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Reorienting information searching research by applying a situated abilities perspective

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Abstract

Introduction. In studies of information searching, people are often characterised with perpetual physical, sensory and cognitive abilities. Situational factors that may affect human abilities are less considered, although they may have an impact on information searching behaviour. For example, a person with dyslexia may struggle with inputting correctly spelled queries. Spelling skills, however, may also be influenced by fatigue, illness, or using a mobile phone while walking. All types of users can therefore at certain times experience challenges related to query input.

Method. This theoretical paper explores the concept of situated abilities in the context of information searching. Eight personas are constructed and used in a discussion of how a change of perspective on human abilities can provide a valuable contribution to research.

Analysis. The personas are based upon empirical findings of user behaviour and are discussed in relation to theoretical frameworks and models.

Results. Human abilities are dynamic and affected by a variety of situational factors. All people experience temporary impairments during their lives. It would therefore be purposeful to reorient information searching research by applying a situated abilities perspective.

Conclusion. A situated abilities perspective may result in more inclusive search systems for all types of users.

Introduction

For decades, researchers and system developers within information science in general and interactive information in particular have debated questions such as: How do people search for information? How to support users during information searching? and how can system support facilitate information searching? (Bates, 1999; Petras, 2023). Within the field of interactive information retrieval, one goal has been to understand the interaction between people and search systems (Ruthven, 2008). Searching involves user actions such as query input, result list assessment and information extraction. These activities require many and complex cognitive skills, such as the ability to identify proper search terms, input and spell query terms correctly, read through results and documents, and decide how to use the acquired information (Sitbon et al., 2014). Some of these activities also involve physical actions, such as operating a mouse and keyboard or using a touch screen.

According to Borlund (2000), potential users as test persons comprise one of three basic components in experimental settings within interactive information retrieval. The application of dynamic and individual information needs, and multidimensional and dynamic relevance judgments constitute the two others. This paper will focus on the first component, namely the user. According to Ruthven (2008, p. 48),

> *All research fields have stereotypes, idealized views of the aims and role of the activities within the field that are used to focus its intellectual debates and research agendas. Interactive information retrieval is no exception.*

In the field of interactive information retrieval, it has been relatively common to consider motor, sensory and cognitive abilities as perpetual. For example, some user studies look specifically at very limited user groups, such as people who are blind, deaf or intellectually disabled (Berget and Macfarlane, 2020). These user groups are often studied isolated from other users or compared with a control group of able-bodied or 'mainstream users' (Berget and Macfarlane, 2020; Hill, 2013). The same approach to users can be found in all types of studies of systems for human use (Wobbrock et al., 2018). The outcome of such research is knowledge about the *average user* and the people who deviate significantly from that norm. Less attention has been directed towards users in between, who sometimes experience challenges due to temporary impairments or are affected by situational factors (Wobbrock et al., 2018).

Participant inclusion criteria are often a result of a rigorous research design where the researcher aims to isolate specific user characteristics, such as spelling skills, sight or reasoning abilities. In such studies, certain abilities are regarded as binary, in other words as being present or not. Consequently, some people are categorised as disabled compared to a mainstream norm. An example is to study how spelling skills affect information searching, using people with dyslexia as participants. However, spelling skills are not binary, but comprise a spectrum of skill levels. Spelling skills can also be temporary (e.g., due to being ill or stressed) or affected by situational factors (e.g., having cold fingers or walking while inputting a query on a smart phone).

This theoretical paper discusses whether a capabilities approach focusing on situated abilities can be applied to re-orient user studies on information searching. Situated abilities is based upon the premise that all people experience functional variations during their lives, due to situational or contextual factors or personal characteristics (Wobbrock et al., 2018). The overall purpose is to explore whether a new user perspective might potentially result in more inclusive search systems because such a perspective will include all types of users.

The research questions are as follows:

> RQ_1: *How can the concept of situated abilities contribute with a new user perspective in research on information searching?*

RQ$_2$: How can knowledge of situated abilities contribute to more supportive search systems for a broader diversity of users?

Information searching comprises many phases which are too comprehensive to address in one paper. Consequently, the scope is limited to the first four phases in the information-seeking framework by Marchionini and White (2007, p. 207), namely recognising, accepting, formulating and expressing information needs. The two first phases are included because it has been suggested that the level of system support or accessibility of a search system may affect whether people decide to accept an information need and initiate information searching (Kvikne and Berget, 2022 ; Marchionini and White, 2007). Moreover, formulating and expressing information needs require cognitive skills, such as writing and naming skills (Sitbon et al., 2014). Empirical studies have shown that impairments in such skills can significantly affect information searching behaviour (see Berget and Macfarlane, 2020 for a review of this research) Consequently, formulating and expressing information needs may provide a purposeful starting point for discussions of situated abilities in an information searching context.

While *information needs* comprise a complex concept that may be defined in many ways (Naumer and Fisher, 2015), the following definition will be applied here: '*an information need arises from a recognized anomaly in the user's state of knowledge concerning some topic or situation*' (Belkin et al., 1982, p. 62). Scholarly debates regarding topics such as the nature of information needs and how they arise, to name a few, are outside the scope of this paper. In this paper the focus is upon the actual process of expressing information needs with words and inputting them as queries into search systems.

The paper is structured as follows: The theoretical framework starts by briefly addressing the paradigm shift from system-oriented to user-oriented research within information science. This change of perspective comprises the foundation for several theories and models addressing user behaviour that many empirical studies build on today. This is followed by a clarification of key concepts, such as different views on what a disability is and alternative user perspectives, such as universal design and situated abilities. (The latter is the concept that will be explored further in this paper in the discussion of RQ$_1$.) This is followed by a section on system support, which is an important foundation affecting the usability of a system. Finally, some research on the impact of impairments on query formulation and input is presented. (These topics comprise a starting point for RQ$_2$, which addresses the need for inclusive search systems.) The background is followed by a short methodology chapter introducing eight personas whose situated abilities are affected by different factors. Both permanent and temporary impairments are represented by the personas. The personas are then applied as examples in the discussion of the research questions before a conclusion is provided.

Theoretical framework

From systems to users

The origin of *modern study of human information seeking behaviour* is often attributed to the Royal Scientific Conference in 1948 (Wilson, 2000, p. 50). From this period until early in the 1970s, researchers were concerned with system use rather than user behaviour. In the 1970s, however, researchers started addressing issues such as information needs. In the 1980s there was a distinct shift towards a more frequent use of qualitative methods and a *person-centred approach* (Wilson, 2000, p. 51). In this period, several models and theories of user behaviour was developed, and many of them are still applied today, such as the work by Nicholas Belkin, Marcia J. Bates, David Ellis, Carol C. Kuhlthau and Thomas Wilson (Fisher et al., 2005; Wilson, 2000), to name a few. This change of perspective was a starting point for studies of more cognitive aspects of information searching, which later also included accessibility studies (Berget and Macfarlane, 2020; Hill, 2013).

The transition to a user-centred perspective led to, among others, the development of interactive information retrieval, which addresses issues such as how individual differences can impact interaction with information systems (Ruthven, 2008). Other topics of interest are, for example, how various stages of information searching demands different types of assistance and that search contexts may affect the requirements for interactive support. According to Ruthven (2008, p. 44), '*interactive information retrieval covers research related to studying and assisting these diverse end users of information access and retrieval systems*'. Consequently, this area of research is well-suited to incorporate many different types of users and abilities.

The concept *disability*

There are many examples of empirical studies addressing disabilities in different contexts within library and information science (Hill, 2013), information seeking and searching (Berget and Macfarlane, 2020). A premise for such studies, however, is some kind of consensus regarding what a disability is and which types of users that should be defined as disabled. Disability as a concept has been viewed differently over the years, from a medical view addressing *what's wrong with a person* via the social model stating that disability is solely constructed by society to the Gap Model (Shakespeare, 2004, 2013). The latter is also referred to as the Nordic relational approach. In both the social model and the gap model, there is a distinction between having an impairment and being disabled. While the first concept is related to the person, the latter is created by society.

In the Gap Model (see Figure 1), which is one of the dominant models today (Shakespeare, 2004), disability is something that occurs when there is a gap between a person's abilities and the design of the environment. In the context of search engines, such a gap would, for example, occur when a system requires correctly spelled queries, and a user with dyslexia frequently make spelling errors. That specific situation creates a disability because the user is not able to utilise the system (Berget and Sandnes, 2015). According to the Gap Model, the number of situations where disability occurs can be reduced by improving the environment and/or strengthening the individual. In other words, by developing search systems with a higher tolerance for spelling errors, there are fewer situations where a person with dyslexia will experience shortcomings during information searching (Berget and Sandnes, 2016).

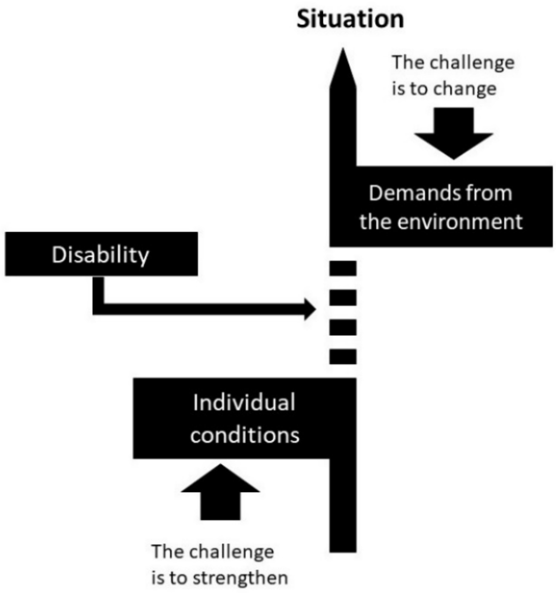

Figure 1. The Gap-model, translated and reproduced from (Sosialdepartementet, 2003)

It has been argued that by addressing what people can do rather than what they cannot do provides the most purposeful starting point for designing inclusive systems for all types of users. For example, according to Wobbrock et al. (2018, p. 62), '*By focusing on users' abilities rather than disabilities, designers can create interactive systems better matched to those abilities*'. In studies of people with disabilities, however, most attention has been directed towards barriers for specific user groups, addressing limitations rather than skills and potential (Berget and Macfarlane, 2020).

There are many approaches to ability-based design. Some of these concepts are overlapping, e.g., universal design, universal usability, design for all, and inclusive design. Common for many of these perspectives is the goal to design products, services and environments that are accessible and usable for as many people as possible without the need for adaptation or specialised design (Steinfeld and Maisel, 2012). Universal design is based on the premise that it is impossible to design for *average people* due to wide-ranging human diversity. Instead, the comprehensive variations in human characteristics must be acknowledged and considered during the whole design process (Steinfeld and Maisel, 2012).

From *disabilities to situated abilities*

Wobbrock et al. (2011, p. 1) point out that some of the concepts applied in the research addressing functional variations cause problems in themselves, for instance the term *disability*:

> *By its very name, a dis-ability is not so much a thing as the lack of a thing, namely the lack of ability. Taking this perspective, a person with a disability is un-able to perform certain everyday tasks, and requires assistance to compensate for his or her limitation.*

Further, Wobbrock et al. (2011) emphasise that abilities vary across a range, are not static and are influenced by context. Based on this reasoning, it makes more sense to address what people can do, and how systems can be designed to accommodate users' abilities, rather than addressing what people cannot do.

Another relevant concept discussed by Wobbrock et al. (2018) is *situational impairments*, entailing that changing contexts, environments or situations can cause different barriers. Consequently, researchers must address disabling situations. The challenge according to Wobbrock et al. (2018, p. 66) is that '*our interactive computing systems know little about their users' abilities, attention, situations, contexts, and environments*'. Examples of situational factors are divided attention, distraction, occupied hands, multitasking, stress, haste and fatigue (Wobbrock et al., 2018). For example, sleep has been reported to be detrimental for human cognitive function. Little sleep and the quality of sleep will affect memory and inferential thinking (Deak and Stickgold, 2010), attention (García et al., 2021), and reading fluency (Torres et al., 2021). In this perspective a lack of abilities is no longer limited to a few people regarded as disabled but can apply to all people. Based on such arguments, the concept of situated abilities is put forward by Wobbrock et al. (2018, p. 64):

> *ability-based design pursues an ambitious vision— that anyone, anywhere, at any time can interact with systems that are ideally suited to their situated abilities, and that the systems do the work to achieve this fit.*

Saplacan (2020, p. 264) has conceptualized situated abilities further, suggesting the following definition: '*Situated ability is the ability to comprehend, manage, or find the meaning in the interaction with a digital system*'. Situated abilities have been applied in some studies, for instance on digital learning environments (Saplacan, 2020) and intelligent systems (Saplacan et al., 2020), but does not seem to have been discussed in the context of information searching or search system development.

System support

Both the field of interactive information retrieval and the related research area human computer interaction (HCI) study the interaction between users and systems. While the first often addresses effectiveness of search systems, the latter has had a focus on usability (Ruthven, 2008). Within HCI, participatory design is particularly relevant in context of users, because the overall goal within this tradition is to engage users when designing technology. Participatory design is rooted in political, social and civil rights movements in the 1960s and 70s and was pioneered in Scandinavia (Robertson and Simonsen, 2013). A predominant attitude has been that technology is not just something we live with, but something we use (Bannon, 2011; Bødker, 2006). The basis is *'an unshakable commitment to ensuring that those who will use information technologies play a critical role in their design'* (Robertson & Simonsen, 2013, p. 2).

According to Wobbrock et al. (2018, p. 65):

> *When users' abilities fail to match the ability assumptions underlying today's interactive computing systems, the burden usually falls on the users to make themselves amenable to those systems, and the systems remain oblivious to the users doing it.*

One way of solving this issue is through system support. According to Ruthven (2008), there is a pool of empirical studies that clearly shows the need for support in searching. To offer sufficient and purposeful user support, however, there is a need for extensive user knowledge about diversity of diversity and contexts (Ruthven, 2008; Wobbrock et al., 2018; Wobbrock et al., 2011).

Bates (1990) discussed levels of system involvement using capabilities as a starting point, asking: *'What capabilities should we design for the system to do, and what capabilities should we enable the searcher to exercise?'*. Bates (1990) presented four levels of system involvement (see Figure 2), from level 0 (no system involvement) to 4b (the system executes automatically and does not inform the searcher). Through the lens of situated abilities, level 3b is particularly relevant, suggesting monitoring search processes and recommending search activities when a need is identified.

Level		Definition
0		**No system involvement**. All search activities human generated and executed.
1		**Displays possible activities**. System lists search activities when asked. Said activities may or may not also be executable by system (higher levels).
2		**Executes activities on command**. System executes specific actions at human command.
3		**Monitors search and recommends**. System monitors search process and recommends search activities:
	a	Only when searcher asks for suggestions.
	b	Always when it identifies a need.
4		**Executes automatically**. System executes actions automatically and then:
	a	Informs the searcher.
	b	Does not inform the searcher.

Figure 2. The levels of system involvement suggested by Bates (1990, p. 577), reprinted with permission

The division of labour between the searcher and system was also addressed by Marchionini and White (2007). In the *information-seeking framework* (see Figure 3), the main activities during search are displayed in boxes of different shapes, defined by the human time and effort required (height) and current system research and development (width).

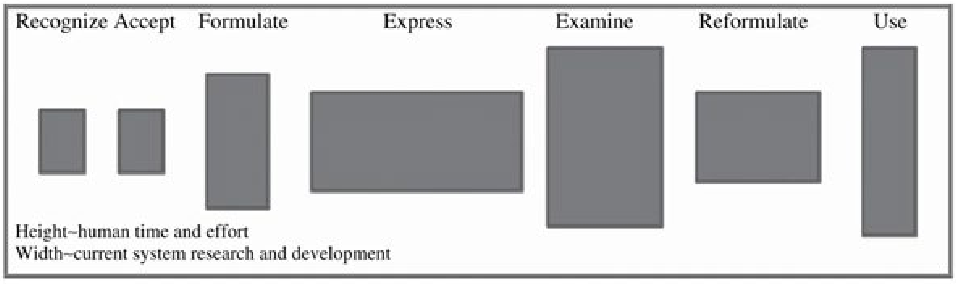

Figure 3. The information-seeking framework by Marchionini and White (2007, p. 207), reprinted with permission

When the framework was developed by Marchionini and White (2007), the systems were most supportive during expression and reformulation of queries, followed by some system support for examination of results. Based on many search systems today, this may still be the case, represented by autocomplete functions, related searches and a relatively high tolerance for spelling errors. These support functions, however, are quite well developed in general search systems such as Google, while bibliographic databases and library catalogues often do not offer the same level of system support (Berget and Sandnes, 2015). For example, one study showed that many people with dyslexia did not manage to search library catalogues and had to rely on Google due to the high demands for correct spelling in the library catalogue (Berget and Sandnes, 2016). Although these studies were conducted some years ago, library catalogues still seem to be less supportive during query input compared to general web search engines.

In the framework by Marchionini and White (2007), an important premise for information searching is recognising and accepting the information need, activities in which there is no system support. Time constraints and the actual design and functionality of the search systems seem important in the acceptance phase. According to Marchionini and White (2007, pp. 208-209): '*Easy to use and effective search systems also help people gain confidence to accept more information problems*'. The level of system support encountered during searching may therefore influence whether users decide to pursue information needs or not (Kvikne and Berget, 2022).

Previous research has reported that some people have additional difficulties in expressing information needs due to reduced vocabulary or impaired naming skills, also referred to as name-finding difficulties. These skills can be permanent, for instance among people with aphasia (van de Sandt-Koenderman, 2011), dementia (Ivanova et al., 2013) or intellectual disability (Berget, 2020). The ability to express oneself properly, however, can also be affected by temporary situational factors. Some examples are people lacking proper technical terms or learning a new language (Bogaards, 2001), are sleep deprived (Huang et al., 2016), depressed (Good and Sambhanthan, 2014), or because of long Covid (Cummings, 2022).

Situated abilities and query input

The actual interaction with a search system typically starts with query-input. Users in general have been reported to produce spelling errors in a high portion of queries (Berget and Sandnes, 2016 ; Cucerzan and Brill, 2004). Query input can therefore be challenging for all types of people in systems with low tolerance for spelling errors but may be especially troublesome for people with learning differences or writing impairments (Berget and Sandnes, 2016). Some search systems offer autocomplete functions which may relieve the user of having to input the whole query. Nevertheless, research has showed that many people with dyslexia do not utilise this function, due to an intense focus on the keyboard during query input (Berget & Sandnes, 2016). In other cases, people may be reluctant to use query-building aids due to incorrect search paths (White and Marchionini, 2007).

For certain users, technical solutions and interfaces have an especially high impact on information searching. Andronico et al. (2006) concluded that people without vision are more affected by interface design than sighted users, among others, due to lacking interaction between search systems and screen readers. The lack of accessible design has been reported to affect information searching behaviour. For instance, Sahib et al. (2012) reported that blind people submitted more long-complex queries compared to sighted users, to get the most relevant results presented first for easy access through assistive technology. Moreover, query-support was rarely utilised because screen-readers could not access the drop-down list. It was also difficult to identify misspelled query terms through speech synthesis for words with similar sounds. Finally, related searches were rarely used due to shortcomings in the interface (Sahib et al., 2012). While assistive technology has been primarily associated with disabilities, much of this technology is now being deployed by all types of users (Stramondo, 2019), e.g., speech recognition, screen readers and eye tracking.

Method

This theoretical paper applies personas as method. Personas are fictional people, with constructed names, ages and gender identities in addition to various other characteristics. Personas are commonly applied within human-centred design, such as participatory design (Chang et al., 2008; Grudin and Pruitt, 2002). According to Friess (2012), personas can help researchers in keeping relevant user characteristics and needs at the forefront due to the focus on individuals. Moreover, the use of personas can improve the understanding of how software products should be designed because this approach allows the researchers and product developers to get a better understanding of the users (Acuña et al., 2012).

In this paper, the personas are applied theoretically, as specific examples of situated abilities in the discussion of the two research questions rather than as a starting point for the development of search systems. The personas will be used to show how very different users can experience similar challenges, but caused by different factors, e.g., having a permanent impairment or experiencing a situational impairment. They will also be applied to explore whether attending to all these diverse disabling situations in research can result in more inclusive search systems.

Persona	Situational factors affecting abilities	Impact on information searching
Name: Katie **Age**: 75 years 	Has aphasia due to a stroke when she was 65 years old. Does not own a computer.	Katie has difficulties recalling the words required to express an information need due to impaired naming skills. She also has challenges inputting a query due to reduced reading and writing skills caused by her aphasia diagnosis (van de Sandt-Koenderman, 2011; Kvikne &and Berget, 2022)
Name: John **Age**: 53 years 	Diagnosed with dyslexia as a young adult. Uses speech recognition to minimise textual input.	Tom has reduced ability to spell search terms properly due to his dyslexia, causing erroneous queries. He also often selects the wrong autocomplete suggestion due to reading errors (Berget and Sandnes, 2016).
Name: Lisa **Age**: 19 years 	Born with Down syndrome. She has some vocabulary, but it is quite limited. Lisa also has unclear pronunciation.	Lisa has restricted access to the Web (Berget, 2020). Due to a limited vocabulary and impaired writing and reading skills, many search systems are inaccessible (Sitbon et al., 2014). Speech recognition is not an option because of her unclear pronunciation (Rocha et al., 2017).
Name: Isak **Age**: 15 years 	Became blind as a small child. Relies on assistive technology such as braille display and speech synthesis.	Isak frequently experiences compatibility issues between search systems and assistive technology, which reduce the utility of help functions such as query suggestions and related searches (Sahib et al., 2012). The speech synthesis does not always make it clear that query terms are misspelled. Sometimes, queries are erroneous because Isak is not aware of content from his previous query still remaining in the search box (Xie et al., 2018).
Name: Ali **Age**: 49 years 	Works as a mechanic. Single dad with two young children. Sleep deprived due to long working hours and children who wake early. Applies speech recognition at work due to greasy hands.	Sometimes, fatigue and lack of sleep affect Ali's cognitive skills, e.g., memory, inferential thinking (Deak and Stickgold, 2010), attention (García et al., 2021), and reading fluency (Torres et al., 2021). Therefore, Ali sometimes struggles with recalling proper terms and inputting them correctly in search systems.
Name: Pam **Age**: 33 years 	Non-native speaker in her first year of learning a new language. Speaks with a strong accent.	Pam has a limited vocabulary due to learning a new language (Bogaards, 2001) which may cause challenges expressing information needs in her second language until required language skills are developed. Spelling errors also occur frequently. Speech recognition does not work due to Pam's strong accent (Vase and Berget, 2023).
Name: Ann **Age**: 42 years 	Has experienced anxiety and depression for some months after losing her twin sister in a car accident.	Ann's cognitive functions, e.g., learning, memory, verbal ability and attention are affected by anxiety and depression. These characteristics have been reported to affect information searching (Good and Sambhanthan, 2014). Ann's mental state of health also affects her spelling skills (Bonifacci et al., 2008).
Name: Tom **Age**: 27 years 	Cancer patient, relying on strong pain-relieving medication and has insomnia due to pain.	Tom's use of pain-relieving medication affects his cognitive function (Strassels, 2008), such as impairments in memory and retrieval processes and difficulties remembering things he has read (Kamboj et al., 2005). Moreover, inferential thinking and reading fluency are affected by lack of sleep (Torres et al., 2021).

Table 1. Personas representing different situational abilities which may impact information searching behaviour

A total of eight personas were constructed (see Table 1). The personas represent users who for different reasons may encounter concurrent challenges when expressing information needs or formulating and inputting queries. Four personas represent permanent conditions, namely aphasia, dyslexia, Down syndrome and blindness (*Katie*, *John*, *Lisa* and *Isak*). The other four personas experience temporary impairments, e.g., due to sleep deprivation, being a non-native speaker, anxiety and illness (*Ali*, *Pam*, *Ann*, *Tom*). The conditions and contexts were selected based upon previous research on the effect of impairments on information searching (see Berget and Macfarlane, 2020) and the work on situated impairments by Wobbrock et al. (2011) and Wobbrock et al. (2018).

Results and discussion

In this study, two questions were raised: *How can the concept of situated abilities contribute with a new user perspective in research on information searching*? and RQ_2: *How can knowledge of situated abilities contribute to more supportive search systems for a broader diversity of users*? These questions will be discussed in this section based upon theory and the personas presented above.

Situated abilities and information searching research

The first question regards how situated abilities can contribute with a new user perspective in research on information searching. In other words, can this perspective inspire to novel research questions or result in new knowledge about users and their information searching behaviour which can develop the research field forward?

If researchers apply the situated abilities perspective as presented by Wobbrock et al. (2018) as a starting point, research on information searching should target as many user types, contexts, and situational factors as possible. The overall purpose should be to create interactive systems that better match the abilities of all types of people (Wobbrock et al., 2011; Wobbrock et al., 2018). In previous studies addressing information searching, the object of study has typically either been *average users*, or more narrowly defined groups, e.g., people with a specific permanent functional variation, such as being blind, deaf or having dyslexia (Berget and Macfarlane, 2020; Berget and Kvikne, 2022). In practice, however, humans comprise a whole spectrum of characteristics that are dynamic in nature and influenced by situational factors. These characteristics may affect information searching in various ways in different contexts. If the purpose is to understand how for example spelling skills affect information searching, it may be useful to study a whole range of users, including different situational impairments, rather than only selecting participants from *the edges* (see Figure 4).

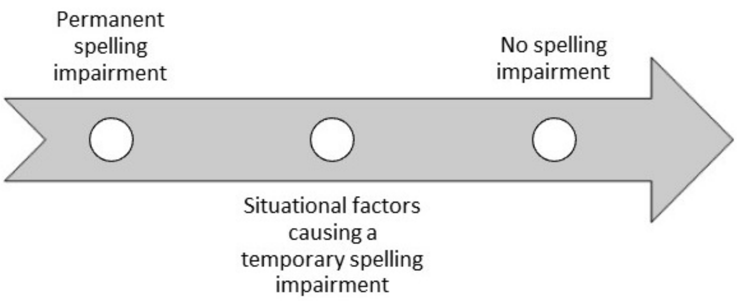

Figure 4. Users with different levels of spelling skills

By including situated abilities in studies on information searching, new information may emerge regarding potential barriers commonly experienced by all types of users. Otherwise, important perspectives and knowledge of certain user behaviour and needs might be overlooked. The needs of people with certain situational impairments may not be sufficiently accommodated in today's research. Based on the personas created for this paper, people such as *Katie*, *John*, *Lisa* and *Isak* would have been addressed in research typically referred to as *accessibility studies* or *disability studies* (Berget and Macfarlane, 2020). Less attention would probably be directed towards *Ali*, *Pam*, *Ann*, and *Tom*, who all represent temporary situational impairments that also have a potentially major impact on information searching. A situated abilities perspective might ensure that the needs of all these users are attended to by researchers, practitioners and system developers.

Several of the personas may experience concurrent challenges caused by dissimilar factors. For example, *Katie* may struggle with identifying proper query terms to express an information need due to her aphasia. *Lisa* and *Pam* may have the same difficulty caused by insufficient vocabulary. In contrast, *Tom*'s word retrieval skills are affected by strong pain-relieving medication and *Ali* is affected by lack of sleep. *Katie* and *Lisa*'s challenges are permanent (although abilities may improve through training or rehabilitation). In contrast, *Pam* will have less problems when her language skills improve, and *Tom* will manage better when he is no longer on medication. *Ali* only has difficulties with word retrieval in periods where he experiences lack of sleep causing fatigue, so his challenges vary over a period according to his sleep pattern. If researchers broaden the user-perspective by addressing the whole range of naming skills represented by these personas and applies a different view on disabilities, as suggested by Wobbrock et al. (2018), the challenges experienced by *Pam*, *Tom* and *Ali* will also be included. The outcome would be empirical data of users and contexts that may be overlooked if the researchers apply a narrower view on the concept disability.

The personas will also apply different strategies to compensate for the impaired naming skills. For example, *Pam* can use a dictionary to find the proper word, while *Ali* can postpone his information searching until he is more focused (unless there is an urgent need for information). Otherwise, all these personas rely on system support from the search systems to compensate for their impaired naming skills.

The situated abilities approach complies well with the gap model (Sosialdepartementet, 2003), but represents an expansion of the original model (see Figure 1) which is limited to permanent impairments. In the gap-model, the overall purpose is to explain disability as a concept. It seems, however, purposeful to revise this model to also include situational impairments. Such impairments can cause situations where users may experience shortcomings due to a gap between their situated abilities and system demands, causing a situational disability. The outline of the model would be the same, but with a modified terminology (see Figure 5). The term situational disability is applied in the model instead of situational impairment, which is the term used by Wobbrock et al. (2018). This revision is made to comply with the purpose of the original gap model, namely, to explain disability as a concept. Further, this terminology is used to clarify the difference between impairment and disability, which is not discussed by Wobbrock et al. (2018) but is an important distinction due to the societal impact that plays a key role in defining the concept *disability* (Shakespeare, 2013).

The revised model presented in this paper acknowledges that the relationship between people and their environments (in this case exemplified by search systems) is fragile and everchanging. The model is also a reminder that the need for accessible and inclusive search systems are not solely related to permanent impairments. The revised version of the model would include all the eight personas, not only the four personas with permanent impairments (*Katie*, *John*, *Lisa* and *Isak*) as in the original model.

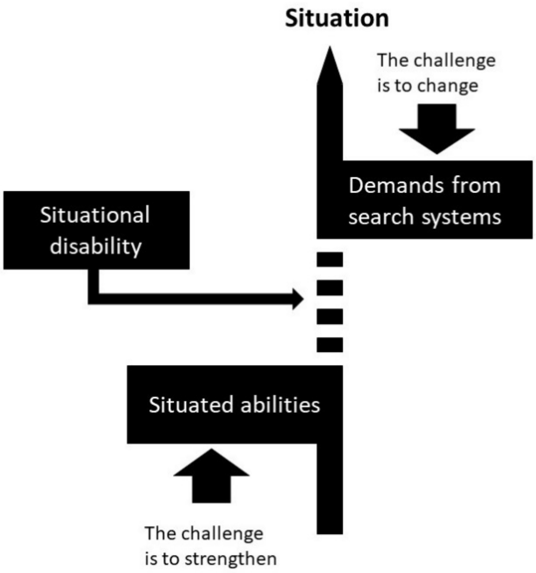

Figure 5. Revised version of the gap-model

Situated abilities and search support

The second research question explores whether knowledge of situated abilities can contribute to more supportive search systems for all types of users, which is an overall goal within the universal design perspective (Steinfeld and Maisel, 2012). This question is closely connected to RQ_1, because extensive user knowledge is required to develop effective and usable search systems (Ruthven, 2008). This perspective is also in accordance with the participatory design approach, which '*seeks to enable those who will use the technology to have a voice in its design*' (Robertson and Simonsen, 2013, p. 1). In this tradition, learning the reality of the users' situation and finding the appropriate technical means to obtain support for them are vital. Consequently, sufficient knowledge of how people search for information is a requirement to develop system support covering the needs of all types of users and contexts.

As pointed out by Sitbon et al. (2014), even low-level tasks required for web searching involve many abilities, e.g., fine motor control, vocabulary, spelling, and reading. One of the purposes of the information-seeking framework developed by Marchionini and White (2007) is to display the variance in system support in the different phases of information searching. In this model, there is very little system support in certain phases compared to others. Although this framework was presented almost two decades ago, the situation seems to be quite similar in today's search systems. Most system support is still for query input and reformulation, although there is a need to develop better system support for other phases in the information-seeking framework. This need can be seen in many of the personas constructed for this paper and that new perspectives might be necessary to move search system technology forward.

Situated abilities and situational impairments seem to represent purposeful variables to study to get a better understanding of search behaviour. By gaining a better insight into potential barriers that all types of users may encounter, it might be easier to comply with demands for universally designed search systems. The initial stages of information searching addressed by Marchionini and White (2007) show the importance of system support. If people struggle with using search systems and are not awarded with relevant results after investing significant effort into expressing information needs and formulating queries, many information needs may not be accepted (Marchionini and White, 2007). Consequently, the accessibility and usability of search systems may be decisive for whether users follow up on information needs through actual searching or not (Kvikne and Berget, 2022).

How users handle difficulties during searching can vary and may also be connected to having a permanent versus temporary impairment. For example, *John* may be used to spelling errors because he has had dyslexia his whole life and has therefore developed a better coping strategy than for example *Pam* or *Ann*. There are also differences in the ability to utilise assistive technology. *John* and *Ann* can use speech recognition (which is also used by *Ali* when he needs to search for information and has greasy hands while repairing a car). *Lisa* and *Pam*, however, are not able to use this technology due to unclear pronunciation or having a strong accent (Vase and Berget, 2023). More knowledge about potential barriers and solutions are required to develop search systems that sufficiently support all these types of users, including people who experience situational impairments for which they have not developed adequate coping strategies.

Based on the personas, the lack of support during the initial stages of an information search would be especially problematic for *Katie*, *Lisa*, *Pam*, and *Ann*. All these users have either permanent or temporarily impaired language skills causing challenges in expressing themselves at the required precision level (unless *Pam* uses her first language). The situational factors are different, but the effect on information searching are the same. By understanding these situational impairments, system developers can acquire the necessary knowledge to understand how to support these different types of situational impairments in stages where systems may not be satisfactory today. It therefore seems likely that exploring system support for expression of information needs through the lens of ability-based design may benefit all these users and help product developers.

A fundamental component of search engine development is to define the level of system involvement. Today, there are noteworthy differences between general web search engines and certain bibliographic databases, such as library catalogues. Previous studies have found that system support can compensate for impaired abilities, such as reduced spelling and reading skills (Berget and Macfarlane, 2020). Such difficulties may be experienced by many types of users, and most of the personas (*Katie*, *John*, *Lisa*, *Pam*, *Ali*, *Ann* and *Tom*). It therefore seems probable that systems on level 3 or 4 put forward by Bates (1990) would be the most beneficial for this phase of the information searching.

Level 3 and 4 as presented by Bates (1990) represent the highest degree of system involvement, where the system either monitors search and recommends search activities (level 3) or executes actions automatically (level 4). Bates (1990) divided these levels into sublevels. At level 3 the system recommends search activities when the searcher asks for suggestions (3a) or when the system identifies a need (3b). At level 4 the system either informs the user about actions executed automatically by the system (4a) or not (4b). In context of situated abilities, level 3 is most relevant to discuss further. While level 3a requires that the user can (and is aware of the possibility to) ask the system for help, level 3b presupposes that the system is able to detect user needs. According to Wobbrock et al. (2018), interactive computing systems do not know enough about user abilities, situations and contexts. For system support to be sufficiently helpful, the situated abilities approach may contribute with broader user knowledge to better identify and accommodate the needs of broader user groups.

Many spelling errors might be easily detected by current search systems. There are, however, some exceptions, e.g., certain mistakes made by people with dyslexia or aphasia (Berget and Sandnes, 2016; Kvikne and Berget, 2022). It might, however, be difficult for the system to understand if users input incorrect terms unless it is possible to detect a context from additional query words. For example, a person with aphasia (such as *Katie*) may input one query term but mean to search for something completely different. This can also be the case for people with impaired or reduced vocabulary, such as *Lisa* or *Pam*. Similar mistakes may be produced by users with temporary difficulties recalling words (*Ali*, *Ann* and *Tom*). In other cases, people with dyslexia (e.g., *John*) confuse certain letters with similar shapes, such as p and b or n and u. Sometimes, such errors may result in correctly spelled, but erroneous queries. Broad user knowledge is therefore needed to better understand how search systems can detect user errors and needs.

In accordance with the gap-model, assistive technology can strengthen the abilities of users and enhance the user system interaction. For some people, personal characteristics such as having impaired vision, a writing impairment or other cognitive challenges may cause difficulties using certain search systems (Berget and Macfarlane, 2020). Some barriers may be compensated for through assistive technology, such as braille displays, speech recognition, or speech synthesis. Although assistive technology has traditionally been associated with permanent impairments (such as *John* and *Isak*), other users may also benefit from using such technology (Stramondo, 2019). *Ali* is a good example of this. He has no writing impairment, but greasy hands due to working on a car makes it more convenient to search through speech recognition than inputting query terms on a keyboard. *Katie*, *Ann*, and *Tom* may also benefit from using speech recognition by removing the need to write when searching for information. In other cases, useful assistive technology is inaccessible for certain users who may benefit from using it. For example, *Lisa* and *Pam* cannot apply speech recognition due to unclear pronunciation and accents (Vase and Berget, 2023). These cases show that more effort is needed to ensure accessible speech recognition for all types of languages (Vase and Berget, 2023).

From a universal design perspective, the preferred solution would be to develop more inclusive search systems, to avoid the need for additional technical support. Much assistive technology can (and has been) an inspiration to system support, such as the possibility to conduct searches through speech or have the content read aloud. From a situated abilities perspective, assistive technology becomes more relevant to explore as inspiration for the development of search systems for all types of users rather than considering this technology as limited to *people with disabilities* (Stramondo, 2019).

Conclusion

Designing for situated abilities is well in line with the concept of universal design, namely, to design search systems accommodating all types of human abilities. As argued in this paper, extensive knowledge and understanding of situated abilities might comprise a premise for sufficient system support for everyone. By applying a framework such as situated abilities, the research perspective is no longer limited to *average users* or *disabled users*, but the whole population. Moreover, the attention is shifted from what people cannot do to what people can do. This re-orientation to an ability-based user perspective should provide a better basis of knowledge of user needs required to move search system development forward and is potentially worth exploring further.

About the author

Gerd Berget is an associate professor at OsloMet. Her main areas of research are interactive information retrieval, universal design, and human computer interaction. She has conducted research involving various neurodiverse users, e.g., people with dyslexia and persons with intellectual disability. She can be contacted at gerd.berget@oslomet.no.

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