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Controversial Search Engine Results: An Exploratory Study of Information Presentation and Use

Abstract

The manner in which search engine results are presented to a user may influence how they come to understand scientific information. Sixty participants were asked to read a mock search engine's result page with the goal of summarizing a science topic for a colleague. The researchers analyzed participants' summaries for the presence of conflicting or negating information from the mock search results page. Preliminary findings indicate that the way in which a search engine displays results can influence a user's understanding of a controversy, particularly document order and genre, which affected the quality of participants written responses. This study has implications for the design of search interfaces, and the mediation of information searching in the context of learning science using online documents.

Resumé

Alamir Novin is a PhD student at UBC at the School of Library, Archival and Information Studies (SLAIS). He has published on the topic of science controversies and online biases and is interested in Human Computer Interaction and Collaborative Information Behaviour.

Dr. Eric Meyers is an Assistant Professor in SLAIS at UBC. He is widely recognized for his research on information practices and the learning sciences. He has earned awards and honours for his scholarship on the information practices of young people in academic and every day contexts.

Introduction

Andreas Ekström, in a widely viewed TED talk (https://www.ted.com/speakers/andreas_ekstrom), claims that there is a common misconception that search engines (e.g., Google, Yahoo, and Bing) are objective, and do not contain human bias. Recent studies show that young people place faith in search engines and use page rank algorithms as a key indicator of quality (Hargittai, 2007, 2010). Studies further show that search engines are not only subject to bias (Ekström, 2015), but the Search Engine Result Presentation (SERP) of online information can affect our opinions and decisions (Epstein & Robertson, 2015). By analyzing SERPs we can explore how people come to understand a topic when online searching is their primary mode of sense-making. This study explores the research question: how does a SERP affect people's understanding of a science controversy?

To answer this question, we observed how document-genre and *presentation-order* (i.e., the order a document appears in a list) affected sixty participants' understanding of a science controversy. The study analyzed whether participants recognized the usefulness of information that conflicts, counterpoints, or negates other information presented in the same list. We refer to

this type of information as *negatory information.* For example, if a searcher used the query "do vaccinations cause autism?", she may see results that confirm or deny the link between these concepts. Should the search engine retrieve Dr. Wakefield's infamous research (1999) that falsely links autism with vaccination, the searcher may come to develop a misconception. However, if the results also include links to research that explicitly debunk such connections, such as Flaherty's study (2011), which contradicts Wakefield's work, then the user will need to resolve conflicting information in the same search set. Our work is predicated on the hypothesis that document order and genre will make a difference in users making sense of search results that contain conflicting information.

Background: The Relationship Between Science Literacy and Information Literacy

The National Science Board reports that, while television is still the primary source of news information for the public, the Internet has become the public's primary source for *science* information. A problem that arose from this shift is that search-engines not only provide access to scientific information, but also to the abundance of misinformation on the Internet. While the average person's scientific knowledge on general topics has slowly increased over the last two decades, certain pseudo-science beliefs have also grown to levels not seen since more than three decades ago (2014). Improved science literacy could assist with minimizing the influence of pseudo-science. Compounding the challenge of science literacy is the uneven support for developing students' information literacy, particularly online search strategies. For example, while the BC Curriculum for Information Technology (2010) prescribes that students "evaluate information retrieved electronically for authenticity, bias, and timeliness" from a variety of sources (p.82), children are not prescribed to search for counterpoints to negate their confirmation biases.

The question of how system design affects how users understand a given topic is of growing interest in Library and Information Science (LIS). In earlier LIS research, information retrieval models often assumed that agents want only the "relevant" documents even though "irrelevant" ones may be useful (Fidel, 2012, p.203). More recently, Nick Belkin has expounded on the concept of usefulness as a more appropriate indicator than relevance (Belkin, Cole, & Liu, 2009; Liu & Belkin, 2015). Results can also be perceived as useful if they are personalized with greater contextual information (Liu & Belkin, 2015). People tend to value highly ranked search results (Behnert & Lewandowski, 2015); top search results are favoured over lower ranking results (Belkin et al., 2009), as people often do not look at anything below the third result (Fidel, 2012). While the top search results can be significantly improved with more user feedback (Agichtein et al., 2006), it is important for these top results to represent accurate information because an extreme form of personalization may lead to an echo chamber effect (Alonso, Hearst, & Kamps, 2015). In other words, because only *not all* documents are selected by an agent, studies suggest that people will rely on their prior knowledge and select documents that confirm their biases (Chapman & Johnson, 2002; Evans & Over, 2013). Selecting documents that only confirm or support an agent's viewpoint is referred to as *confirmation-bias* (Evans & Over, 2013, p.104). Confirmation-bias becomes especially troublesome in search queries dealing with controversial science topics where conflicting information may be retrieved (Mynatt, Doherty, & Tweney, 1977). Search engine results on scientific issues may display sources that are tainted by the personal agendas of fringe scientists, non-scientific agenda building by the media, and

corporate science organizations that seek monetary gains at the expense of scientific accuracy (Novin, 2013).

Methods

To investigate user interactions with different perspectives on a science controversy, it was important to choose a topic that participants had little prior knowledge or opinions about. At the same time, the topic needed to be easy to grasp and relevant to their interests once they became aware of it. To limit the chance of prior knowledge from students, the science controversy that was used for this experiment was a lesser-known controversy with an equally lesser-known negation to the controversy. As previous studies show, the subject that meets this criteria is biofuels (Carriquiry, Du, & Timilsina, 2011; Delshad, Raymond, Sawicki, & Wegener, 2010; Longstaff, Secko, Capurro, Hanney, & McIntyre, 2015; McKone et al., 2011; Secko & Einsiedel, 2014; Smith, 2015). Biofuels is organic matter that is used as an alternative fuel. It is looked upon positively due to its renewable nature and Canada has invested billions of dollars into developing the technology (National Resources Canada, 2015). The scientific controversy behind the older generation of biofuels, such as corn, is that, while it provides renewable energy, it also replaces agricultural land that could be used for food (Longstaff & Secko, 2014). As a consequence, the process takes up land space and drives up the price of food. We identified this "Food vs. Fuel" debate as negatory information. The "Food vs. Fuel" debate is not distinguished by Google's search engine and a pilot study of 14 participants found that participants did not mention the debate when looking at these Google's search results. However, it was found that modifying the search engine to present negatory documents explaining the “Food vs Fuel” controversy directly affected the quality of participants’ understanding of the topic. Building on this finding, we sought to test the strengths of negatory information in a Google result page. To do so, we tested whether participants would identify and use negatory information presented in an order controlled mock search page. The mock page contained the "Food vs. Fuel" controversy and a second negation: Advanced Biofuels. Advanced Biofuels are often defined as a possible answer to the "Food vs. Fuel" debate because they rely on non-food plant types, such as algae (Longstaff et al., 2015; Smith, 2015).

Sixty participants were recruited from a large public research university for this study, ages 18-30, with roughly equal gender distribution (45% female); 91% had little to no knowledge of the topic prior to their participation. The experiment was conducted in five stages. In stage 1, participants were asked two questions about their previous knowledge on a scientific topic. In stage 2, participants were asked to read and rank six search results. The results appeared on each page in different in three different orders whereby the negatory result appeared at either the top, middle, or bottom of the search page. Students were randomly assigned to read one of these pages. In the third stage, all the students wrote their own summary of the scientific topic as though they were writing for a colleague. In Stage 4, Stage 2 and 3 were repeated with the summaries of the search results being extended from 25 words to 100 words. Participants were then asked if there was any information they wished to add to their summaries. All the participants then ranked the usefulness of a diagram on the scientific topic in Stage 5.

Results

The pilot study tested whether participants would mention the "Food vs. Fuel" controversy when writing up a summary based on the results Google provided. The study found that participants did not mention the controversy. When the study used a mock Google results page that displays the "Food vs. Fuel" results, 67% of participants mentioned a controversy existed and 60% identified it as the "Food vs. Fuel" demand. After controlling for document-order and document-genre, 90% of participants mentioned that a controversy existed and 77% identified it as the "Food vs. Fuel" demand.

Although the study results are still being analyzed, early findings indicate that presentation order plays a significant role in how people write about a science topic. When presented with the secondary-negation of "Advanced Biofuels" users tended not to view potentially conflicting information as useful and ranked its usefulness as a low 27%. After reading the Google result in more detail that score increased to 69%. Less than half of users (40%) actually used the words "Advanced Biofuels" in their write-up. After controlling for document-order and document-genre, 63% of participants mentioned "Advanced Biofuels" in their write-ups.

The findings suggest that upon initially viewing a search results page, users were more likely to disregard negatory information as not being useful by giving it a low score (27%). It was only when participants were asked to fully read the results, that the negatory information was deemed as useful and the score increased to 69%. While 40% of users used negatory information in their write-up of biofuels, the correct document-genre could cause the negatory information to have a higher uptake by participants (63%).

Discussion

The paradox of negatory information in a search engine is that while search engines are designed to play to a user's inclination for quick answers (as exemplified by Google's "I'm Feeling Lucky" button), negatory information forces a user to re-think their query all together. This study believes some confirmation bias can be controlled when both agents and the system work together so that 1) agents make an effort to seek out negatory information and 2) search engines emphasize the negatory information:

1) As one participant explained, the study's task was "difficult because you need a strong analytical skill." Students should develop these analytical Information Literacy skills. Currently, students often trust Google's algorithm over their own analytical skills and focus on the top result (Meyers, 2012). However, this merely leads users to adopt Google's own biases (Ekström, 2015). Furthermore, Google does not account for the implicit biases in a users query (e.g., is a query for "vaccines cause autism" made by a parent concerned about vaccines or by researchers concerned about parents concerned about vaccines?). Therefore, students should aim to falsify their own implicit biases in their queries by actively searching for information that conflicts, counter-points, or even contradicts their search results.

2) When a search engine only aims to deliver ideal answers, it narrows the possibility that multiple perspectives exist. In certain cases, this leaves the discovery of 'the other side of a story' to serendipity. As the findings indicate, including a negatory result at the top of a search engine's result page is vital to whether users intake multiple perspectives on information. However, one factor that became immediately apparent in our study is that placing a negatory article at the top does not work if it lacks the proper document-genre because readers will often skip the article. As one participant explained why they skipped a scientific article on Advanced Biofuels, "if I don't know anything about the topic, then it's difficult to read that quite detailed algae article first, because I don't have any knowledge base of biofuels to relate it to." Future studies may test whether context can be provided by the search engine page if it visually identifies the negatory result more explicitly. One method would be to include a label that explains a search result's usefulness as a negation. This type of information indexing has a strong precedent if one considers the importance of antonyms in a thesaurus.

There are several important limitations to this work. First, the pilot and main study were conducted with a student population that may not represent the broader public. Second, the small number of participants in the pilot and main study (14 and 60 respectively), limit the power of the analysis. Nonetheless, this study paves the way for additional analyses of how search engine result pages interact with learning tasks to influence how individuals develop their understanding of science topics.

Conclusion

An informed citizenry is an essential value of Canadian society. However, the tools we use to research everyday topics in science may not be leading the public to better information and a more sophisticated understanding of our world. We conclude that the various forms of bias that affect online searches may be mitigated if two criteria are met: 1) users of online search engines learn how to critically gauge for bias in results and 2) the results page of search engines highlights information that contains negating information. We hope to use these results to develop both interfaces and search curriculum that help challenge users to make better sense of the information they see online.

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