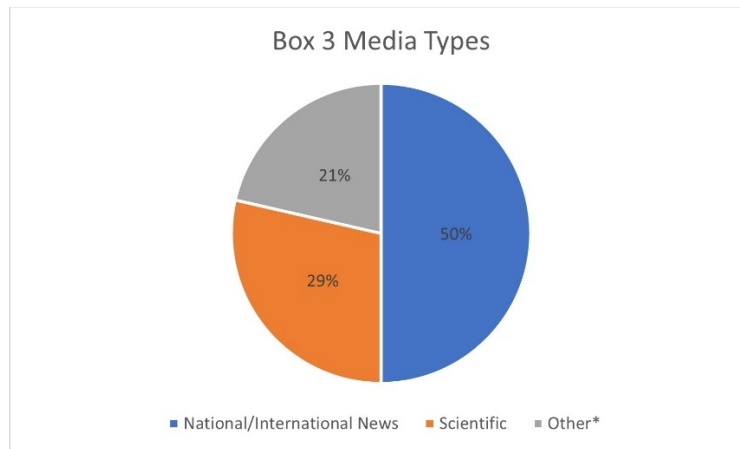


Figure 6. Media types where Box 3 type articles (focused on evaluation of concerns) can be found Discussion

There were two parts to our research/study, the first focused on assessing people's preferences on reading information on science generally as well as on a topic that is of high interest or impact, and the second on assessing ease with which the preferred type of science information can be found using a popular internet search engine (Google). Our science topic of interest was genetically modified mosquitoes. We hypothesized that people would want to be well-informed about science but that it would be hard to come across well balanced articles on the scientific topic when searching for it on the internet.

Results of our survey showed that a vast majority of respondents would like to see information on risks and/or concerns stated and evaluated when communicating on genetically modified mosquitoes. They also noted that it was not hard for them to understand this topic when presented to them in Box 3. It is worth noting here that when we wrote Box 3 as a mock sample, we took care to adapt information found in a scientific journal to bring out more lucidly the key concerns and evaluate them in an unbiased manner within the sample article. This confirms our hypothesis that there is a strong preference for scientific communication to be well balanced and that people prefer to be made aware of the risks along with an evaluation of the risks without any conclusion or bias being introduced.

The survey also found that none of the respondents thought that information on science from a local media type of article (Box 1, public reaction-focused) was reliable. When searching for the topic of interest using Google as the search engine, we found that Box 1 type of article was the most prevalent in the Google search, as evidenced by our analysis shown in Figures 5 and 6. This could perhaps be explained by the fact that 50% of the respondents of the survey said that Box 1 captures their attention the most (with the rest split between Boxes 2 and 3). Media and news sources are likely well aware of this preference and thus use this to communicate science in a manner that sensationalizes the information. Thus, articles that prioritize getting clicks (capturing attention) rather than presenting quality balanced information are more available on Google search.

## Limitations

The sample population we were able to access with our survey was highly educated which may introduce some bias. For the Google search analyses, we did not take any additional measures in terms of removing sources that could be untrustworthy. Another limitation of the Google search analyses is that while we assigned each of the Google hits to each of the article types (Box 1, 2, or 3) using objective criteria, our assessment may still leave some subjectivity in this assignment.

## Implications and Future Direction



Our survey results clearly show that most people agree that a well-balanced scientific article was most reliable and trustworthy when trying to arrive at a decision on a topic of high relevance and interest to their community. The challenge then within the scientific communication field is how does one balance getting the attention of the lay public on scientific subjects or topics while also ensuring that the information they receive is well balanced and addresses the risks and concerns involved? Is there a way that those news or media organizations that rely on getting the public's attention for succeeding in their business can also be held accountable for communicating science in a well-balanced way? Can more information be made available to the public that is more readily or easily accessible? These are all important considerations for us to debate as a society. With the accelerated rate at which science is advancing arriving at a solution to address these issues is more important than ever.

## Acknowledgments

I would like to thank all of the survey respondents for their timely and thoughtful responses. I would also like to thank my parents for encouraging and supporting my interest in science and this project.

## References

- The BMJ. (2021). *Guidance for BMJ Patient and Public Reviewers*. <https://www.bmj.com/about-bmj/resources-reviewers/guidance-patient-reviewers>
- Canis, B. (2021, April 23). Issues in Autonomous Vehicle Testing and Deployment. Congressional Research Service.
- Carrillo-Marquez, M., & White, L. (2013). Current controversies in childhood vaccination. *South Dakota medicine : the journal of the South Dakota State Medical Association, Spec no*, 46–51.
- Freeman, A. L. J., Spiegelhalter, D. J., van der Bles, A. M., & van der Linden, S. (2020). The effects of communicating uncertainty on public trust in facts and numbers. *Proceedings of the National Academy of Sciences*, 117(14), 7672–7683. <https://doi.org/10.1073/pnas.1913678117>
- Freeman, A. L. J., Galvao, A. B., Mitchell, J., Spiegelhalter, D. J., van der Bles, A. M., van der Linden, S., & Zaval, L. (2019). Communicating uncertainty about facts, numbers and science. *Royal Society Open Science*, 6(5). <https://doi.org/10.1098/rsos.181870>
- Gottfried, J., & Funk, C. (2017, September 21). *Most Americans get their science news from general outlets, but many doubt their accuracy*. Pew Research Center. <https://www.pewresearch.org/fact-tank/2017/09/21/most-americans-get-their-science-news-from-general-outlets-but-many-doubt-their-accuracy/>
- Healthline Media. (2018, August 2). *GMO vs Non-GMO: 5 Questions Answered*. Healthline. <https://www.healthline.com/health/head-to-head-gmo-debate#1>
- Kitcher, P. (2010, June 4). The Climate Change Debates. *Science*, 328(5983), 1230–1234. <https://doi.org/10.1126/science.1189312>
- Pierce, M. (2013, January 22). *The intersection of science and public policy*. American Association for the Advancement of Science. <https://www.aaas.org/intersection-science-and-public-policy>
- Van Noorden, R. (2014, May 7). *Global scientific output doubles every nine years*. Nature news. <http://blogs.nature.com/news/2014/05/global-scientific-output-doubles-every-nine-years.html>
- Zerzan, A. (2019, July 8). *Why should scientists communicate clearly with the public?* British Council. <https://www.britishcouncil.org/voices-magazine/why-should-scientists-communicate-clearly-public>