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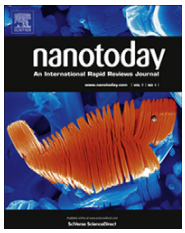

NEWS AND OPINIONS

Information snapshots: What Google searches really tell us about emerging technologies

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Summary For most consumers, Google is the window to the (nano) world. At the very least, Google and other search engines are the place where many consumers get the first glimpse of emerging technologies. In order to explore the critical role that online media play as information gateways, we tracked Google search patterns related to nanotechnology over a 17-month period. Our data show that the snippets of websites highlighted in top Google search results present policy themes about nano more than themes about application or social implications. General searches for ''nanotechnology'' present a neutral tone, while ''risk''-related search results present a negative tone and ''benefit''-related searches present a positive tone. The majority of websites appearing in Google searches are non-nano specific sites (e.g., www.sciencedaily.com). We discuss the important implications of Google search results for nanotechnology audiences.
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''Google Web Search result content is likely to play a pivotal role in the formation of nanotechnology knowledge and attitudes among the public and — ultimately — regulation and funding policy.'' (subhead)

For most consumers, Google is the window to the (nano) world. By far, Google ranks as the most popular search engine, claiming around 64% of all searches [1]. At the very least, Google is the place where many consumers get a first glimpse of emerging technologies. As a result, Google plays a critical role as a gatekeeper of information about new technologies. Google also technically ranks the websites in its search results by looking at the sum of all pages linking to it [2,3]. Furthermore, Google audiences' search behavior and information processing techniques usually determine which information they pay attention to and find valuable.

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Most online users keep their Web queries short and do not click past the first page of search results [4]. Along with search result relevance, users are more likely to click on higher-ranked Google results [5]. This means that the very first information about nanotechnology individuals come across matters. It can potentially impact public perception, discourse, and support related to nanotechnology. Moreover, an individual's future information-seeking activity about nanotechnology may depend on prior perceptions and understanding of the issue. Therefore, the following questions are worth exploring: What does the general public see in the first few moments they spend online searching for information about nanotechnology-related topics? Specifically, are there patterns over time in what appears on the very first page of Google search results?

To answer these questions, we tracked Google search patterns related to nanotechnology over a 17-month period. From April 2009 to August 2010, we simulated Google searches for various topics related to nanotechnology (including a general ''nanotechnology'' search, and specific searches for nano-related ''risk'', ''benefit'', ''regulation'', ''environment'' and ''health''[1]), based on popular past user searches and their relevance to the discourse on nanotechnology [6]. We erased cache and search history after each search to prevent this from affecting subsequent searches. We explored the thematic content[2] (analyzed by using six root words per theme [6,7]) of the ten website titles and snippets — or two-line website descriptions — that appeared on the first page of Google search results ($N = 1870$) during this time period. Looking at the results of Google searches for general ''nano'', ''risk'' and ''benefit'' ($N = 430$), we examined for positive or negative tone (valence), and potential consequences (outcomes) suggested in the search results.

In short, the data show that the snippets of websites highlighted in top Google search results present policy themes about nano more than themes about application or social implications. General searches for ''nanotechnology'' present a neutral tone, while ''risk''-related search results present a negative tone and ''benefit''-related searches present a positive tone. The majority of websites appearing in Google searches are non-nano specific sites (e.g., www.sciencedaily.com). We will discuss the implications of each finding.

Prevalent policy themes in most searches

Google primarily presents policy-related thematic content (e.g., *business*, *research*, *regulation*, and *technology*)[3] in the results of almost all nano searches (except specific searches for ''risks''), more so than social implications (e.g., *risk*, *benefit*, and *uncertainty*) or application-related content (e.g., *health*, *environment*, and *national security*). This is consistent with nanotechnology coverage in newspapers — over the same time period — which focused mostly on policy (e.g., thematic content of *business* and *research*) [8]. The trend was consistent for the entire time period of our analysis. This means that Google potentially steers the general discourse of nanotechnology to be primarily around policy issues, and this may contextualize future public awareness and attitudes toward nanotechnology. It was noticeable, for instance, that thematic content related to *national security* barely appeared in the Google snippets. Because an individual's future information-seeking activity about nanotechnology may depend on prior perceptions and understanding of the issue, Google may potentially further narrow the different aspects of nano that are being discussed [9]. In other words, Google may increasingly engage the public in discourse about nano-related policy more than other aspects of the technology.

Prevalent *health* and *environment* themes in ''risk'' searches

Under ''risk'' searches, people were more likely to encounter application-related themes — *health* and *environment* — as dominant thematic content. This makes sense because *health* and *environment* are more relevant and salient themes to the public, who already have concerns about the possible hazards of nanotechnology. Such discourse may further increase their concern about the health and environmental impact of nanotechnology. People tend to use mental shortcuts when weighing risks against benefits [10], and exposure to these themes may potentially prime specific aspects of this new technology in people's memory. Consequently, when people are prompted to think about nanotechnology at another time, this prime will influence later information seeking and processing.

A more precise and concrete presentation of ''risk'' than ''benefit''

General ''nanotechnology'' searches mostly had a neutral tone with a fairly small fraction (25%) containing portrayals of concrete positive outcomes. Nearly two-thirds of the snippets expressed negative valence toward nanotechnology

[1] In terms of Google query, the general ''nanotechnology'' search consisted only of ''nanotechnology OR nanotech'' (the quotation marks are used to denote a search string for the purposes of this study but were not included in the actual Google query). Other topics (and sub-keyword searches, if applicable) were searched in conjunction with ''nanotechnology OR nanotech.'' For example, the ''risk'' search query in Google was ''(nanotechnology OR nanotech) risk.''

[2] Different thematic content was not exclusively presented in a single Google snippet. For example, a title in the search results ''Nanotechnology Surges into Health and Fitness Products'' was coded for both themes: health and business.

[3] Because some of our Google search queries were the same as the root words of thematic subcategories (e.g., Google search for ''risk'' and the thematic subcategory of *risk*) and snippets include the original searched words in their description, we excluded from our analysis situations where search terms and thematic subcategories matched. This rationale was applied to Google searches for nanotechnology-related ''risk'', ''benefit'', ''regulation'', ''health'', and ''environment.''

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and about one-fifth of them claiming a tone of uncertainty. Comparatively, slightly more than half of the nanotechnology ''benefit'' searches included a positive tone and almost none expressed uncertainty. Comparing nanotechnology ''risk'' to ''benefit'' searches, individuals are more likely to come across information about tangible negative consequences (e.g., health and environmental hazards) from a ''risk'' search than they are to come across specific positive consequences from a ''benefit'' search.

How does this affect the lay public? Most Americans are not well informed about nanotechnology, and yet they form opinions about it based on external cues (e.g., new information they come across in various news media). Knowing how nanotechnology is initially framed is crucial to determine how this new technology will be perceived. Previous studies have revealed that frames about specific risks of nanotechnology are more influential in shaping public opinion and attitudes than frames on its benefits [11]. By portraying specific risks in a negative tone, Google search results could reinforce negative perceptions of nano among those who are already aware of the risks. For people who are already familiar with nano-related benefits, Google may develop their perception of nano in a positive but less powerful way. By portraying general nanotechnology as mostly neutral, Google does not induce some of the reinforcement effect on people's overall perception of nanotechnology that tends to result from risk framing.

Prevalent non-nanotechnology websites

In Google searches for general ''nano'', ''risk'' and ''benefit'', the majority of websites appearing in the results are non-nano specific sites compared to other website categories such as government sites, nano-specific sites, and blogs. About half of them were from non-nanotechnology websites (e.g., www.sciencedaily.com), while over a third were from nanotechnology websites (e.g., www.nanowerk.com), a small proportion from government websites (e.g., www.america.gov), and Wikipedia. This means that nano research centers, companies, or government agencies were not shaping the discourse.

Let's take a look at the connection between these categories of websites and their content. As a previous study showed [2], non-nano specific sites usually discuss nano in the context of health and the environment, while nano sites discuss it in terms of business. Government websites are more likely to discuss business and regulation aspects. Thus, the popularity of non-nano specific sites means Google is steering discourse toward environment or health dimensions rather than business or economic dimensions. This means Google may incite the public to think that environmental and health concerns are more salient and relevant than other dimensions of nanotechnology. Google is likely to have a potential impact in shaping public opinion, support, regulation, and funding policy related to environmental and health issues associated with nano.

Information snapshots may matter

''Googling'' is now a household term and many Americans use the search engine on a daily basis. More importantly, the public has trust in the search engine's result ranking and content [5]. Our data show that online searches present consumers with an information environment that produces very specific selective snapshots rather than a fine-grained, well-balanced picture. There are many reasons for how and why Google algorithms highlight aspects of nanotechnology in a particular fashion. Technically, this can be explained by PageRank, a technology that determines the rank of a website in Google search results. PageRank determines the ''importance'' of a website by looking at the sum of all pages linking to it [2,3]. What is more important are the potential consequences. Because it is the first information individuals are likely to encounter online, Google Web Search results are likely to play a pivotal role in the formation of nanotechnology knowledge and attitudes among the public and — ultimately — regulation and funding policy.

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