



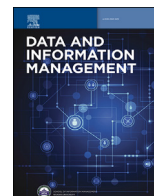
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What difficulties did the college students encountered in information seeking during the COVID-19 pandemic?

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ABSTRACT

To better promote information service and fight the infodemic, this paper investigated the difficulties that Chinese college students encountered in information seeking during the COVID-19 pandemic. We collected data in two stages. In the first stage in November 2020, we collected data from *the Foundation of Information Science* course. 54 college students who took the course completed an assignment to illustrate their information needs and difficulties during the pandemic. In the second stage in March 2021, through convenience sampling we conducted an online survey by WenJuanXing. The participants were required to answer the same question as the question in the first stage. We collected 204 valid responses. Then, based on the search task difficulty reason scheme proposed by Liu et al. (2015) (denoted LKC15), we used content analysis to code the responses to analyze the difficulties that Chinese students encountered. LKC15's difficulty reasons were classified from three aspects: user, task, and user-task interaction. The findings indicated that 14 of the 21 difficulty reasons in LKC15 were identified in this study. Moreover, we added 17 new Difficulty reasons to revise the scheme. The difficulty reasons of user-task interaction were mentioned most frequently. In terms of user-task interaction, the difficulty reasons related to document features were mentioned most frequently, followed by the search results. Finally, it provided some suggestions and discussed the directions for future study.

1. Introduction

From the beginning of 2020, the outbreak of COVID-19 pandemic caused great panic among the public. People keep great attention to the pandemic (Arpaci et al., 2020). Meanwhile, due to the rapid increase of information associated with the COVID-19 in a short period, the overwhelming information caused infodemic (Zarocostas, 2020). There were too much false or misleading information in both digital and physical environments during the pandemic. As reported by Islam et al. (2020), they collected 2311 COVID-19-related infodemic reports in 25 languages from 87 countries between December 31, 2019, and April 5, 2020. With the content analysis, they found that 89% of the reports were rumors, 7.8% were conspiracy theories, and 3.5% were stigma. Infodemic prevents people from obtaining authoritative and reliable information effectively, which might lead to people's risk-taking behaviors, mistrust

in health authorities, and undermined the public health response.¹ On 15 February 2020, Dr. Tedros Adhanom Ghebreyesus, the director-general of the WHO, mentioned at the Munich Security Conference that we were not just fighting an epidemic but also fighting the infodemic. Fake news was dangerous and spread even faster than viruses.²

To better fight the infodemic, insights into the difficulties people encountered in information seeking are significant. Moreover, the difficulty is one of the critical task attributes (Vakkari, 2003), affecting users' search behaviors, performances, and experiences (Li & Belkin, 2008). By exploring the difficulty and difficulty reasons in information seeking during the pandemic, information service providers could find better way to promote the information system design and assist users in coping with difficult problems more effectively, especially in the event of a public crisis.

However, the previous studies on health information seeking

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¹ World Health Organization. (2021). Infodemic. World Health Organization. Retrieved May 28, 2021, from <https://www.who.int/westernpacific/health-topics/infodemic>.

² World Health Organization. (2015, February 15). Munich Security Conference. Retrieved May 28, 2021, from <https://www.who.int/director-general/speeches/detail/munich-security-conference>.

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behavior have discussed more on the information needs (such as the type and amount of information that users sought) and the seeking behavior (such as the sources users used) (Lambert & Loiseau, 2007). Few studies have focused on the difficulties encountered in information seeking, especially in emergencies. In the field of interactive information retrieval (IIR), the difficulty of information search and task difficulty have attracted more attention of researchers (White & Iivonen, 2002; Kim, 2006; Liu et al., 2014, 2019). We draw on the work of Liu et al. (2015) to examine what difficulties college students perceived in information seeking during this pandemic. Although college students are not a typical vulnerable group, the pandemic has changed the traditional scope of vulnerable groups and made more people vulnerable because of the pandemic and the measures of pandemic prevention and control (Chang, 2020). The pandemic has brought many challenges to the lives of college students. Travel restrictions, home isolation, and online learning during COVID-19 pandemic have great impact on students' daily life (such as study arrangements, social communication, and internship hunting). Although college students received higher education, they usually lacked enough knowledge and skills to seek and evaluate health information available on the Internet to cope with various situations (Stellefson et al., 2011). Therefore, this paper investigated Chinese college students to identify their difficulties in information seeking during the COVID-19 pandemic, which can strengthen our understanding of the difficulties and provide suggestions for better finding solutions.

We draw on the work of Liu et al. (2015). They summarized three types of task difficulty reasons that spread across different aspects in information search, including task feature, user aspect, and the interaction between users and tasks. Information search behavior is narrower than information seeking behavior, which mainly refers to the micro-level of behavior employed by the searcher in interacting with information systems (Wilson, 2000). Information seeking behavior also includes individual's interactions with information sources that are not computer-based. Nevertheless, user, task and user-task interaction are basic components of information seeking procedure. Therefore, this paper addresses the following questions.

- What kind of difficulties related to task feature did college students encounter in information seeking during the COVID-19 pandemic?
- What kind of difficulties related to user aspect did college students encounter in information seeking during the COVID-19 pandemic?
- What kind of difficulties related to the user-task interaction did college students encounter in information seeking during the COVID-19 pandemic?

2. Related work

2.1. Research on difficulty in IIR

Some researchers discussed the difficulties from the perspectives of IIR. Bell and Ruthven (2004) pointed out that the perception of difficulty mainly included three aspects: the difficulty of understanding what information was needed, the difficulty of handling the search procedure, and the difficulty of judging the relevance of results. Similarly, White and Iivonen (2002) discovered the reasons for the difficulty of search tasks can be divided into three categories: question characteristics, human judgment, and the context. They conducted a questionnaire survey and summarized 13 difficulties. In addition, Moriyama et al. (2015) discovered when people tried to find information about the trend of data changes, they had difficulty in formulating professional queries to search in search engines, understanding the meaning of data in a table, and integrating information from different sources effectively. Further, Kim (2006) distinguished the pre-search difficulty and post-search difficulty. Liu and her colleagues have done much work on search task difficulty. In 2013, Liu and Kim (2013) summarized 21 difficulty reasons. Based on

that, they verified the reasons again in new task-based searching experiments in 2015 and identified major difficulties that the participants encountered (Liu, 2015). In 2019, Liu et al. proposed a concept of primary top difficulty reasons and further summed up eight major Difficulty reasons.

2.2. Research on difficulty in health information seeking

Some researchers discussed the difficulties from the perspectives of health information seeking. To deal with health-related problems and meet specific health needs, people seek health-related information (Weaver et al., 2010). Pang et al. (2016) pointed out that when people sought health information in search engines, the difficulties they perceived included that it was difficult for them to express their health status with appropriate search keywords, the search results were not optimized for medical query, and the search process did not consider the differences of individual literacy level and preference. Suarez-Almazor et al. (2001) evaluated online information on arthritis and found that many easily accessed sites were commercial advertisements to promote alternative therapies, however, the effect of which was questionable. It possibly harmed people's health and hindered people's access to scientific health information. Manafo and Wong (2012) used grounded theory to conduct in-depth interviews with the elders in the Toronto community. They found that information overload and the difficulty in understanding health information exacerbated the anxiety of the elderly, which also prevented them from further searching information. Zhao and Wu (2019) conducted semi-structured interviews with the elderly to understand their health information search behavior. They found that the elderly was confronted with individual factors and social support obstacles when searching for health information.

2.3. Research on difficulty in information seeking during the pandemic

Some researchers have discussed the difficulties in the previous pandemic. At the beginning of the H1N1 epidemic, Dickman et al. (2011) used the semi-structured interview method to investigate Frank international airport passengers and staff to and from Mexico. They found that uncertainty about the pandemic, contradictory messages from experts and media and confusing jargon were the problems the passengers and staff faced when receiving information. Majid and Rahmat (2013) asked the participants if they encountered any problems in seeking information during the H1N1 outbreak. A considerable number of the participants mentioned that too much duplicate information and emails providing H1N1 information were two main problems. Li et al. (2020) used questionnaires to investigate the information needs satisfaction of college students during COVID-19 and found that the information with low satisfaction was characterized by uncertainty, ambiguity, complexity, and difficulty in understanding. Dadaczynski et al. (2021) found that the greatest challenge that university students in Germany encountered during the COVID-19 were assessing the reliability of health-related information and judging commercial interest behind the information. Basch et al. (2020) used an online readability calculator to assess the readability of information on the Internet posted about COVID-19. They found that the readability of the website was much higher than recommended, which would be an obstacle for the public to understand the information. Ebrahim AH et al. (2020) found that the "spread of rumors" and "the massive information about the epidemic" were prominent obstacles for parents in Bahrain to seek COVID-19 related information.

3. Methodology

3.1. Difficulty coding scheme

To identify the difficulties students encountered, we used the search

task difficulty reason scheme proposed by LKC15. LKC15 conducted controlled laboratory experiments to develop a 21-item scheme. They recruited participants to complete assigned search tasks that were designed following a task classification scheme. They used questionnaires to collect participants' ratings on task difficulty and reasons. Based on the collected data, a 21-item scheme was proposed. Although the scheme was developed from information searching scenario rather than information seeking scenario, the meaning of information seeking is wider than information searching (Wilson, 2000). The 21-item scheme covered the basic aspects of task, user, and use-task interaction in human information interaction. Later, Liu and her colleagues further simplified the 21-item scheme to an 8-item top reason list (Liu et al., 2019). To identify more complete types of difficulties students encountered, we used the original 21-item scheme in LKC15 as a basic coding scheme. Then we used content analysis to code the participants' responses and added new difficulty reasons to revise the scheme.

3.2. Data collection

The critical incident technique (CIT) was used to collect data. The CIT reports the facts associated with a specific incident or behavior (Flanagan, 1954) and can offer insight into the vital factors under an incident (Bitner, Booms, & Mohr, 1994), like the pandemic.

We collected data in two stages. Firstly, we collected data in November 2020 from the *Foundation of Information Science* course. At that time, Chinese universities have just resumed offline teaching. We asked 54 students who took the course to recall their impressive experiences and submit a document to report their information needs during the COVID-19 pandemic and their difficulties as many details as possible. The 54 students were from 23 majors, including public administration, computer science, history, English, and information management. Among the students, 36 were freshmen, 16 were sophomores, and 2 were juniors. Among them, female and male students accounted for 62.96% and 37.04%, respectively. Based on their responses, 45 students reported their difficulties, while another 9 students said that they had no difficulties.

Secondly, we collected data in March 2021 by WenJuanXing, which is a popular free online survey platform. The questionnaire included two sections. The first section collected basic demographic information regarding gender, major, and grade. The second section asked the same question as the first stage. The participants reported impressive difficulties in information seeking during the COVID-19 pandemic. The convenience sampling was used by distributing the questionnaire in WeChat groups and via personal WeChat moments. A total of 204 valid questionnaires were collected, including 59 males and 145 females. The participants were from 72 universities, of which 42.16% were from Beijing Normal University. They were from five type of majors, including Science and Engineering (42.65%), Literature and History (27.45%), Social Sciences (21.08%), Comprehensive (5.88%), and Agriculture/Medicine (2.94%). Participants' grades included freshmen (9.80%), sophomores (24.51%), juniors (21.08%), seniors (18.63%), first-year postgraduates (5.39%), second-year postgraduates (5.39%) and third-year postgraduates (0.49%).

Based on the data we collected in two stages, content analysis was used to code the documents that the students have submitted in the first stage and the responses that the participants have submitted via the online survey. To identify the difficulty categories into which the participants' responses were to be placed referring LKC15, three of the authors were trained and coded a sample of responses from ten participants. Disagreements between them were discussed and resolved. Then the actual coding work started. In the actual coding procedure, the coders placed each difficulty reason mentioned by the participants into LKC15's scheme. If the coders found it tough to find an appropriate category, they added a new difficulty reason type. Finally, all the authors discussed the coding results and the new difficulty reason types and reached an agreement.

4. Findings

4.1. Task feature related difficulty reasons

Two types of task-related difficulty reasons in LKC15's scheme were mentioned in this study. But the difficulty reason of Complexity in LKC15 did not occur in this study.

The difficulty of "Time consuming" meant that users must cost much time and energy to seek information. Many students mentioned that they spent a lot of time filtering useful information from a large number of rumors and noise information.

- *During the pandemic, I would like to know when to start school, take the college entrance examination, the number of daily new infections, personal epidemic prevention requirements, etc. However, with too many rumors and different media reports, I felt anxious about too much information and had to waste much time browsing. (#111)*
- *Due to the multiple choices of the information sources and information providers, rumors and uncertain comments aggravate the difficulty to seek information, which cost a great deal of time. (#42)*

The difficulty of "Specific requirements" meant that the users' information needs were specific, not general. The students who wanted to find information about a certain street, community, and city might face the difficulty.

- *During the outbreak, my family and I were most concerned about the local data, including the number of confirmed cases, suspected cases, deaths, and the action path of the confirmed cases, which influenced our daily life directly. When I tried to know more details about the 100 confirmed cases at that time, I could only find some general provincial distribution of the data, without finding the details about them. Even though I tried to visit the official account of "Yidu Dibao", I still could not find the data I wanted. (#40)*
- *Early in the outbreak, the epidemic maps only showed the situation of each province but did not show the detailed regional status. (#44)*
- *I have tried to find out the latest situation of the epidemic situation in foreign cities. But in Chinese websites, the epidemic situation abroad is calculated by the country, not by the city. (#27)*

4.2. User aspect-related difficulty reasons

Five types of user-related difficulties were mentioned in this study. The difficulty of "Low topic knowledge" described that users were not familiar with the information needs or lacked some domain knowledge, which brought them the difficulty in understanding the seeking results, epidemic-related policies. The following were the cases who described their experiences:

- *It was difficult to find specific data on the epidemic in the community, for I was not familiar with the official names of local communities when the epidemic began. (#258)*
- *When seeking specific policies related to the college entrance examination, I found it challenging to understand the content of these policies because I had no idea about the background of policymaking. Finally, I sought help from teachers and staff in our school. (#53)*

The difficulty of "Little experience using systems/low system knowledge" meant the difficulty reason related to the lack of experience in information seeking. This was the case for #63, who described her experience:

- *When the epidemic situation in China is getting better and the international epidemic situation is intensifying, I want to know about the status of USA. Due to the lack of knowledge about foreign websites, I don't know how to*

find out the exact number of daily confirmed cases in the United States. (#63)

The difficulty of “Did not learn well in the search process” described that users did not think they have increased much new knowledge in the information seeking procedure. This was the case for #40, who described her experience:

- *I wanted to find the correct official website of the local hospital, but it seems no one maintains the website regularly. I have a question and find no information in the website could inspire me. Then I submit a question. However, no one answer my question. (#40)*

Two new Difficulty reasons were added. One was that users didn't have the permission to access the information source, even though they knew where to get it, during the pandemic.

- *I couldn't use the resources on the CNKI, for I was studying at home. My computer was unable to access to information resources of the education network. (#56)*

The second one was that users have no equipment to connect to the Internet. Some college students were high school students during the outbreak of the pandemic. At that time, some of them lived at communal dormitories at the campus to prepare for the important college entrance examination in summer. To help students concentrate on the learning, some high schools did not allow them to bring electronic devices like computer or cell phone to school. That was why they thought it not convenient to obtain information (#38).

4.2.1. User-task interaction related difficulty reasons

4.2.1.1. *Uncertainty with task before starting.* This study identified two kinds of uncertainties with task before starting, including uncertainty about information available, uncertainty/need to identify information need (decision making). The other two uncertainties (uncertainty about task requirements and unclear about the amount of information needed) were not found in this study.

The difficulty of “Uncertainty about information available” meant that users were not clear where to get the information. This difficulty was mentioned frequently in the early and middle stages of the pandemic.

- *Early in the outbreak, I wanted to know the number of confirmed cases, but I have no idea where to find them. (#163)*
- *Since February, I have tried to find information about the epidemic situation near my residential area and the specific geographical location of confirmed cases, but I don't know where could provide the information. (#194)*
- *In the beginning, there was a shortage of epidemic prevention supplies such as masks. We didn't know how to buy them. We couldn't buy masks at all. (#51)*

The difficulty of “uncertainty/need to identify information need (decision-making)” meant that users did not precisely know what information they wanted. The case for #83 described his experience that he felt aimless to look for the Covid-19 related information at the beginning of the outbreak.

4.2.1.2. *System selection.* The Difficulty in finding the right site/system to search in referred to the difficult reason that users were uncertain about choosing the appropriate search tool or system.

- *At that time, I was writing a course paper, and I needed to find the epidemic data of a certain state in the United States. I was unclear which search platform I should use. (#62)*

4.2.1.3. *Query formulation.* The difficulty of “Hard to formulate queries” meant that users felt it difficult to come up with appropriate search terms to formulate queries which could express their needs.

- *Early in the break, I couldn't come up with keywords to search pandemic related information. (#170)*
- *When I tried to obtain information about the epidemic situations, I really didn't know what words I should input in the input box. Then I asked others for help. (#135)*

4.2.1.4. Information system and search result features

4.2.1.4.1. *information system.* Based on LKC2015, we split the difficulty related to information system into two sub-categories. One was the “System function”, which meant that the difficulty caused by the lack of function design (such as information navigation) in the information system.

- *In December 2020, to complete the course work, we needed to search the policies introduced by various countries during the epidemic. Because of the different systems in different countries, the classification of policies was also different, and it was impossible to distinguish the targeted policies for enterprises, public institutions, and individuals. Finally, only the unclassified policies were found on the official website of various governments. (#186)*
- *The information in many websites was not classified, which made information search difficult and inefficient. However, these difficulties have not been solved effectively, and we have to rely on ourselves to filter information. (#16)*

The other one was “System performance”, which meant the performance features such as stability, safety, timeliness, and accuracy of response. The mismatching between information queries and search results led to low accuracy (#92) and revising the interactive interface without keeping the old version (#95) both brought users poor experience.

- *In the outbreak phase, to understand the development of the epidemic situation, I searched for "Wuhan epidemic situation, Wuhan city closure". The search results were messy. (#92)*
- *As the epidemic situation intensified, some websites, like hao123, provided the function of a real-time epidemic map. However, when the epidemic situation eased a few days later, I found that the link to the real-time epidemic map was not placed in the original location. I could not find the real-time epidemic map quickly and felt confused. (#95)*

4.2.1.4.2. *Search result features.* This study identified ten difficulties related to search result features, of which six were newly added. The difficulty of “Too much (unrelated) information & too many choices” meant that users felt it tough to choose from multiple search results. The number of the search results was too large and full of irrelevant information.

- *I found it difficult to get accurate information from people's comments and discussions. For example, there were many different points of view in the prevention of COVID-19. This made me at a loss. It was difficult to find reasonable protective measures to avoid infection. There was too much information about this topic, making it very difficult for me to find the information I needed. (#14)*

The difficulty of “Not enough information” meant that the number of search results was very limited.

- *At the beginning of the epidemic, there were no platforms to show the whole situation of the country. We can only track the epidemic situation by browsing different media. That hindered our understanding of the overall situation. (#4)*

The difficulty of “Not straightforward (exact) answer” meant that the search results did not provide users with a straightforward solution.

- *When verifying the credibility of some claims, such as the fact that Shuang Huang Lian oral liquid could prevent the COVID-19 virus, it wasn't easy to find a straightforward answer. (#60)*
- *Last April, when I was trying to find the number of newly confirmed COVID-19 cases locally, I found no statistical reports. Finally, I calculated the result manually. (#111)*

The difficulty of “Results not as expected” meant that search results differed from users’ expectations.

- *I often search for information about the outbreak in Singapore, but I can only find rough data, not what I want. (#117)*
- *While I was searching for information about the epidemic, many of the results were ads not what I expected. (#253)*

This study identified six new difficulties, including too many advertisements, too much duplicate information, inconsistent information, lagging information, not free, scattered information. The following were the cases who described their experiences:

- *When I tried to find information about the vaccine development process and national policies, the Internet was flooded with too many advertisements and useless information, which made me feel very inconvenient. (#14, too many advertisements)*
- *When I tried to find information about changes in the policies on the college entrance exam, the spread of the epidemic, and the prevention measures, we met lots of ads. (#15, too many advertisements)*
- *There are many duplicate news and messages on Weibo and news. (#16, too much duplicate information)*
- *When trying to get the latest news on the epidemic, I found that the news reports were almost the same. (#70, too much duplicate information)*
- *People returning from low-risk areas will be quarantined for 10 days, but other cities do not have such policy. I called the local CDC to ask about this, but their answers were inconsistent. (#184, inconsistent information)*
- *I once wanted to find the number of confirmed cases in the world, but I found that the statistics of different platforms were different. (#116, inconsistent information)*
- *I want to know the current situation of epidemic prevention and the distribution of high-risk groups around. But the information was not released in time, so I had to check it myself. (#42, lagging information)*
- *I needed to find out the development of the epidemic in my hometown, but news about the situation was somewhat lagging. (#126, lagging information)*
- *During the epidemic, I wanted to find paper on CNKI for free through the education network, but I could not do so because my school did not provide a remote extranet. I borrowed my classmate's account from another school to log in and found the paper. (#89, not free)*
- *At the beginning of the outbreak, there was no platform to show the overall situation of various places, and the information was scattered in different places. (#4, scattered information)*
- *When searching for internships during the epidemic, I found that these websites were overloaded and fragmented. That wasted too much of my time. (#110, scattered information)*

4.2.1.5. *Document features.* LKC15 proposed two difficulty reasons related to document features. One was that users felt difficult because they needed to read or comprehend information to find the specific pieces of information. No student mentioned this difficulty in this study.

The other one was that users felt difficult because they were uncertain or unsatisfied with the resource credibility or quality. Many of the students mentioned this difficulty. The pandemic broke out suddenly. In the early stage, the source of the virus, infection symptoms, transmission

routes, measures of detection and treatment were all unclear. People's lives were filled with views and opinions from different channels. The issue of information credibility and quality has become the main obstacles (#87, #72, #173, #10). At the same time, the shortage of supply chain materials caused by the outbreak of the pandemic also made people face misinformation when purchasing epidemic prevention materials, especially in the social media environment. #161 mentioned that at the beginning of the outbreak, she wanted to purchase N95 masks on online shop, but the regular sales platforms were in short supply. She tried to find some information about purchasing channels through WeChat moments, but she thought it was unreliable.

Therefore, we further classified the reasons for the difficulties in information credibility and quality, including the authority, authenticity, correctness, timeliness, clarity, vividness, and media diversity.

- *I wanted to find the infection data of front-line staff, but I could not find unified and authoritative data. The data provided by various places were inconsistent. (#98, authority)*
- *At the beginning of the epidemic, some people in the WeChat group always said that there were suspected cases in some village. At that time, it was difficult to judge whether it was true. (#278, authenticity)*
- *I paid attention to the changes of the time and policy of the college entrance examination affected by the epidemic situation. The difficulty encountered was that the information was too complicated, and sometimes there were some “gossips,” which made it impossible to determine the authenticity and credibility of the information. (#17, authenticity)*
- *After the epidemic started for a while, people were isolated at home. And it was reported on the Internet that someone was infected near my home. At that time, people were panicked and did not know whether the news was true or false. (#80, authenticity)*
- *I wanted to buy epidemic prevention materials through the Internet, but I didn't know whether the advertisement was correct. (#147, correctness)*
- *National policies and other information were constantly changing, and I felt it was hard to keep up with the speed of change. I have to listen to the news every morning to get the latest new information. (#14, timeliness)*
- *We went out on a trip and had to find the local protective measures. It turned out that many of the measures were ambiguous and not detailed. (#162, too vague)*
- *I was unsure about the quarantine policy when I came back home on holiday, and the official notices were ambiguous. I heard that someone was not allowed to go back to the district, but others said that they could come back home as usual from other towns. (#141, too vague)*
- *Early in the outbreak, I was eager to know the exact number of suspected cases and confirmed cases in different countries, provinces, and cities. I hoped to have an intuitive chart (It was best to use the color change to express the epidemic's severity). At that time, I could only find the epidemic data of China, but I could not find the data of foreign countries. The domestic data were presented in figures, lack of visual charts, and were too abstract. (#27, too abstract)*
- *During the epidemic, I couldn't get the paper version of the learning materials, so I had to read the electronic version, which brought more trouble to learning. (#32, media diversity)*
- *In March, I went to the library to look for Comprehensive History of Japan because I had to write a paper for Japanese history course. Since the library was closed, I couldn't borrow books and had to look for the book online. But I couldn't find the electronic version of the book through various means. (#118, media diversity)*

5. Discussions

5.1. The revised difficulty scheme

Based on the data collected in the two stages, we identified a total of 31 difficulties, which were all classified into one of the three aspects: user, task, and user-task interaction. Based on LKC15, we proposed a revised scheme in Table 1 to demonstrate what difficulties students have

encountered during the COVID-19 pandemic. Of the 31 difficulties, 14 were in original LKC15's scheme, and the other 17 were newly added.

As shown in Table 1, we kept the basic classification and all the reasons that were in the original scheme. We revised it from two aspects. On the one hand, new difficulty that we have discovered from the students' responses were added into LKC15's scheme. We added two and fifteen new difficulties in the user and interaction categories respectively. On the other hand, some categories were further refined. We split the category of "System performance and Search result features" into "System performance" and "Search result features" separately. We changed the name of System Performance to Information System. Under this category, we set up two subcategories including System Performance and System Function. In addition, we refined the Resource Credibility/Quality into eight subcategories.

As shown in Table 1, it compared the revised scheme with LKC15's scheme. The asterisk on the right of the difficulty indicated that it was a new category. The plus sign in the right two columns indicated that the difficulty was identified in this study or in LKC15.

Compared with LKC15, it was found that six difficulties in LKC15 were not identified in this study: Complexity, No interest, Uncertainty about task requirements, Uncertainty about the amount of information, Need to read/comprehend information (to find the specific pieces of information), and No specific reason. It does make sense that the differences are possibly caused by the research method. This study used CIT and open-ended question to collect participants' experiences. However, most previous work (Liu & Kim, 2013; Liu et al.,2015, 2019; White & livonen, 2002) conducted experiment studies by asking participants to complete assigned tasks, articulate or write down difficulties. Since the

tasks simulated in the experiment were not from the participants' real information needs, the participants might have no interest or be unclear with the information requirements.

Nevertheless, the revised difficult reason identified 14 new difficulties. In particularly, the difficulty of "Resource Credibility/Quality" was most widely subdivided. This might be related to two reasons. One was that the scope of information seeking was wider than information searching. LKC 15 was developed in IIR, while this study asked the participants to recall their experiences in information seeking. The other one was that the infodemic led to more diversity difficulties than usual. The difficulty of "Uncertainty about the authority of information source", "Uncertainty about the authority of information", "Uncertainty about the authenticity of information", "Uncertainty about the correctness of information", "Uncertainty about the latest version of the information" were all in line with the impacts of Infodemic (Pian et al., 2021). Moreover, epidemic prevention and control measures have also brought some special difficulties during the pandemic, such as the difficulty of "Lack of access to information", "No equipment to connect to the Internet", and "No paper version/electronic version".

5.1.1. The difficulties in information seeking during the pandemic

According to the coding results, we counted the frequency of each difficulty. Fig. 1 demonstrated the frequency distribution of difficulties. As shown in Fig. 1, the difficulties of user-task interaction were mentioned most frequently, far more than the frequency of task feature and user aspect.

In terms of task feature, the difficulty of "specific requirements" were mentioned most frequently. It is reasonable that physiological and

Table 1
Comparison between revised scheme and LKC15's scheme.

General category	Category label	This study	LKC15	
Task feature	Time limitation/time consuming	+	+	
	Complexity		+	
User aspect	Specific requirements	+	+	
	Low topic knowledge	+	+	
	Little experience using systems/low system knowledge	+	+	
	No interest		+	
	Did not learn well in the search process	+	+	
	Lack of access to information*	+		
	No equipment to connect to the Internet*	+		
User-task Interaction	Uncertainty with task before staling		+	
	Uncertainty about task requirements		+	
	Uncertainty/Need to identify information need (decision making)	+	+	
	Uncertainty about amount of information		+	
	Uncertainty about information available	+	+	
	System selection	Difficulty finding the right site/system to search in	+	+
	Query formulation	Hard to formulate queries	+	+
	Information system	System performance	+	+
		System function		
	Search result features	Too much (unrelated) information; too many choices	+	+
		Not enough information	+	+
		Not straightforward (exact) answer	+	+
		Results not as expected	+	+
		Too many advertisements*	+	
		Too much duplicate information*	+	
Inconsistent information*		+		
Lagging information*		+		
Not free*		+		
Scattered information*		+		
Document features	Need to read/comprehend information (to find the specific pieces of information)		+	
	Resource credibility/quality	Uncertainty about the authority of information source*	+	
		Uncertainty about the authority of information*	+	
		Uncertainty about the authenticity of information*	+	
		Uncertainty about the correctness of information*	+	
		Uncertainty about the latest version of the information*	+	
		Too vague*	+	
		Too abstract*	+	
No specific reason	No paper version/electronic version*	+		
	Does not fall in any of the above, did not state why		+	

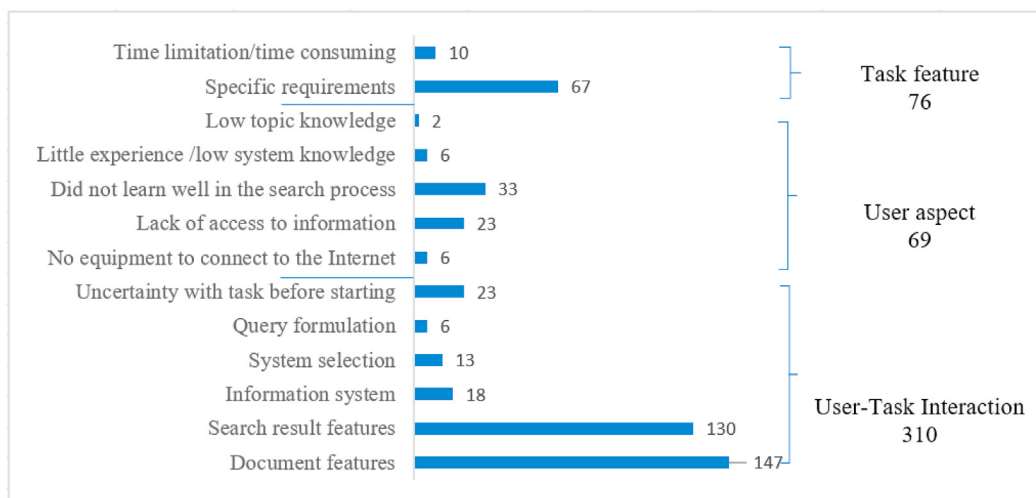


Fig. 1. Frequency distribution of difficulties.

safety were the basic needs of people (Maslow, 1943). The COVID-19 pandemic makes people feel a high risk of health and life. Therefore, people paid close attention to the pandemic related information such as infection symptoms, ways and features of infection, virus treatment and preventive methods, national and local pandemic data (Huang et al., 2021). In particularly, people are highly concerned their own residential community. Therefore, students desired to know about the pandemic information about specific towns, streets, communities, even the same building as theirs, which caused the difficulty of “specific requirements”. In addition, for the needs of course assignments, or for the places of work and study that they want to go, students’ information needs were specific. Early in the outbreak, the regional epidemic data report was not sufficient. Later, government departments (such as Health Commission), mass media (such as CCTV), and professional information portal (such as Tencent, DingXiangYuan) provided more complete pandemic information. At the same time, the launch of WeChat applet and App for real-time pandemic situation search based on map further meets people’s specific information needs.

In terms of user aspect, the difficulty of “Did not learn well in the search process” and “lack of access to information” were both mentioned more frequently than other reasons. It makes sense that duplicate information reduces the value of content that people have viewed. Inconsistent information increases people’s cognitive effort to increase their knowledge. Therefore, to increase knowledge in information seeking under the epidemic situation, it’s better to improve people’s knowledge and skills of seeking, evaluating and using information. Besides, due to the epidemic prevention and control measures, students also face challenges to get learning materials, especially which is only provided within local network. Similar findings could be seen in Yasmin et al. (2021). For people who work and study remotely, universities and enterprises need to provide more stable and secure VPN access to reduce the impact of remote mode on learning and work efficiency.

In terms of user-task interaction, the difficulties related to document features were mentioned most frequently, followed by the search results, which were quite different from the findings of previous studies in normal daily life (Kim, 2013; Liu et al., 2015, 2019). Nevertheless, our findings strengthened that the difficulty related to document features and search result features were popular among different population during the pandemic, similar with the findings of previous studies on students (Li et al., 2020), travelers (Dickman et al., 2011), parents (Ebrahim et al., 2020), and the general public (Majid & Rahmat, 2013). It does make sense that infodemic brought people great burden to filter information (Mohammed et al., 2021). Therefore, the difficulties related to the

reliability, quality, and quantity of information become more prominent during the pandemic.

6 Implications

To alleviate the difficulties of users in seeking information during the pandemic, many aspects could be strengthened to better serve the public.

Firstly, information literacy education for the public needs to be further strengthened. Information literacy is defined as the ability to effectively access and evaluate information for problem solving and decision making (Rader & Hannelore, 1991), which is a significant competence in identifying misinformation and helps the public to combat infodemic (Luengo-Oroz et al., 2020). Many libraries took actions to contribute to the information literacy training and education, such as the IFLA releasing “How to Spot Fake News-COVID-19 Edition” (the IFLA, 2020), Mike Caulfield’s “Sifting Through the Pandemic: Information Hygiene for the Covid-19 Infodemic” and so on (Caulfield, 2020). In USA, two librarians from University of Maine and Miami University designed a weeklong program on Facebook named the COVID-19 Misinformation Challenge, which aimed at teaching the public how to discern facts from social media, and the program was proved to be popular and educational (Bonnet & Sellers, 2020). Besides, libraries should strengthen the daily reader training, offering information literacy lectures and guidelines for the public (Naeem & Bhatti, 2020). In China, many academic libraries (Renmin University of China, Beijing Normal University, Fudan University, etc.) released video mini-courses on information literacy and how to find high-quality information resources through various platforms, such as WeChat, Zoom, Bilibili and so on (Guo & Huang, 2021). Furthermore, libraries should enhance the stability of network access and further expand the degree of openness to the public, which could benefit more people.

Secondly, information technology and information system should be further promoted. Infodemic has been defined as a global pandemic of rumors, fake news and conspiracy theories, and the human rumor-spreading behavior and the psychological problems of the public are the main characteristic of the infodemic (Pian, Chi, & Ma, 2021). Our findings also strengthened the features of infodemic. Therefore, infodemic requires higher performance and better functions for information system. Over 70% of the participants in Huang et al. (2021) expected that the information system could provide better function in searching for authoritative and reliable health information sources and searching for anti-rumors. Moreover, well-designed information classification can prevent users from getting lost in mass information (Morville &

Rosenfeld, 2006). Besides, classifying user behaviors and interests through log mining can provide more accurate information recommendation service (Ghavare & Ahire, 2018). The information system which offers user-friendliness, searchability, visualization and well-established interface design will better meet the need of users (Wu et al., 2021).

Third, the censorship and supervision of online speech need to be strengthened. It's necessary to strengthen the formulation of systems, norms, and regulations to copy with infodemic. The WHO Epidemiological Information Network has organized a two-day global online counselling session on 7 April 2020. 1483 people from 111 countries and territories attended the meeting to discuss the situation and recommendations on the infodemic. The proposals under discussion were summarized into 50 recommendations for action (Ebrahim et al., 2020). In China, the State Telecommunications Office also took stepped-up punishment measures for online information violations, organizing a clean-up of 6126 articles and shutting down 18,576 accounts between March and April 2020. Furthermore, to promote the timeliness of information release or to enhance communication and explanation with the public could suppress rumors. Timely response to demand and increase openness and transparency can stabilize the social order.

7. Conclusion

In summary, this study explored the difficulties that Chinese college students encountered in information seeking during the COVID-19 pandemic. We collected data in two stages. In the first stage in November 2020, we collected data from the *Foundation of Information Science* course. 54 college students who took the course completed an assignment to illustrate their information needs and difficulties during the pandemic. In the second stage in March 2021, through convenience sampling we conducted an online survey by WenJuanXing. The participants were required to answer the same question as the question in the first stage. We collected 204 valid responses. Then, based on the search task difficulty reason scheme proposed by LKC15, we used content analysis to code the responses to analyze the difficulties that Chinese students encountered. LKC15's difficulty reasons were classified from three aspects: user, task, and user-task interaction. The findings indicated that 14 of the 21 difficulty reasons in LKC15 were identified in this study. Moreover, we added 17 new Difficulty reasons to revise the scheme. The difficulty reasons of user-task interaction were mentioned most frequently. In terms of user-task interaction, the difficulty reasons related to document features were mentioned most frequently, followed by the search results. Finally, it provided some suggestions and discussed the directions for future study. These findings have further deepened our understanding of the difficulties in information seeking during the COVID-19 pandemic, which are helpful to promote the information systems and improve students' information literacy.

This study has some limitations. First, the sample size is small, and the findings need to be tested on a larger sample. Second, although our findings revised LKC15's scheme, we didn't discuss the relationship between information needs and difficulties. Future studies could examine the relationship between types of information needs and difficulties, the difficulty extent and impact factors of individual perceptions of difficulties to revise the difficulty scheme. Finally, although college students are not typical vulnerable group, the revised difficulty scheme provided a difficulty framework to study typical vulnerable group, such as the elderly, the teenagers, the disabled, and the low-income people.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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References

- Arpaci, I., Alshehabi, S., Al-Emran, M., Khasawneh, M., Mahariq, I., Abdeljawad, T., & Hassani, A. E. (2020). Analysis of twitter data using evolutionary clustering during the COVID-19 pandemic. *Computers, Materials & Continua*, 65(1), 193–204.
- Basch, C. H., Mohlman, J., Hillyer, G. C., & Garcia, P. (2020). Public health communication in time of crisis: Readability of on-line COVID-19 information. *Disaster Medicine and Public Health Preparedness*, 14(5), 635–637.
- Bell, D. J., & Ruthven, I. (2004, April). Searcher's assessments of task complexity for web searching. In *European conference on information retrieval* (pp. 57–71). Berlin, Heidelberg: Springer.
- Bitner, M. J., Booms, B. H., & Mohr, L. A. (1994). Critical service encounters: The employee's viewpoint. *Journal of Marketing*, 58(4), 95–106.
- Bonnet, J. L., & Sellers, S. (2020). The COVID-19 misinformation challenge: An asynchronous approach to information literacy. *Internet Reference Services Quarterly*, 24(1–2), 1–8.
- Caulfield, M. (2020). Sifting through the coronavirus pandemic. Retrieved from <https://infodemic.blog/>.
- Chang, J. (2020). Special protection of the human rights of the four vulnerable groups under the sudden major epidemic situation. *Journal of Human Rights*, 20(201), 5–12. CNKI: SUN: RQYJ.0.2020-01-00.
- Dadaczynski, K., Okan, O., Messer, M., Leung, A. Y., Rosário, R., Darlington, E., & Rathmann, K. (2021). Digital health literacy and web-based information-seeking behaviors of university students in Germany during the COVID-19 pandemic: Cross-sectional survey study. *Journal of Medical Internet Research*, 23(1), Article e24097.
- Dickmann, P., Rubin, G. J., Gaber, W., Wessely, S., Wicker, S., Serve, H., & Gottschalk, R. (2011). New influenza A/H1N1 ("swine flu"): Information needs of airport passengers and staff. *Influenza and other respiratory viruses*, 5(1), 39–46.
- Ebrahim, A. H., Saif, Z. Q., Buheji, M., AlBasri, N., Al-Husaini, F. A., & Jahrami, H. (2020). COVID-19 information-seeking behavior and anxiety symptoms among parents. *OSP Journal of Health Care and Medicine*, 1(1), 1–9.
- Flanagan, J. C. (1954). The critical incident technique. *Psychological Bulletin*, 51(4), 327.
- Ghavare, P., & Ahire, P. (2018, August). Big data classification of users navigation and behavior using Web server logs. In *2018 fourth international conference on computing communication control and automation (ICCCUBEA)* (pp. 1–6). IEEE.
- Guo, J., & Huang, J. (2021). Information literacy education during the pandemic: The cases of academic libraries in Chinese top universities. *The Journal of Academic Librarianship*, 47(4), Article 102363.
- Huang, K., Hao, X., Guo, M., Deng, J., & Li, L. (2021). A study of Chinese college students' COVID-19-related information needs and seeking behavior. *Aslib Journal of Information Management*, 73(5), 679–698.
- Islam, M. S., Sarkar, T., Khan, S. H., Kamal, A. H. M., Hasan, S. M., Kabir, A., ... Seale, H. (2020). COVID-19-related infodemic and its impact on public health: A global social media analysis. *The American Journal of Tropical Medicine and Hygiene*, 103(4), 1621.
- Kim, J. (2006, April). Task difficulty as a predictor and indicator of web searching interaction. In *CHI'06 extended abstracts on human factors in computing systems* (pp. 959–964).
- Lambert, S. D., & Loiselle, C. G. (2007). Health information-seeking behavior. *Qualitative Health Research*, 17(8), 1006–1019.
- Li, Y., & Belkin, N. J. (2008). A faceted approach to conceptualizing tasks in information seeking. *Information Processing & Management*, 44(6), 1822–1837.
- Liu, J. (2015). User assessment of search task difficulty: Relationships between reasons and ratings. *Library & Information Science Research*, 37(4), 329–337.
- Liu, J., & Kim, C. S. (2013). Why Do Users Perceive Search Tasks As Difficult? Exploring Difficulty in Different Task Types. *ACM*, 1–10.
- Liu, J., Kim, C., & Creel, C. (2015). Exploring search task difficulty reasons in different task types and user knowledge groups. *Information Processing & Management*, 51(3), 273–285.
- Liu, J., Li, Y., & Hastings, S. K. (2019). Simplified scheme of search task difficulty reasons. *Journal of the Association for Information Science and Technology*, 70(5), 526–529.
- Liu, C., Liu, J., & Belkin, N. J. (2014, November). Predicting search task difficulty at different search stages. In *Proceedings of the 23rd ACM international conference on information and knowledge management* (pp. 569–578).
- Li, Y., Zhang, J., & Bao, H. (2020). Information needs and satisfaction of college students in the context of public health emergencies. *Library and Information Service*, 64(22), 85.
- Luenigo-Oroz, M., Pham, K. H., Bullock, J., Kirkpatrick, R., Luccioni, A., Rubel, S., ... Mariano, B. (2020). Artificial intelligence cooperation to support the global response to COVID-19. *Nature Machine Intelligence*, 2(6), 295–297.
- Majid, S., & Rahmat, N. A. (2013). Information needs and seeking behavior during the H1N1 virus outbreak. *Journal of Information Science Theory and Practice*, 1(1), 42–53.
- Manafa, E., & Wong, S. (2012). Exploring older adults' health information seeking behaviors. *Journal of Nutrition Education and Behavior*, 44(1), 85–89.
- Maslow, A. H. (1943). A theory of human motivation. *Psychological Review*.

- Mohammed, M., Sha'aban, A., Jatau, A. I., Yunusa, I., Isa, A. M., Wada, A. S., ... Ibrahim, B. (2021). Assessment of COVID-19 information overload among the general public. *Journal of racial and ethnic health disparities*, 1–9.
- Moriyama, Y., Matsushita, M., & Takama, Y. (2015, November). Visual user interface to supporting information seeking behavior in context searching. In *2015 conference on technologies and applications of artificial intelligence (TAAI)* (pp. 77–82). IEEE.
- Morville, P., & Rosenfeld, L. (2006). *Information architecture for the world wide web: Designing large-scale web sites*. O'Reilly Media, Inc.
- Naeem, S. B., & Bhatti, R. (2020). The Covid-19 'infodemic': A new front for information professionals. *Health Information and Libraries Journal*, 37(3), 233–239.
- Pang, P. C. I., Verspoor, K., Pearce, J. M., & Chang, S. (2016, January). Finding and exploring health information with a slider-based user interface. In *HIC* (pp. 106–112).
- Pian, et al. (2021). *The causes, impacts and countermeasures of COVID-19 "infodemic": A systematic review using narrative synthesis*. IPM, 2021.
- Pian, W., Chi, J., & Ma, F. (2021). The causes, impacts and countermeasures of COVID-19 "Infodemic": A systematic review using narrative synthesis. *Information processing & management*, 58(6), 102713.
- Rader, H. B. (1991). Information literacy: A revolution in the library. *RQ*, 31(1), 25–30.
- Stellefson, M., Hanik, B., Chaney, B., Chaney, D., Tennant, B., & Chavarria, E. A. (2011). eHealth literacy among college students: a systematic review with implications for eHealth education. *Journal of Medical Internet Research*, 13(e102), 1–26.
- Suarez-Almazor, M. E., Kendall, C. J., & Dorgan, M. (2001). Surfing the net—information on the world wide web for persons with arthritis: Patient empowerment or patient deceit? *Journal of Rheumatology*, 28(1), 185–191.
- Vakkari, P. (2003). Task-based information searching. *Annual Review of Information Science and Technology*, 37(1), 370–396, 413–464. Vol.50.
- Weaver, J. B., III, Mays, D., Weaver, S. S., Hopkins, G. L., Eroğlu, D., & Bernhardt, J. M. (2010). Health information-seeking behaviors, health indicators, and health risks. *American Journal of Public Health*, 100(8), 1520–1525.
- White, M. D., & Iivonen, M. (2002). Assessing level of difficulty in web search questions. *The Library Quarterly*, 72(2), 205–233.
- Wilson, T. D. (2000). Human information behavior. *Informing Science*, 3(2), 49–56.
- Wu, D., Ma, L., & Zhang, H. (2021). *Evaluation of open health data portals for COVID-19 from the perspective of the user experience*. The Electronic Library.
- Yasmin, S., Ali, M. H., Rahman, S., & Salma, N. (2021). Preference and feasibility of online classes among Bangladeshi students during COVID-19. *Pandemic. International journal of ecological economics & statistics*, 42(1), 26–36.
- Zarocostas, J. (2020). How to fight an infodemic. *The Lancet*, 395(10225), 676.
- Zhao, D. (2019). Exploring older adults' health information seeking behavior: Evidence from urban China. *Proceedings of the Association for Information Science and Technology*, 56(1), 847–848.