ABSTRACT
Non-native English speakers (NNESs) often search in English due to the limited availability of information in their native language on the Web. Information seeking in a non-native language can present special challenges for users. Current research literature on non-native language search behavior is insufficient and even less is known about how online systems and tools may accommodate NNESs’ needs and assist their behaviors. To gain a better understanding of user behavior and the search process of NNESs, this paper presents a study of online searching in English as a foreign language (EFL) or second-language (L2). Particular attention is paid to language selection, search challenges, query formulation and reformulation, as well as user interaction with online systems and tools. Results from eight focus groups (36 participants) and 36 questionnaires indicate NNESs face a unique set of challenges that may not be present for native speakers when searching for information in English. A user interaction model is abstracted to address the iterative and spiral search process of NNESs. Implications for design of systems and tools to assist this particular user group are discussed.

Keywords
Information behavior, query formulation & reformulation, online search, non-native English speakers.

INTRODUCTION
A strong disparity exists between the language distribution of Web content and the representation of speakers of different languages among Web users. For example, while English content makes up 55.5% of all content on the Web (World Wide Web Technology Surveys [W3Techs], 2015), native English speakers make up only 28.6% of all Internet users (Internet World Stats [IWS], 2013). In contrast, Chinese first language speakers make up 23.2% of Web users (IWS, 2013), while Chinese language content accounts for only 2.8% of Web content (W3Techs, 2015). This disparity forces many NNESs to search in English to satisfy their information needs. Previous research has identified these users to be a large community (e.g. Kralisch & Mandl, 2006).

Current research is insufficient to fully understand the information behaviors and habits of NNESs when they conduct online searching in EFL or L2. Even less is known about their search strategies and interaction with systems and tools to accommodate their needs and assist their behaviors. The purpose of this research is to explore and further understand the user behavior of NNESs when they conduct online searching in English and, subsequently, to provide implications for the design of systems and tools to support them. Specifically, we aim to answer the following research questions:

• Q1: How do NNESs search for information in English (search behavior and user experience)?
• Q2: What are the typical challenges of NNESs?
• Q3: What user interaction model can be abstracted to describe the typical search processes and characteristics of NNESs?

Based on the nature of the research questions we aim to address, a qualitative study was conducted. Specifically, eight focus group discussion sessions involving 36 participants took place in two countries, Hungary and the US. Two groups of participants were selected, native Hungarian participants (in Hungary) and native Chinese participants (in the US). They are all typical NNESs with a tendency to search in English. However, they differ significantly in their motivation to search in English, their cultural backgrounds, and their exposure to and relationship with an English-speaking culture. This paper presents the results of the study and provides a better understanding of NNESs search challenges, processes, and strategies. User interaction models are abstracted and insights for design systems and tools to support NNESs are discussed.
RELATED WORK
Previous research and development activities in the area of multilingual search usually focused on two areas: information seeking behavior and information retrieval (IR) techniques.

Information Seeking Behavior
This area of research focused on the study of multilingual Web users. Researchers were interested in understanding the reasons for utilizing multiple languages to search and the patterns of such search behaviors. The following three themes were found to be central to this avenue of research:

Content Availability
Content available in many languages other than English is limited and of perceived low quality (Kralisch & Mandl, 2006; Aula & Kellar, 2009). Many searchers with sufficient English language skills search for information in English to supplement their findings in other languages. Berendt and Kralisch (2009) even argued that the underrepresentation of non-English languages is further strengthened by users’ tendency to accept information in English.

Language Proficiency
While polyglots would use any language to search in as long as they possessed sufficient proficiency in it (Steichen, Ghorab, O’Connor, Lawless, & Wade, 2014), searchers’ varying levels of language proficiency were found to impact their language selection and usage, search tools usage, search performance and preference (Berendt & Kralisch, 2009; Marlow, Clough, Recuero, & Artiles, 2008).

Other Contextual Factors
A series of contextual factors were also identified, analyzed, and proven to make a difference for multilingual searchers’ language selection and usage. To name a few, domain of knowledge (Berendt & Kralisch, 2009; Clough & Eleta, 2010), domain of search topics (Steichen, Ghorab, O’Connor, Lawless, & Wade, 2014), and usage purpose (Steichen, Ghorab, O’Connor, Lawless, & Wade, 2014) individually or collectively had impacts on non-native speakers’ search behavior.

These studies shed light on searching in non-native languages. However, they usually focused on language selection and factors impacting it, or the impact of a narrow set of factors on behavior. Our study instead takes a more holistic and qualitative approach to better understand user behavior.

IR Techniques
IR research involving searching for and retrieving information in multiple languages was often noted as “multilingual information access and retrieval” (e.g. Peters et al., 2005). Three overlapping terms were commonly used in this research area: Cross-language Information Retrieval (CLIR), Multilingual Information Retrieval (MLIR), and Multilingual Information Access (MLIA). During the interaction with search engines, CLIR was, to simplify, entering queries in one language and retrieving relevant information in another (e.g. Grefenstette, 1998; Peters, 2001; Nie, 2010). MLIR was a broader term and embraced the concept of CLIR, because it dealt with “managing information access and discovery in multiple languages both monolingually and across languages” (Peters, Braschler, & Clough, 2012, p.5). MLIA was usually used in the broadest sense and addressed the problem of “accessing, querying, and retrieving information from collections in any language at any level of specificity” (Peters, Braschler, & Clough, 2012, p.5).

These three areas of research focused on enabling technologies such as tools and interfaces to support query formulation, translation, results merging, summarization, and presentation (e.g. Gao et al., 2007; Amato, Cigarrán, Gonzalo, Peters, & Savino, 2007). Though fruitful, this group of research was focused on backend translation and retrieval technologies and less attention was paid to user interaction issues of these systems and tools. More recently, researchers started to address these issues. For example, Steichen & Freund (2015) discussed user preferences in the interfaces presenting multilingual search results. However, studies on NNESs search process, as a whole, and user experience (UX), user preference, and user satisfaction issues during it, are still less common.

A gap between the above-mentioned two groups of research exists. Our study bridges the gap between user studies of search behaviors and system development by closely coupling and linking the two. A better understanding of NNESs search behaviors, processes, and strategies provides guidelines for the design of systems and tools to assist such users.

METHODOLOGY
Due to the nature of our research questions, seeking to explore phenomena, qualitative research methods were utilized, specifically, semi-structured focus groups and structured questionnaires with open-ended questions. This section introduces the research design, methods, participant recruitment, study procedure, and data analysis methods.

Research Design and Methods
Qualitative research, focus groups specifically (Denzin & Lincoln, 2005), was carried out in a semi-structured way. Four or five participants and one or two investigators engaged in a discussion. The investigators developed and used a discussion guide, which contained a list of open-ended questions and topics to be covered during the conversation, in a particular order. The discussion followed the guide, but was able to follow topical trajectories in the conversation that might have strayed from the guide, if appropriate. New, usually follow-up and clarification, questions were added when necessary. Open-ended questions allowed participants to respond in their own words, rather than forcing them to pick from fixed
In each focus group discussion session, four or five participants were invited to a user studies laboratory and after giving their informed consent, they were asked to take part in the discussion, which took approximately one hour and was video and audio recorded. At the end of the discussion, the participants were given the questionnaires. After completing the questionnaires, they were given an opportunity to ask questions and make comments. They were then paid and dismissed.

The native language (Hungarian or Chinese) of the researchers was the same as that of the participants and the focus groups were conducted in the native language of the participants. This ensured more openness and better rapport between the participants and the researchers, as well as provided more accurate cultural interpretation of the data during analysis.

**Data Analysis**

Three forms of qualitative data were collected, voice recordings of focus groups, detailed investigator notes, and answers to the open-ended questions on the questionnaires. Thus, the first step of the data analysis was to transcribe the voice recordings in either Hungarian or Chinese.

Subsequently, the coding process was executed in Hungarian or Chinese, as well. Researchers who were native Chinese or Hungarian speakers carried out this analysis. The investigator notes were first coded to identify preliminary concepts of interest. Then, the transcripts were coded through an inductive and iterative qualitative data analysis process. In the initial open coding phase, concepts describing language selection, search strategies, query formulation, challenges, and ideas for system support were identified. Next, axial coding took place to group the concepts and create relationships between themes. The method of constant comparison was used as new transcripts were added and the more recently emerging concepts and categories were compared to those previously identified (Corbin & Strauss, 2008; Merriam, 2009). This analysis process was carried out in iterations. The resulting themes were then translated into English along with representative quotes for each concept and category. The themes identified from both the Hungarian data set and the Chinese data set were compared and discussed and the results were presented as unified themes, although differences were noted.

**RESULTS**

In this section, we describe participant demographics, as well as the resulting themes identified from the analysis. Results from the two sets of data (Hungarian and Chinese) are compared and discussed.

**Demographics**

*Chinese Data Set*

Four focus groups were conducted with four participants in

<table>
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<tr>
<th>Focus group, discussion guide</th>
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<tr>
<td>1. What topics do you search for in your native language and in English? Why?</td>
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<tr>
<td>2. What search engines or websites do you use in the case of searching and browsing in English?</td>
</tr>
<tr>
<td>3. How are your searching and browsing different in English and in your native language?</td>
</tr>
<tr>
<td>4. What problems do you find during searching and browsing in English?</td>
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<tr>
<td>5. How can search engines and websites help searching and browsing in English?</td>
</tr>
<tr>
<td>6. What advice can you give to other Chinese/Hungarian students who have recently started searching for information in English (e.g. incoming first year university students)?</td>
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<table>
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<tr>
<th>Focus group, a follow-up question example</th>
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<tbody>
<tr>
<td>1. How do you come up with your search expressions while searching in English? Why?</td>
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<tr>
<th>Questionnaire, open-ended questions</th>
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<tbody>
<tr>
<td>1. Please list at least three topics for which you search in your native language.</td>
</tr>
<tr>
<td>2. Please list at least three topics for which you search in English.</td>
</tr>
<tr>
<td>3. What are the problems or difficulties arise from searching in English?</td>
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</table>

Table 1. Sample questions in questionnaires and focus groups.

responses, as quantitative methods do (Mack, Woodsong, MacQueen, Guest, & Namey, 2005). The questions concerned search topics in all languages, strategies, query formulation, tools, and challenges (see Table 1 for sample questions).

Structured questionnaires were used in this study to gather demographic information about participants, such as age, gender, and levels of education. However, open-ended questions were also included to gather qualitative data and triangulate the data collected through focus groups (see Table 1 for some sample questions).

**Participant Recruitment and Study Procedure**

Two groups of NNESs were selected, native Hungarian participants (in Hungary) and native Chinese participants (in the US). Both groups comprised college and university students. They are all typical NNESs with a demand to search in English. However, they differ significantly in their cultural backgrounds and their exposure to and relationship with an English-speaking culture.

The participants were selected based on two criteria. First, they all spoke English at a conversational level. Second, they all regularly searched in English both to support their studies and their non-academic interests. These two criteria qualified them for the purposes of this study. A total of 36 participants were recruited (20 Hungarian participants and 16 Chinese participants) to complete eight focus group discussion sessions (four in each country).
each in the US. All participants in this pool were born in China and were native speakers of Chinese (93.8% of whom spoke Mandarin and 6.2%, Cantonese). In self-report questionnaires, they all indicated they spent most of their lives in China (over 18 years) and came to the US to pursue higher education, mostly graduate studies (over 90% of the participants already earned a BA/BS in China). Most, 93.8% specifically, have not lived in countries other than China and the US.

The average age of our participants was 29.6 years (age range: 21 - 35 years, SD = 3.6; see Table 2). The average duration of stay in the US was 4.3 years (stay range: 3 months - 8 years, SD = 2.3). Of our sixteen participants, seven were female and nine were male (56.3% male participants).

All participants reported that they spoke English well enough to have a reasonable conversation with a local person in the US (since this was one of the study requirements). About one third, 31.2% specifically, of participants stated that they learnt English as a foreign language during childhood and spoke it almost at native level. Most indicated they often used English in information search on the Web. Other than English, they did not speak or use another non-native language.

**Hungarian Data Set**

For this participant pool, four focus groups were conducted with five participants each. All participants were born in Hungary and were native speakers of Hungarian. Similar to the Chinese participants, they spent most of their lives in their native country. However, they had a lower average age (22.3 years) and age variation (age range: 20 - 24 years, SD = 1.3; see Table 2) as they were mostly undergraduate students and recent graduates. They reported lower average level of education completed (55% BA/BS, 45% high school).

They indicated, however, more diversity in their languages and countries of stay. All participants reported that they spoke English at a conversational level. Ten percent of them stated they spoke it almost at native level. Some indicated they spoke other languages at a conversational level (35% participants indicated they spoke German at a conversational level; 30%, French; 10%, Spanish; and 5%, Russian). Forty percent of the participants stayed in countries other than their native country (from one month to fourteen months). The countries were: the US, Austria, Switzerland, Mexico, Spain, Canada, Germany, and Bulgaria.

### Search Behavior and UX (Q1)

The first research question pays particular attention to how NNESs search. Thus, this subsection presents results about the search behavior and process.

**UX: Lack of Confidence, Stress, and Attention**

The vast majority of both Chinese and Hungarian participants indicated that searching in English as a non-native language was not as convenient as it was in their native language. This was consistent with the findings of previous research that indicated challenges existed in non-native language searching (Chu, Jozsa, Komlodi, & Hercegfi, 2012). Participants often described strain on their attention and an increased cognitive load. They also associated feelings of uncertainty and stress with English language searching: “I didn’t like searching in English for a long time. I know that I understand the content in English but it bothered me. Especially when I search for an unknown topic… it makes me unsure…”.

**Language Selection: Cultural Interpretation of Topics**

A series of factors were identified impacting multilingual searchers' language selection and usage: content availability in a specific language (Kralisch & Mandl, 2006; Aula & Kellar, 2009), language proficiency (Berendt & Kralisch, 2009; Marlow, Clough, Recuero, & Artiles, 2008), domain of knowledge (Berendt & Kralisch, 2009; Clough & Eleta, 2010), domain of search topics (Steichen, Ghorab, O'Connor, Lawless, & Wade, 2014), and usage purpose (Steichen, Ghorab, O'Connor, Lawless, & Wade, 2014).

Previous research usually isolated the factors impacting language selection. This was appropriate for some scenarios, for example, searching for content that existed only in a specific language. We encountered similar scenarios in our data. For instance, a participant mentioned that he had to search in Chinese for particular content, the blog posts and reviews of a Chinese news critic, which was only available in Chinese.

In addition to the simple impact of topic on language selection, we also found a culturally-mediated effect of the search topic. Our participants would choose the language of the search not just depending on the topic and the availability of the information, but also influenced by how they expected the topic to be represented in different cultures.

Chinese participants indicated a preference for searching in Chinese when they sought emotional support from the groups in which they were members, whereas they chose English to search for scientifically-based facts. When participants were selecting a language to search in, cultural affinity made a significant difference. For instance, when a

<table>
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<tr>
<th>Basic Demographics</th>
<th>Chinese</th>
<th>Hungarian</th>
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<tbody>
<tr>
<td>Ave. Age</td>
<td>29.6</td>
<td>22.3</td>
</tr>
<tr>
<td>SD Age</td>
<td>3.6</td>
<td>1.3</td>
</tr>
<tr>
<td>Male</td>
<td>9</td>
<td>7</td>
</tr>
<tr>
<td>Female</td>
<td>7</td>
<td>13</td>
</tr>
</tbody>
</table>

**Table 2. Participant demographics.**
participant was pregnant and looked for discussions on symptoms of pregnancy and feelings, baby care topics, and prenatal symptoms, she indicated a preference for using Chinese in these searches because she believed the feelings of expectant mothers with the same cultural background were more relevant and easier to accept. On the other hand, she searched in English for treatment options, medications, and side effects as she said "these topics in English seem more scientific".

Another example where the searchers’ cultural ties influenced language selection was political events. Chinese participants usually searched in Chinese for news about local political events that occurred in China. However, they also searched in English for the news of the same event to gain access to western voices and observe a different point of view on the events.

Language Selection: Same Topic – Different Approach
We found that multiple factors interacted to influence language selection in other scenarios as well. For example, two major factors, topic and type of information (general introduction vs. specific questions), usually worked in concert. English was mentioned by most participants as the language used to search for academic materials. However, both Chinese and Hungarian were also used by the participants to search for academic topics. Why did they use different languages to search for the same topic? Because they searched for different types of content in the two languages. When searching in their native language, participants noted, they wanted an overview: "I just wanted to take a look at the academic topic, general discussion, issues, research questions to gain some general understanding, because I read Chinese a lot faster". In English, they look for information on more specific topics: “I am trying to gain a deeper understanding and looking for references and papers for citation ... these papers and materials were more directly related to my own research”. Recall that, in the example in the previous sub-section about the cultural factor, the participant was also searching in both languages for the same topic but for different content (emotional feelings in native language and scientific description in English). Thus, a combination of the topic and the type of information influenced searchers’ language selection.

Language Selection: Patterns of Mixed Language Use
Though searching solely in one language was not rare (such as English for music or movies, international news, and information for travel in an English speaking country), alternating languages in searching was mentioned by most participants, in both the Hungarian and the Chinese data sets. Participants in our research combined searching in their native language and English as it suited their needs. Searches in the two languages were complementary and often supported the searchers’ interpretation of the information found in the other language. The patterns of language use fell into three categories:

1. Switching from the native language to English
Participants often mentioned two reasons for such a switch: They did not plan to search in English, but failed to find enough content in their native language; or they intended to search in English from the beginning, but they started to search in their native language to get an overview of the topic. Similar quotes could be found in both the data sets.

2. Switching from English to the native language
After searching in English, participants sometimes switched back to their native language to double-check their interpretation of information: “If we’ve found something in English maybe afterwards we search for it in Hungarian as well.” “I found information in English on Wikipedia, but the content is too much ... I sometimes look back at Chinese articles in order to have an overview.”

3. Intertwined languages
Recall that the results in the previous sub-section showed some factors together made a difference in language selection. For example, topic and type of information went hand in hand and impacted language selection together, especially in the case of academic searches (searching in native language to get an overview and general information and search for a deeper understanding in English). Another example could be that they searched for computer parts (in Chinese for specifications and reviews and in English for prices and buying options). As such, queries in the native language and English often followed and complemented one another.

Challenges (Q2)
We will next describe our findings organized around various steps of the search process. We will present challenges and typical behavior intermixed as they emerge around various search process steps.

Challenge 1: Query Formulation
Query formulation was one of the first steps in the search process. It was indicated by most participants to be the most challenging job they faced while searching in English. We believed this was a common challenge for all NNESSs. They faced this challenge because finding the appropriate keywords to search on was very difficult in a non-native language.

Some Chinese participants stated "sometimes I had trouble expressing myself accurately in English." Others confirmed this and indicated it was especially difficult when it came to “certain specialized or academic terms” and “common established expressions” in English. One mentioned a strategy to deal with this issue, "the result might not be accurate if I used sentences instead of keywords when searching for information (in English) and I usually started with simple keywords."

Similar concerns were found in the Hungarian data. They tended to use only a few words in English as query terms,
whereas in Hungarian they were more likely to use longer phrases and even sentences. They reported using fewer words and simpler expressions for searching in English, as these were easier to create than longer, more complex queries. “In English, we’d rather use keywords. If I enter a whole sentence I may make grammatical or other mistakes so I prefer entering an important keyword and I hope I will find what I seek. In Hungarian, I have a greater chance to find specifically what I am thinking of.”

**Challenge 2: Query Reformulation**

Similar to query formulation, our participants struggled with reformulating queries. It was especially difficult for them to pick an appropriate synonym of the original term. As one of our Hungarian participants mentioned, “there are a wide variety of Hungarian expressions for different meanings which are supposed to exist in English as well but we don’t know them.”

NNESs faced this challenge due to the lack of specific vocabulary and an unawareness or insecurity about slight variations in meaning. Under such circumstances, translation tools, such as dictionaries or online translation, did not help much. For example, a Hungarian participant stated “Google Translate shows 2-3 expressions but I can’t decide which one is the best or most commonly used.” To address this problem, Hungarian participants reported testing synonyms, querying similar expressions one after another to better understand differences in their meanings.

**Challenge 3: Viewing and Skimming Search Engine Result Pages (SERPs) and Websites**

Our study confirmed the results from previous studies (e.g. Chu, Jozsa, Komlodi, & Hercegfi, 2012) that it took longer time to find results in a non-native language. Query formulation and reformulation took longer and so did viewing results. When it came to viewing and skimming SERPs and websites, our participants indicated that they read content in their native language faster than they do in English. For example, a Chinese participant stated, ”I read English content word by word, but I read Chinese content one paragraph at a time.” The same situation was described by the Hungarian participants, “It takes so much time… I have to open several pages (on a SERP) to find what I really need.”

Skimming a resulting website was even harder since it usually contained more textual content than a SERP did. As discussed above, our participants often described facing overwhelmingly large result sets of varying levels of relevance. Not surprisingly, it usually took them longer and they found it more difficult to process text in English, a non-native language. Three typical types of behavior were identified to deal with this issue in both datasets:

- Using the vertical search tools of search engines (e.g. using “Images” to get visual results which indirectly led them to textual information)
- Skimming text rather than reading the content of websites line by line (using "Ctrl+F" keyboard shortcut to easily locate keywords so that it was not necessary to read the full text of a webpage)
- Choosing one specific website and continuing to search inside to avoid facing the information overload of the result sets

NNESs faced these three types of typical challenges when conducting online search in English. The challenges intertwined during each step of the search process and made the entire process further complicated.

**DISCUSSION**

The analysis of the study findings sheds light on user challenges, experiences, and behaviors. In this section we summarize our key findings, provide further insights, and discuss implications.

**Dilemma of High Recall vs. High Precision (Q3)**

The competing forces of recall and precision in information retrieval are always difficult to balance. Looking at these two extremes of information retrieval performance, the analysis of user challenge and experience indicated that a dilemma existed during non-native English search as well. The dilemma offered the following two possibilities:

- High recall: Formulating a short and general query is simpler, but it generates a large amount of results with lower overall relevance, and hence, requires the user to process more information in a non-native language, thus creating a more difficult challenge in the second half of the process: reading SERPs and websites.
- High precision: Formulating a long and specific query generates a smaller, but more relevant result set, and requires searchers to process less information in a non-native language. This requires users to create more complex and appropriate queries.

This issue is faced by native English speakers as well. However, NNESs' English language proficiency adds another dimension of complexity to the problem. Our focus in this paper is on the first scenario, formulating a short and general query, because this behavior was usually identified and described by our participants during the creation of queries.

**Query Formulation and Reformulation: Two Strategies (Q3)**

To address the challenges associated with query formulation, our participants used two different strategies. The two strategies are: 1) the translation strategy, and 2) the discovery strategy. By adapting and modifying Broder's classic model for IR (Broder, 2002), we present the two strategies in Figures 1 and 2.
Translation Strategy
Due to their relatively low English language proficiency level, English learners usually have difficulties finding keywords and forming proper and idiomatic English queries or expressions. The translation strategy is thus especially helpful to NNESs whose English language proficiency is less fluent or who are new to English searching.

Digital dictionaries and online translation tools or websites are recommended when facing this issue. While in CLIR systems translation is done automatically, users manually translated queries in our study. Some participants stated they either were not aware of such CLIR systems or did not trust the automatic translation. Figure 1 is the user interaction model for this strategy (the modification to the original Broder’s classic model for IR is highlighted).

Discovery Strategy
The second strategy is carried out solely in English. When searchers are not familiar with proper or idiomatic English expressions, they usually start with simple keywords and search. Subsequently, while browsing the SERP, they identify better English expressions for the query. Thus, they reformulate the original query by using the search expression identified through browsing the results and searching iteratively. In other words, a gradual, progressive, and spiral query formulation strategy is utilized (see Figure 2) during which searchers learn about the English vocabulary used in a domain. One of the Hungarian participants suggested: “Start your search with fewer keywords. Then, during the search, you can view and browse the results to modify and refine your original term. This will get more accurate results.”
User Interaction Model: A Model of Iterative Learning and Reformulation (Q3)

The behaviors described in Figures 1 and 2 did not appear in isolation. They were usually used iteratively and in combination within the same search session by the same searcher. Figure 3 provides a user interaction model for the NNESs search process, which was an iterative and spiral process. In each iteration, NNESs utilized either a translation strategy (see left panel in Figure 3) or a discovery strategy (see right panel in Figure 3) to formulate and reformulate their queries and then by reading and learning from the results encountered, they gained a better understanding of the information they were searching for. Each iteration built on the results of the previous and provided even further understanding. While this was typical in information seeking in general, the process of learning the vocabulary of the domain in a non-native language was emphasized in this process. The focus of the search task remained the same, searchers used the process to learn the language of the domain they were searching about and to enhance their queries through this new knowledge. The difference between the NNESs and the monolingual search process lay in the fact that users were not just learning about the topic of their information need, but also learning the way English is used in that topical area. The whole search process terminated when NNESs satisfied their information need or quit the search task.

Implications for Design

Query Formulation and Reformulation
The challenges identified in query formulation and reformulation called for solutions to assist NNESs in shaping reliable and effective queries. Automatic query translation might fail when multiple synonyms with slight variations of meaning are applied. New tools for helping NNESs formulate queries are necessary.

Result Presentation
Our participants described using alternate languages when viewing results. The complementary interaction of the two languages showed that, though not playing the same role, each language contributed something unique to the users’ understanding of an information problem. Search engines allow for this integrated interaction to a certain extent, but better integration of results in multiple languages can be helpful.

Interface Personalization
The results of this study indicated various user preferences of NNESs. The user preferences, in turn, urge variant personalization and customization. They may be provided on query formulation and reformulation (e.g. query translation and recommendation system), result presentation across languages (e.g. a personalized interface showing and linking results in different languages), and tools and features on SERPs (e.g. a customizable vertical search tool bar).

CONCLUSION AND FUTURE WORK
The disparity between the language distribution of Web content and the representation of speakers of different languages among Web users exists and forces many NNESs to search in English to satisfy their information needs due to the lack or low quality of content in their native languages. The prevalent use of the Internet for information access means that knowing how to search in English has become an important element of information literacy globally. Current research is insufficient to fully understand the information behaviors and habits of NNESs when they conduct online searching in EFL or L2. Even less is known about their search strategies and interaction with systems and tools to accommodate their needs and assist their behaviors.

Searchers usually combine their native language and English while searching. They face language-based challenges both in the query formulation/reformulation and the results viewing phases. Searchers used both translation and discovery/learning methods to formulate queries. They also combined information sources in both languages when reading results and learning about the topic of the search. New system and interface solutions are needed to support these behaviors.

For future work, we intend to further our current study in two ways. First, we will increase our participant pool both vertically and horizontally, by inviting more participants to the current participant pool and incorporating participants who speak other languages. The diversified data will not only increase triangulation, but we also expect will identify new themes. Second, based on the findings of the current study, one or more prototype interfaces will be designed, developed, and evaluated. This evaluation will provide information about the utility of the proposed solutions, as well as further inform the model for information seeking behavior of NNESs.

English proficiency was one of the criteria while we recruited our participants. It was recorded and identified from merely self-reported data. It can be argued that English proficiency varies in different aspects (e.g. reading and writing) and settings (e.g. conversational settings and academic settings). In future research, we will address these issues by utilizing a controlled English proficiency measure (e.g. a language test score). Another limitation of this paper is the lack of data to identify and separate the extent to which NNESs face challenges due to language difficulties or due to unfamiliar domain knowledge and cognitive issues (the latter may also be faced by native English searchers). Thus, attention in future work will also be paid to the differentiation of language difficulties from others, such as knowledge domain and cognitive issues.
REFERENCES


