

Web Page Evaluation and Opinion Formation on Controversial Search Topics

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Abstract. This study investigates the types of web pages people find useful regarding controversial topics and how these pages affect people’s opinion formation capacity. An experiment was conducted involving participants who were asked to decide whether they agreed or disagreed with a given topic. During the study, information on the types of web pages participants found useful and the reasons for their opinions were collected to analyze how and why individuals formulated their opinions. Analysis of the results revealed the following. In the homework task, participants found that useful web pages included those that contained information and opinions from multiple viewpoints, as well as evidence-based information. In the vaccine task, many participants found that useful web pages included those that contained evidence-based information. Moreover, opinion formation was categorized into seven types, including damage minimization, merit-oriented, demerit-oriented, credibility-oriented, majority, single-page, and prior beliefs.

Keywords: Information retrieval · Controversial topics · Search behavior analysis

1 Introduction

Currently, web search engines are used for various purposes. One is to help formulate opinions on a particular topic. According to a survey by Moz, 46% of the respondents answered that they often use Google to make important medical decisions [14].

Regarding health information searchers, studies have been conducted on the quality of health information available on the Web [5][19] as well as the criteria for credible web pages [18][13][12]. However, limited studies have been conducted on controversial search topics, such as “Should I become a vegetarian?” and “Is homework necessary for elementary school students?” In this study, controversial topics were defined as those in which the truth was unclear, resulting in arguments for and against them. Such controversial topics require careful opinion formation from various information sources because the answers remain unknown. A better understanding of how people search the Web for answers regarding controversial topics, what information they find useful, and how they finally form their opinions is crucial in the development of reliable web search engines.

To this end, the following research questions were investigated.

RQ1: What kind of web pages do people find useful when they search on controversial topics?

RQ2: How do people form their opinions after searching?

In the user study, 12 participants were asked to use a web search engine to formulate their opinions on controversial topics, such as “Is homework necessary for elementary school students?” and “Should children receive the COVID-19 vaccine?” After completing the search task, the participants were then asked to assess the usefulness of the web pages they viewed during the search task, their opinions on the topic, and the reasons in formulating them. By analyzing the data, it can be clarified what web pages people found helpful and how people formulated their opinions on controversial topics.

To answer RQ1, the web pages, which evaluate data obtained from the post-task questionnaire and interview content, were analyzed. Specifically, labels based on previous studies of highly rated web pages were assigned [18]. The labeling results revealed that in the homework task, useful web pages included those that contained evidence-based information, such as experimental results, and those that contained information and opinions from multiple perspectives. Meanwhile, in the vaccine task, useful web pages included those that contained evidence-based information.

To answer RQ2, opinion formation data obtained from the posttask questionnaire and interview content were analyzed. Specifically, descriptions of the reasons for opinion formation given by the participants were classified into seven types: damage minimization, merit-oriented, demerit-oriented, credibility-oriented, majority decision, single-page belief, and prior belief.

2 Related work

This section discusses the related studies on controversial topics, search behavior analysis, and opinion formation analysis.

2.1 Controversial Topics

There are studies conducted to identify whether or not a query is controversial [3][10] and studies focusing on search results and user search behavior [1][7][9]. For example, Gyllstrom et al. found that it is possible to identify whether or not a search query is controversial by checking Google’s query completion function [10]. Meanwhile, Gezici et al. found that search results for queries related to controversial topics tend to be biased [9].

Research has also been conducted on search systems that can provide both supporting and opposing views on controversial topics [4][6][17]. Stab et al. developed and demonstrated the usefulness of a search system called *ArgumentText* that visualizes supporting and opposing views on a controversial topic [17].

However, few studies have clarified what types of web pages are referred to and how opinions are formulated. Therefore, this study focuses on the analysis of these two aspects.

2.2 Search Behavior

Research has been conducted to reveal user web search behavior [16][21][22]. Yamamoto et al. defined “verification attitude” as the attitude toward behavior that is necessary to obtain reliable information through web searches and clarified the relationship between verification attitude and actual web search behavior [22]. Moreover, Pothirattanachaikul et al. found that when users read documents containing opinions contrary to their preexisting beliefs before conducting a search, they tend to exert more effort during the search process and are more likely to change their initial beliefs after the search [16].

2.3 Opinion Formation

Studies have also been conducted on how searchers formulate their opinions when they search for health information. For instance, White et al. found that for yes-no type queries in health information, searchers tend to view web pages with positive results on the search engine results page and avoid those with negative results [20]. A search engine manipulation effect (SEME) is also known to occur when using web search engines to form opinions. SEME refers to intentionally biasing search results in favor of one opinion or the other to influence the opinion formation of searchers [2][15]. Pogacar et al. found that biasing search results with correct information tends to result in accurate opinion formation, while biasing results with incorrect information tends to result in inaccurate opinion formation [15].

3 Methods

This section first describes the user study procedure and then thoroughly describes the participants and the selection of topics for the search task. Finally, the pretask questionnaire, search task, posttask questionnaire, and interviews conducted in the user study are described in detail.

3.1 Procedure

Figure 1 shows the flow of the user study. First, the participants were informed as to what data will be collected during the experiment and that these data would be used for academic purposes. Only participants who agreed were involved, who were then asked to sign a consent form.

Next, a training task was conducted for the participants to get familiarized with the search system developed by the authors. In the training task, they were asked to search for the following topic: “Should they become a vegetarian?”.

After completing the training task, the participants were asked to answer a pretask questionnaire that examines their level of interest in the search topic, prior knowledge, and prior thoughts about the search topic (Section 3.3). After answering the pretask questionnaire, the participants were asked to perform a

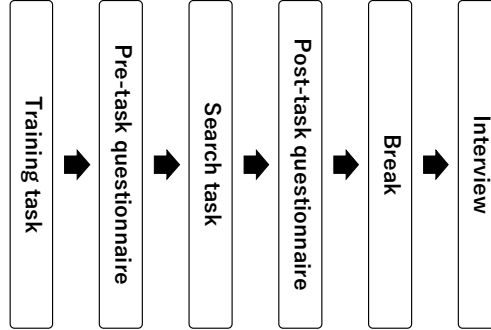


Fig. 1. Flow of the user study.

search task described in Section 3.4. After completing the search task, they were asked to answer a posttask questionnaire, wherein they expressed their opinions regarding the topic and the reasons for their opinions. In addition, they were asked to evaluate whether the web pages they viewed during the search task were helpful or not in formulating their opinions (Section 3.5). Finally, the user study concluded with an oral interview to further investigate the posttask questionnaire content.

3.2 Topics

Topics were selected from the list provided in ProCon.org¹, a website that presents various controversial topics. The two selected topics are the following: “Is homework necessary for elementary school students?” “Should children receive the COVID-19 vaccine?” The former and the latter topics will be referred as the “homework task” and “vaccine task,” respectively.

3.3 Pretask Questionnaire

Before performing the search task, the participants answered a pretask questionnaire, wherein they were asked about their interest, prior knowledge, and prior thoughts about the search topic.

In the homework task, participants were asked about their level of interest in the topic with the question, “How interested are you in the necessity of homework for elementary school students?” The response options were measured using a 5-point Likert scale (1, not interested at all; 2, not very interested; 3, neutral; 4, somewhat interested; 5, very interested). Meanwhile, participants were asked regarding prior knowledge with the question, “How much do you think you know

¹ <https://www.procon.org/>

about the necessity of homework for elementary school students?” The response options were also measured using a 5-point Likert scale (1, no knowledge at all; 2, not very knowledgeable; 3, neutral; 4, somewhat knowledgeable; 5, very knowledgeable). Finally, participants were asked regarding their prior thoughts about the search topic with the question, “Do you think homework is necessary for elementary school students?” The response options were measured using a 5-point Likert scale (1, strongly disagree; 2, somewhat disagree; 3, neutral; 4, somewhat agree; 5: strongly agree). The same questions were framed in context with the vaccine task.

3.4 Search Task

After completing the pretask questionnaire, the participants were asked to perform the search task. They were instructed to read the task description before engaging in it. The following description was presented to the homework task participants:

In this search task, the target was limited to elementary school students, and homework was defined as an assignment that is mandatorily assigned by a teacher. You recently watched a TV program discussing homework. Today, a new homework method called AI Drill is spreading, while some schools are doing away with homework.

In this task, you are free to use a web search to investigate whether homework is necessary for elementary school students.

Participants were given a maximum of 30 min to complete the search task and were allowed to stop searching if they felt satisfied with their search even before the 30-min duration. A 30-min duration allowed the participants to have a sufficient time searching. If they had not completed the search after 28 min, they were instructed to, “Please finish the search in about two minutes.”

Figures 2 and 3 show the actual search system interface used in the user study. Participants were allowed to use only this search system. The search system uses the Microsoft Bing Web Search API² to retrieve and return search results to the participants. The participants were allowed to issue any queries, click the search results, and visit the web pages.

3.5 Posttask Questionnaire

After the search task, a posttask questionnaire was administered to investigate participants’ opinions about the search topic and their evaluation of the web pages they viewed during the search task.

² <https://www.microsoft.com/en-us/bing/apis/bing-web-search-api>

Please conduct a search on the following task.

Task1

Is homework necessary for elementary school students?

For this search task, we limit the target to elementary school students. Also, homework is defined as an assignment that is compulsorily given by teachers.

You recently watched a TV program discussing homework. Today, a new homework method called AI Drill spreading, while some schools are abolishing homework itself.

Please thus feel free to use a web search in this task to find out if homework is necessary or not.

Read the above text and press "Start Search" when you are ready.

[START SEARCH](#)

SimpleSearch

elementary school students homework [SEARCH](#)

Should Kids Get Homework? - U.S. News & World Report
<https://www.usnews.com/articles/should-kids-g>
 Homework gives elementary students a way to practice concepts, but too much can be harmful, experts say. By Sarah Wood | March 11, 2022, at 9:34 a.m. Should Kids Get Homework? More...

Homework and Children in Grades 3-6: Purpose, Policy and ...
<https://link.springer.com/article/10.1007/s10905-021-09505-0>
 Background Homework exerts demands, including larger amounts of assigned homework, is correlated with various challenges for children. While homework stress in middle and high school has been studied, research evidence is scant concerning the effects of homework on elementary-aged children. Objective The objective of this study was to understand later perception of the purpose of homework ...

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<https://www.kslearning.com/free-worksheets-for-kids/>
 Children's stories Levelled Stories Fables Comprehension Exercises Content clues Cause & effect Compare & contrast Fact vs. fiction Fact vs. opinion Figurative language Story Structure Exercises Main idea & details Sequencing Story elements Prediction Conclusions & inferences Explore Free Worksheets for Kids Math Worksheets

Fig. 2. Search task.**Fig. 3.** Search results page interface.**Table 1.** Content of posttask questionnaire.

ID	Questions
Q1	To what extent did you view the web pages you visited?
Q2	Did the web page you viewed mention whether homework is required?
Q3	Which of the following applies to the content of the web pages you viewed?
Q4	How helpful were the web pages you viewed in forming your opinion?
Q5	Please tell us why you made the choices you did in Q4.

Participants’ Opinions on the Topic After the Search The posttask questionnaire was used to explore the opinions of participants following the search task.

From a list of options, the participants were asked to choose what opinion they held about the topic and to describe the reasons for their opinion in a form of a free text. Specifically, in the homework task, the first question asked their opinion about the searched topic: “Did you think that homework was necessary for elementary school students?”. The participants could select from three options: “Yes,” “No,” or “I couldn’t determine from the search.” They were also asked to provide the reason for choosing one of the options in the free-response section. After providing opinions about the search topic, the participants were then asked about the reasons as to why their opinions on the topic were not opposed. For example, the following response was given to participants who answered that homework was necessary for elementary school students were asked: “Please give any reason you can think of why you did not agree that homework is not necessary for elementary school students.” The same questions were framed in context with the vaccine task.

Web Page Evaluations The participants were asked to evaluate all the web pages they viewed during the search task to investigate what kinds of web pages searchers found helpful. Table 1 lists the five questions from Q1 to Q5. A 5-point Likert scale was used for the answers (1, not at all; 2, not very much; 3,

undecided; 4, a little; 5, a lot). Q1 asked, “To what extent did you view the web pages you visited?” Participants who answered “not at all” were asked to answer, “Please select this option if you chose “not at all” in Q1 for Q2, Q3, and Q4, and Q5: “Nothing in particular.” Q2 asked, “Did the web pages you visited mention whether elementary school students need to do their homework?” The response options were “mentioned” or “did not mention.” Q3 asked, “Which of the following applies to the content of the web pages you viewed? The response options included “expressed agreement with the task”, “expressed disagreement with the task”, “expressed both agreement and disagreement with the task”, or “was unrelated to the task.” Q4 asked, “To what extent did the web pages you viewed help you to form your own opinions?” A 7-point Likert scale was used for the answers (1, not helpful at all; 2, not very helpful; 3, somewhat helpful; 4, undecided; 5, somewhat unhelpful; 6, very helpful; 7, extremely helpful). Finally, Q5 asked, “Please tell us why you made the choices you made in Q4.” Participants were then asked to answer by writing freely.

3.6 Interview

After the participants completed the posttask questionnaire and took a 5-min break, semistructured interviews were conducted to thoroughly investigate what they had answered in the posttask questionnaire. During the interview, questions were asked while reading their respective posttask questionnaire answers and evaluation of the web pages they viewed. All interview contents were recorded. The two questions were prepared in advance and varied according to the participants’ responses. The first question focused on the reasons for opinion formation. Specifically, the participants were asked, “Could you please explain why you formed the opinion after viewing various web pages?” The second question focused on the reason for completing the search. Specifically, the participants were asked, “Could you explain what information you found that led you to end your search?” Participants who had searched for 30 min were asked, “Was your search satisfactory enough through searching for a long time?” Moreover, they were asked about their evaluation of the web pages and the reasons for their answers. For example, a participant may indicate that a particular page was very useful, or he/she may write in the free-response section of the questionnaire that the page was useful since it included both advantage and disadvantages. In this case, they were asked, “Why do you find it helpful to have both positive and negative aspects of a topic presented?” For each question, additional questions were asked depending on the participant’s responses.

3.7 Participants

The study was conducted from November 15 to December 5, 2022. Participants were recruited through the communication tool of University of Hyogo. A total of 12 participants (6 males and 6 females) were recruited, and all were first- to fourth-year undergraduate students majoring in social informatics.

Table 2. Labels for annotating web page evaluation.

Label	Definition
Expertise	Whether the author has sufficient knowledge to handle the information properly
Authoritative	Whether the organization providing the information is socially credible
Objectivity	Whether the information is based on facts without personal ideas or commercial intentions
Popularity	Whether or not the information is popular
Detail	Whether the information is detailed or not
Double-sided presentation	Whether the information states both advantages and disadvantages
Comprehensibility	Whether the information is broad- based
Opinion	Whether the advantages and disadvantages are clearly stated
Example	Whether the information is based on actual experience
Viewpoint	Whether the information is from the viewpoints of the various stakeholders
Knowledge Acquisition	Whether or not the user learned information they did not know
Other	Those that do not fit into the above labels are evaluated according to the criteria

The participant who took the shortest time to complete the experiment finished in approximately 45 min while the participant who took the longest time finished in 1 h and 30 min. All 12 participants completed the study and were each paid 1,455 JPY.

4 Results

This section provides a detailed description of the results obtained from the web page evaluation and opinion formation analysis. These analyses were conducted to address the two research questions introduced in Section 1.

4.1 Web Page Evaluations Analysis

This section analyzed the types of web pages that were found helpful by the participants. First, the analysis method is described, followed by a detailed description of the results.

Approach To analyze the evaluation of the web pages, an analysis of the free-response statements in the posttask questionnaire regarding the reasons for the evaluation of the web pages viewed by participants was conducted. Specifically, the web pages, where the participants rated “somewhat helpful,” “very helpful,”

Table 3. Types of web pages found helpful by the participants.

	Homework task	Vaccine task	Sum of both tasks
Expertise	2	1	3
Authoritative	0	2	2
Objectivity	4	10	14
Detail	7	6	13
Double-sided presentation	3	1	4
Comprehensibility	3	0	3
Opinion	7	2	9
Example	2	1	3
Viewpoint	4	2	6
Knowledge acquisition	15	6	21
Other	16	5	21
Sum	63	36	99

or “extremely helpful,” were annotated. Table 2 presents the labels and their definitions used in the annotation process. The labels were mainly prepared based on the existing studies [12][13][18] that discussed the credibility of web pages. For example, the label “Expertise” was annotated to the reasons in which the participants felt the author of the page has sufficient knowledge about the topic.

The labeling was performed on a per-web-page basis. Three annotators, one being an author of this study and two being recruits from the institution, annotated the responses collected in Sections 3.5 and 3.6. The annotators were asked to judge whether the label was appropriate to the response. Multiple labels could be given to one response. Furthermore, the annotation process was performed independently. If one of the annotators assigned a different label to the response, all three annotators will discuss as to what the appropriate label(s) will be. Furthermore, the “knowledge acquisition” label was excluded from analysis as it was considered natural for participants to find web pages that provided information they did not know of previously during their search.

Findings Table 3 presents the labeling results in the web page evaluation. It can be seen that in the homework task, viewpoint was evaluated the highest, followed by objectivity. Detail and double-sided presentation were also evaluated. Participants were then interviewed. When asked why they found that the double-sided presentation of the web page they viewed was helpful, one of the participants responded, “I feel that a person who writes both merits and demerits is considering various things.” (ID5) When asked why they found that objectivity of the web page they viewed was helpful, one of the participants responded, “I feel that information based on evidence, such as research, is more credible.” (ID3) These results indicate that in the homework task, web pages that contain information and opinions from multiple perspectives and those that contain evidence-based information such as experimental results, are more helpful. In the vaccine task,

Table 4. Types of opinion formation.

	Homework task	Vaccine task
Damage minimization type	2	0
Merit oriented type	0	3
Demerit oriented type	0	2
Credibility oriented type	2	0
Majority type	1	0
Single page type	1	0
Prior belief type	1	0

objectivity was evaluated by most of the participants, followed by detail. Since the topic of vaccines also involves health information, it is likely that the participants referred to web pages that provided evidence-based information, such as research results. When asked why they responded that the objectivity of the web page they viewed was helpful, one of the participants responded, “Media and articles are subjective, so I think that data from research is more reliable.” (ID7) These results indicate that in the vaccine task, many people refer to web pages that contain evidence-based information such as experimental results

4.2 Opinion Formation Analysis

This section describes the results of the analysis of how searchers formulate their opinions based on the information they obtain. The type of data that was used, the analysis method, and a detailed description of the analysis results are presented.

Approach To analyze opinion formation, the free-form responses and interview content obtained from the posttask questionnaires completed by participants were examined. Specifically, the reasons for participants’ opinion formation decisions based on the free-form responses and interview content were manually classified into various types through discussion among the research team. A single participant may have multiple types of opinion formation. For example, participant ID1 may present two types of opinion formation, such as “damage minimization” and “prior belief.” Table 4 lists the seven types of opinion formation.

Findings The analysis revealed seven types of opinion formation.

- Damage minimization
- Merit oriented
- Demerit oriented
- Credibility oriented
- Majority

- Single page
- Prior belief

These seven types are described in detail below.

Damage Minimization Type This type of opinion formation avoids negative consequence as much as possible. One of the participants responded in the posttask questionnaire:

“I thought that assigning too much homework was not good, but not assigning any homework at all would obstruct academic progress.” (ID3)

This type of participant seems to focus more on minimizing losses rather than maximizing gains.

Merit-Oriented Type This type of opinion formation considers the merits more than the demerits for a given topic. One of the participants responded in the posttask questionnaire:

“I determined that the symptoms of developing severe illness from getting infected with the novel coronavirus were more severe than any side effects from the novel coronavirus vaccine.” (ID9)

This type of participant seems to focus more on the greater advantages while perceiving the disadvantages.

Demerit-Oriented Type This type of opinion formation considers the demerits more than the merits for a given topic. One of the participants responded in the posttask questionnaire:

“I was afraid to vaccinate my own children against the novel coronavirus because of the unknown potential long-term side effects.” (ID7)

This type of participant seems to formulate opinions by judging that the disadvantages exceeded the advantages.

Credibility-Oriented Type This type of opinion formation refers to web pages with high credibility. Credibility is defined as “the degree of confidence in the intention of the sender to convey the most reasonable claims” [8]. One of the participants responded in the posttask questionnaire:

“Many websites expressing opposing views have distorted Professor Cooper’s research findings that ‘too much homework has many disadvantages’ and have claimed that homework should not be assigned.” (ID11)

This type of participant seems to focus more on the impartial information of a web page.

Majority Type This type of opinion formation prioritizes opinions advocated in the majority of viewed web pages. One of the participants responded in the posttask questionnaire:

“There are many articles that argue homework includes the intention of making study habits, and I agree with this view.” (ID10)

This type of participant seems to focus more on the information described in most web pages they viewed.

Single-Page Type This opinion formation type prioritizes information from the most reliable web page. One of the participants responded in the posttask questionnaire:

“The study by Professor Harris Cooper, who has conducted research on homework, described the many benefits of doing homework.” (ID11)

This type of participant seems to focus more on the most helpful web pages among those viewed.

Prior Belief Type This type of opinion formation prioritizes prior thoughts about the search task. One of the participants responded in the posttask questionnaire:

“Since I work as a cram school tutor part-time, I had a personal belief based on my experience that homework is necessary.” (ID5)

This type of participant seems to focus more on information in web pages that contain the same opinions as they did prior to conducting the search.

5 Discussion

This section discusses the reflections and implications of the insights obtained from the analysis in the previous section, followed by an examination of the limitations of the analyses conducted in this study.

5.1 Implications

From the web page analysis results evaluation in Section 4.1, it is concluded that information and opinions from multiple perspectives were evaluated in the homework task because the topic included various positions involved. The topic “Is homework necessary for elementary school students?” involves interests from various positions, including elementary school students, parents, school teachers, and cram schools. Therefore, it was assumed that information from various viewpoints, rather than just a minority of viewpoints, was evaluated. In the vaccine task, the topic “Should children be vaccinated against the novel coronavirus?” has a property that is closer to health information. Health information is directly related to human life; therefore, information based on solid evidence rather than individual opinions was considered helpful.

Based on the opinion formation analysis in Section 4.2, as the topics treated in this study involved both advantages and disadvantages, the opinion formation types that compared both views, such as damage minimization, merit-orientation, and demerit-orientation, were observed.

From the web page analysis evaluation in Section 4.1 and the opinion formation analysis in Section 4.2, it can be concluded that various opinion formation types exist, and presenting web pages that are relevant to each type can encourage cautious opinion formation by searchers. For example, credibility-oriented searchers tend not to rely heavily on web pages with low credibility. This suggests that if a web page that contains an opposing view has high credibility, the searcher is more likely to adopt that view. In other words, searchers may change their opinions significantly depending on the credibility of the web pages they browse. Therefore, by presenting more high-credibility web pages, searchers can be encouraged to form their own opinions by examining their both advantages and disadvantages. In summary, it is assumed that providing relevant web pages for each searcher type can promote careful opinion formation.

5.2 Limitations

This study has three limitations. First, the participants were recruited from the same information science department as the author; hence there may be bias in the selection. Hölscher et al. found that experienced searchers are better able to create complex queries and find relevant information compared to general searchers [11]. Therefore, it is possible that information science students are skilled searchers and may have obtained more relevant search results than general searchers. Moreover, it is assumed that more detailed data can be obtained by conducting user studies that consider the age of the searchers and their search expertise.

Second, the user study addressed only two topics: “Is homework necessary for elementary school students?” and “Should children receive the COVID-19 vaccine?” However, topics contain a variety of properties. For example, the topic “Should children receive the COVID-19 vaccine?” contains the nature of advantages and disadvantages as well as health information. Since topics have various properties, conducting a user study with an increased number of controversial topics, such as “Should students have to wear school uniforms?” and “Should euthanasia be legal?”, may enable the discovery of useful web pages and opinion formation patterns that were not obtained in this study.

Finally, the questionnaire and interview responses of participants are analyzed. However, analyzing the log data of participants’ search behavior may enable support from the perspective of search behavior. For example, if participants were not able to input diverse queries, recommending search queries may allow them to obtain more diverse information, thereby supporting opinion formation. Moreover, if participants had viewed many web pages that contain only one side of an argument, then presenting web pages that contain the opposing argument may enable support for exposure to diverse information. In the future, an analysis that focuses on the search behavior of participants will be conducted.

6 Conclusion

This study investigated the types of web pages people refer to regarding controversial topics and how these pages ultimately affect the formation of their own opinions. A user study was conducted involving 12 participants, with data collected from questionnaires and interviews. As for the web page evaluation analysis, the data of web page evaluations answered by the participants was labeled based on previous studies and as discussed among the authors. The labeling results showed that in the homework task, searchers reported that useful web pages included those that contained information and opinions from various perspectives and those that contained evidence-based information such as experimental results. In the vaccine task, many searchers also reported that useful web pages included those that contained evidence-based information, such as the results of an experiment. Furthermore, in the opinion formation analysis, the free descriptions of opinion formation reasons answered by the participants were manually classified into seven types: damage minimization, merit oriented, demerit oriented, credibility oriented, majority, single page, and prior belief. The findings of this study suggest that the usefulness of a search system, which presents easily referenced web pages by considering the opinion formation type of searchers, can be demonstrated when searching for controversial topics.

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