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## Vertical and Horizontal Relationships amongst Task-Based Information Needs

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### Abstract

In this article, we present a conceptual framework of information needs for task-based information studies. The framework accounts for both vertical and horizontal relationships between information needs as fluid activities in work-task performance. As part of task performance, pieces of information are gathered from various, heterogeneous sources, not primarily to fulfil any expressed formulation of information needs, but in order to make progress in the task. The vertical relationships pinpoint connections between general and specific, from the workplace context to the interaction with an information source, and the horizontal relationships between parallel information needs. These relationships enrich the conceptual understanding of information needs in information studies, which previously has focussed on sequential relationships. The sequential, vertical and horizontal relationships form an analytical network that allows a departure from the black-box depiction of information needs.

*Keywords:* Information needs, Task-based information seeking and retrieval, Conceptualizations

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## **1. Introduction**

Research on and related to information needs is central in information studies. It appears in many subfields, such as information/knowledge management, information literacy, information retrieval and human-computer interaction, and is particularly incremental in the fields of information behaviour and interactive information retrieval. In pursuit of providing the most useful and timely information for those looking for it, information needs have been seen as a fundamental aspect in understanding why people search for and seek information. This has made it one of the most used concepts in information studies; commonly used to mediate various aims or reasons for acquiring information (cf., Naumer & Fisher, 2009; Savolainen, 2017). However, the definitions remain unclear and are seldom discussed in depth. Empirical research in particular takes the concept as a black box; while an aspect of the information needs may be addressed (e.g., complexity or ambiguity) in research designs, the construction of concept itself is often left unconsidered. Similarly, theoretical reasoning behind the concept is scarce, as most theories focus on the information seeking and searching activities (Savolainen, 2017).

Amongst other information-related activities, with relationships to the other activities and particularly between activities, information needs themselves may advance our understanding of information needs and their role in research designs. We focus on conceptualizations of information needs and their vertical and horizontal relationships as part of work-task performance. The vertical relationships entail addressing information needs at different levels of granularity from overall context to the points of interaction with an information source, and the horizontal - in essence a parallel - division of information needs at the same vertical level. These relationships complement the sequential relationships that highlight information needs' transformation as a result of information gathering (e.g. pre- and post-focus information needs).

When interacting with information, people may have many different purposes: to complete a work task, to resolve a personal problem, to achieve goals within one's hobby, to give assistance to others, to keep oneself entertained, etc. We delimit our scope in the context of work, which is a highly relevant area of research and provides a coherent base for the argumentation. Whereas, we believe that much of the reasoning is equally relevant for many work-like, goal-oriented situations in other contexts of life, strictly viewed, the analysis concentrates on work-task-based information needs, with an emphasis on their intellectual and physical dimensions. In keeping with this scope, we define information needs in this article accordingly:

*Information need* denotes a – more or less clearly – identified piece of information that is expected to facilitate reaching a – more or less clearly – identified goal; it exists simply because the information is considered necessary to acquire in order to make progress. Information need(ing) is seen as an activity alongside information seeking and searching.

This definition may be emphasised as a matter of individual cognition, or as a socially constructed, shared understanding. It has *per se* nothing to do with claims of truth, objective sets of requirements, nor completeness. The focus is on the acquisition of information considered necessary for reaching a goal, in this article, a successful completion of a work task. Thus, information needs can lead to the acquisition of information never to be used for task resolution, nevertheless considered necessary in pursuing the resolution. This makes information needs an activity resulting in, but also as a result of, other activities. Information needs are thus not equalised by requirements for the resolution of the task. They do not have any fixed scope, but adjust fluidly until the resolution of the work task is reached, or the task is abandoned. We claim and discuss below how information needs are the result of the relationship between past (already happened), anticipated (not yet happened) and parallel (occurring approximately simultaneously) information-related activities in individually and socially, facilitated and constrained, information environments. We base our reasoning on earlier studies, mainly in the fields of information behaviour and (interactive) information retrieval, on which we also aim to contribute.

Next, we will address related research in the fields of information behaviour and (interactive) information retrieval, resulting in a broad view on different conceptualisations of information needs and (work) tasks. Thereafter, we analyse task-based information needs in vertical levels of professional and workplace context, work task, as well as its sub-tasks information seeking and information searching, and their related horizontal divisions. Lastly, we discuss the consequences of the analysis for future research.

## 2. Information needs and work tasks – summarising literature review

### 2.1 *Conceptualisation of information needs*

Information needs have been the subject of some conceptual investigations, as independent review articles or as part of theoretical frameworks for empirical studies on information needs. Taylor's (1968) work is pivotal and his four levels of information needs - visceral, conscious, formalized, and compromised – have been continually returned to in information studies (Tyckoson, 2015). Ruthven (2019) summarizes information need conceptualizations in relation to problematic situations (e.g., Belkin, Oddy, & Brooks, 1982; Dervin, 1983); to emotion/affective feelings (e.g., Kuhlthau, 1991); to sensation/bodily feeling (e.g., Lloyd, 2010); and, to cognition (e.g., Brashers, 2001), and relates them further to information need formulations in interaction with information retrieval systems. Cole (2015) emphasizes the role of searching information to first discover and, then address, the revealed information needs. Naumer and Fisher (2009) relate the concept to human needs and motivation and, following Wilson (1981), approximates it as a secondary need to more prevailing human needs, such as physiological, affective and cognitive needs. They also conclude that the social contextualization of information needs (e.g., Savolainen, 1995) is gaining footing alongside being addressed as individual mental activity in the field of information behaviour research. Savolainen's (2017) review on information needs revealed two types of conceptualizations: information needs as a primary trigger, a "root factor",

behind identifying and accessing information sources, or as a secondary trigger or driver, determined by more fundamental elements (e.g., a work task). He concludes that task-based information needs are usually viewed as the latter.

The above works provide insights into the information need conceptualizations separately in the field of information behaviour *and* in the field of (interactive) information retrieval. Below, we provide a short overview of previous findings, in order to reflect the cross-section *between* the fields of information behaviour and (interactive) information retrieval. This overarching viewpoint has been largely neglected in previous conceptual considerations.

Information needs are understood and studied in different ways depending on the context: for instance, a search process, a work task, or an entire profession. Within a cognitive viewpoint, which relies on explanations offered by individual characteristics, such as the skills and knowledge of an individual, information needs are often described as an individual's need to acquire information to solve a problem or to learn about a topic of interest (Ford, 2015). Within a socio-cognitive viewpoint, sometimes referred to as a collectivistic approach (e.g., Talja, Tuominen, & Savolainen, 2005), shared understandings of valid needs and relevant information are seen as more apt explanations for perceived information needs (Byström, Ruthven, & Heinström, 2017; Byström, 2002). Yet, again, from the pure system-oriented perspective, information needs are considered as requests providing a testbed within which information systems' effectiveness can be measured (Kekäläinen & Järvelin, 2002).

In Taylor's (1968) seminal definition of information needs, these are distinguished at four levels; as visceral and unexpressed needs, as conscious but ill-defined needs, as formalized and expressed needs, and lastly, as compromised needs aimed at interaction with an information system (Taylor, 1968). Information needs may be prompted by other, more basic needs, such as affective, physiological and cognitive needs (Wilson, T. D., 1981). Furthermore, outside the pure algorithmic interests, information needs are often seen as evolving cognitive processes, in Taylor's model, (1968) towards the compromised needs, or, as in Kuhlthau's model (1993) along with the focus formulation. Their main assumption is that information needs become more explicit in conjunction with information gathering. These views emphasize an individual's role in defining information needs as part of their understanding. Cole (2011) presents, in his

theory of information needs for information retrieval, another interpretation of Taylor's information needs and claims "the user's information need manifests itself to the user differently over the course of performing a task" whereas it once instantiated to its deepest level "then stays the same" (Cole, 2011).

Within information behaviour research, a well-known, dynamic information need conceptualization is the "gap" in Dervin's Sense-Making metaphor (Dervin, 1983). She argues that information needs are most suitably defined as a gap between the current situation and the desired change for an individual. Allen (1997) frames information needs similarly from the perspective of a "person-in-situation". Cole (2011) roots information needs beyond an individual's comprehension, and grants them an existence outside the individual, as something instigating activities with which the individual engages. Thus, information needs are sometimes viewed as a fixed objective, a prearranged goal to be satisfied (e.g., Cole, 2011) sometimes as an established focus (e.g., Kuhlthau, 1993). The former is indicating that the information needs must first be revealed before they can be attended to and, the second, emphasizing the on-going construction of information needs simultaneously with attending to them.

## *2.2 Studying information needs in relation to tasks*

Information retrieval (IR) research that takes a system-centric, or algorithmic, perspective on interactions assumes that information searchers come to an information system with clear information needs. The articulated query is equalized with the information needs but may be reformulated to emphasize different aspects. The information retrieval system is successfully satisfying the need if the results match the query terms (Baeza-Yates & Ribeiro-Neto, 1999). While being useful in algorithmic testing (Kekäläinen & Järvelin, 2002), this view does not consider any additional conditions, and treats the information needs on a basis of string matching and topical relevance. In addition, these information needs are commonly studied against a single collection consisting of similar information objects (e.g., documents). In this type of research, information needs are reduced to an objective, contextually unbounded instrument for measuring purposes.

More recently, search logs have been used to study information retrieval based on real user queries. In his seminal paper on Web information needs, Broder (2002) added transactional and navigational information needs to purely informational needs. The first means searching for information to be able to “perform some web-mediated activity” such as shopping or downloading files. The latter kinds of needs cover searching in order to reach a particular site. As a result of further elaboration of Broder’s categories, Rose and Levinson (2004) conclude, similar to Dervin (1983), that “the ‘why’ of user behaviour is actually essential”, and introduce “underlying goals” as concepts to address the reasons for searching, indicating that reaching the goal equals satisfying the information needs. However, Broder (2002) himself stated that classifying the needs based on the query is often merely “a wild guess”, indicating that information needs are complicated phenomena, and irreducible to query formulations.

In the information behaviour (IB) research field, information needs are viewed as abstract constructs that may give reason to consult multiple information sources on multiple occasions, interactions that are referred to as information seeking (Wilson, T. D., 1981). Rather than addressing an interaction with a specific information source, these studies investigate what kinds of information are requested and from which sources. Studying information-related activities by diverse professionals is one of the largest interests in this research field, although task-based studies, as such, are not very common (cf., Case & Given, 2016). Taylor’s (1991) seminal framework Information Use Environment (IUE) differentiates between information-related activities of different professions. By defining groups of people and their settings, as well as identifying their common problems and preferred resolutions, their information-related activities, including information needs, become more comprehensible. Byström, Heinström and Ruthven. (2019) adjusted the IUE model to acknowledge multiple professions’ information needs playing together in workplace information environments (WIE).

Focussing on work roles, Leckie, Pettigrew and Sylvain (1996) identified a set of roles that every professional occasionally plays carrying out their work, such as expert, manager, administrator, educator and student. Each of these roles has related work tasks and information needs. Byström and Järvelin (1995) focussed on how increasing complexity of work tasks led to a need to acquire several types of information from

multiple information sources. Kuhlthau and Tama (2001) found that work tasks where uncertainty was high led to information needs on both pre- and post-focus stages of task performance. Common to many information behaviour studies is the view that information is sought from a number of different information sources, and that early on (e.g., Gerstberger & Allen, 1968), a colleague was found to be the most useful source of information, able to provide task-related details, domain specific general knowledge, as well as instructions for how to do something (e.g., Byström & Järvelin, 1995).

The development of the interactive information retrieval (IIR) research field is partly a result of the realization of the complexity of real users' information searching. This branch of research addresses people's interaction with information systems, focusing specifically on the design, use or evaluation of the systems, but also, more broadly, on the role of information systems in seeking information. Belkin and colleague's (1982) seminal Anomalous State of Knowledge (ASK) model provides a cognitive view on information needs and may be seen as a starting point to IIR research. ASK describes information needs as knowledge structures, cognitive maps shifting along with the conceptual development of a person. The Berrypicking metaphor by Bates (1993) focused on the idea of exploratory information searching as the development of a person's conceptual understanding. Similarly, Kuhlthau (1991) introduced the, now widely established, idea about the importance of focus formulation in her Information Search Process (ISP), which was later developed further by Vakkari for IIR research (Vakkari, 2001).

The prevailing factor for them all is the emphasis on evolving information needs, as results of gaining more information and becoming more knowledgeable. Related to ideas from Dervin (1983) and Rose and Levinson (2004), Todd's concept of information intent refers to people's engagement with information in "purposeful, deliberate, and selective ways to get expanded and/or changed and/or clearer and/or verified picture, and by being able to state positions" (Todd, 2005). Thus, within the cognitive viewpoint information needs are seen as prerequisites for increasing one's knowledge.

To sum up, whilst information needs are a part of empirical research in all three fields of IR, IIR and IB, theoretical analyses of the concept are scarce. While theoretical reasoning on information needs has been practically non-existing in IR, it has raised

some theoretical interest in the IIR field. Even though it has been mostly addressed in the IB field, there is no strong body of research on the concept. In both IIR and IB fields, the references to Taylor's (1968) four levels of information needs are common and, in both fields, information needs are often seen as triggers for looking for information that evolve in sequential steps. However, they target the concept on different levels of granularity. Simply put, information behaviour studies typically address the entire need for information of a given situation, whereas (interactive) information retrieval studies concentrate on a fraction of it, suitable to be directed at an information retrieval system (Byström & Hansen, 2005).

### *2.3 Interpretations of information needs*

In addition to granularity and context, the ontological views on information need differ per se. This difference is not primarily between the research fields as but between individual studies. One view emphasizes information needs as a fixed objective, the other as a fluctuating activity. The former defines information needs as independent objectives in the world. For instance, Cole (2011) explicitly interprets Taylor's four levels of information needs as different manifestations of one, sometimes hidden, information need. Information needs are given, but are not necessarily obvious for the person attending to a situation where the need exists; it must be first revealed and is only thereafter possible to satisfy. The alternative view considers information needs to be an activity resulted by information interactions taking place. Kuhlthau (1993), for instance, gives prominence to the activity of interacting with information first to settle a focus and then acting upon it. Bruce (2005) refers to anticipated information needs, as do Byström et al. (2017), indicating that information needs 'travel' over time, particularly in recurring situations, such as many work tasks.

Theoretical development in information studies adds an additional dimension to understanding information needs. The cognitive viewpoint, which epistemologically and ontologically emphasizes the individual agency in formulating and satisfying information needs, has been dominating in modern information studies. Within this line of thought, information needs have primarily been connected to characteristics of the

individual looking for information. Information needs and, coping with them, are thus viewed as dependent on her capacities, such as motivation, her prior knowledge on the topic, or her skills in using information systems and other information sources (cf., Byström, 2007).

During the past couple of decades, the information behaviour field has incorporated practice-theoretical views that emphasize the social agency in defining and explaining information-related phenomena. For the purposes of information needs, this means that it is not exclusively a matter of an individual facing a situation where she requires and accesses information in order to proceed, but that the situation encompasses her socially and culturally predefined context; the situation is part of a collectively shared material and intellectual environment. The situations have occurred many times, perhaps becoming routines, establishing both norm and material structures that intermediate expectations, valid actions and legitimate goals (such as the criteria for preferred information and the collection of information sources). This means that whereas some information needs may be unique, many of them are not. Furthermore, the context, such as a workplace, sets boundaries for what kind of information needs are appropriate (cf. Byström, 2007; Salancik & Pfeffer, 1977), and what are legitimate measures to address them (cf., Taylor, 1991). Thus, within practice-orientation, information needs are explained by social conventions of a workplace, making them perceived and treated in a similar manner by most members in the same context (cf., Taylor, 1991; Wenger-Trayner & Wenger-Trayner, 2015). It may be claimed that the practice-oriented perspective is already firmly established within the research field of information behaviour, but has not yet been acknowledged in the field of (interactive) information retrieval. However, Cole's (2011) take on Taylor's (1968) conceptualization of information needs could be interpreted as a step towards practice theories, if the information needs to be revealed are understood as socio-cultural, relatively stable objectives of a practice, like those related to school assignments, or to work tasks. Nevertheless, the linkage to social context is not so far explicitly addressed in research on interactive information retrieval.

There are only a handful of scientific contributions that make mention of *task-based information needs*. Apart from Savolainen (2017), none of them has used it in any elaborated sense. However, the term is implicit in a large amount of research within the

task-based approach, both in the field of information behaviour, as well as in the field of interactive information retrieval. Savolainen (2017) concludes that, in the field of information-behaviour research, the task-based information needs are viewed both as triggers that *set* information seeking in motion and as drivers that *keep* information seeking in motion.

#### *2.4 Information needs in information intensive tasks*

While moving on to conceptually analysing task-based information needs, we identify the level of work-task as intermediary level of granularity that binds the information behaviour and (interactive) information retrieval fields together. This concept is used in both fields, but seldom fully connects the two. Byström (1999; Byström & Hansen, 2005) explicitly introduces a nested relationship between work-task, information-seeking tasks, and information-searching tasks. Wilson's (2000) nested model places information searching in information seeking and, furthermore, in a general framework of information behaviour. Leckie et al. (1996) connect work tasks and subsequent information seeking to different work roles engaged in by professionals. Taylor's (1991) conceptualization of information use environment (IUE) indicates that each profession forms ideological and material structures to frame their information usage. Lloyd (2010) emphasizes the power of social-cultural practices in the formation of information landscapes where information is sought and used, and in which the work is carried out (Byström & Lloyd, 2012). Ingwersen and Järvelin (2005) focus on information-search tasks and view them as part of information seeking and as a consequence of work tasks or other interests. Byström and Hansen (2005) share the same view, while placing equal emphasis on work tasks, information-seeking tasks and information-searching tasks. Kumpulainen and Järvelin (Kumpulainen & Järvelin, 2010; 2012; Kumpulainen, 2014) provide one of the very few empirical investigations in which all three levels are addressed. In the following, we use the works above as a source of inspiration – well aware that they include different ontological and, even epistemological, groundings – to further investigate how the concept of information

needs unfolds on four levels: professions, work tasks, information-seeking tasks, and information-searching tasks.

Not all tasks lead to active information seeking and searching. Some tasks may require only recalling earlier learnt and, already known, information, and thus lead to no information needs as set out in the definition used in this article. However, our focus is on information-intensive tasks that require explicit information seeking and searching in order to be completed. According to Byström (2007), a task is usually seen as a purposeful set of interlinked concrete or cognitive activities performed by people or machines. Furthermore, it normally has a meaningful purpose, and an identifiable beginning and end. Tasks are constructed in varying contexts within research: they can be authentic work tasks (e.g., Kumpulainen & Järvelin, 2010; Saastamoinen, Kumpulainen, & Järvelin, 2012), leisure tasks (Wilson, M. L. & Elsweler, 2010), learning tasks (Limberg, 2007), simulated tasks (Borlund, 2016), as well as assigned or self-generated (Bilal, 2002; Savolainen & Kari, 2006), depending on the aims and settings of the research. Furthermore, tasks can be seen as task descriptions or as task processes (Byström & Hansen, 2005). The first view resembles an assigned or simulated task, whereas the second addresses a task as manifested through its execution. The latter emphasizes the dynamic nature of a task, including a set of actions in the pursuit of a particular evolving goal (Byström & Hansen, 2005). An enduring characterization of a task is that it is a goal-directed activity (e.g., Hackos & Redish, 1998; Hansen & Järvelin, 2005; Järvelin et al., 2015; Vakkari, 2003).

One central aspect for tasks is the level of granularity. Ingwersen and Järvelin provided an embedded model of information seeking and retrieval design and evaluation framework (Ingwersen & Järvelin, 2005). It entails examining the various layers of context that influence the search process, namely socio-organizational and cultural context, work task, information seeking and lastly, information searching, i.e., level of retrieving information. At the most specific level, which is the searching task, all the other layers withstand, implicitly. Similarly, Byström and Hansen (2005) provide a conceptual framework, building on the layers of different granularity and the relationships between, and within, the layers. In their framework, search tasks are embedded in seeking tasks, which are embedded in work tasks, correspondingly. Furthermore, they divide tasks into three phases; task construction on a conceptual

level, actual performance, and, task completion, and there may be several, one or no information-seeking and searching tasks involved during each phase.

At the most granular level, the search tasks may be simple lookup tasks (e.g., factual, known-item searches, or navigational searches); or exploratory searching including learning and investigations (Marchionini, 2006). Marchionini (2006) provides a hierarchy of needs to be addressed, which range from (i) basic facts that guide short-term actions to (ii) networks of related concepts that help to understand phenomena or execute complex activities to (iii) complex networks of tacit and explicit knowledge, which accumulate into expertise during the course of life.

In the following, we aim to conceptually analyse relationships of task-based information needs on the basis of the levels of granularity in task-performance process and propose a conceptual framework for both the information-behaviour field and the (interactive) information retrieval field. We believe such a framework is necessary to fully bridge the research fields.

### **3. Task-based information needs – vertical and horizontal relationships**

The previous models all account for defining task-based information needs as part of task performance, often emphasising the sequential development or evolvement of information needs. What is missing is the explicit consideration of information needs as multi-level activities resulting in different kinds of information needs. This activity occurs, not only at various phases of the task-performance process (e.g., pre- and post-focus), but also at various levels of granularity (e.g., work task or search task) and at the points of interaction with an information source (e.g., an information system or a colleague). Put in Taylor's terminology, one visceral need may result in a number of interconnected compromised needs (cf., Cole, 2011). Both expectations related to the work task and to the information sources chosen for use create an anticipated intent for a result at each point of interaction with an information source. Therefore, the overall context – consisting of previous experiences, social norms, situational preconditions, and information already available for the task – often leads to information needs that

are not necessarily unique, but specific at the current point of interaction with an information source. Sometimes, the entirety of information needs for the task at hand is treated in one interaction, at other times it is only a fraction of them. It is the intent at the point of interaction with an information source that manifests in information needs, entirely or only partly, through formulations put forth (cf., Ruthven, 2019) and operationalized as compromised needs (cf., Taylor, 1968). In the case of partial coverage of information needs, the separate points of interaction are intertwined with each other, addressing the same or different aspects. Thus, intents form parallel, rather than sequential, relationships to each other. This means that in one work task, there may be several information needs on different levels of granularity, tied to each other by vertical, as well as horizontal relationships.

Table 1 distinguishes between the vertical and horizontal relationships of information needs. Both types of relationships are illustrated in the section below by an example of two work tasks, writing a scholarly article and requesting travel expenses. Whereas all information needs concretizing into intents at the point of interaction with an information source, they only make a difference and are possible to assess in relation to their context. The vertical and horizontal relationships represent a hierarchical arrangement of the context for analysing information needs during a task performance. It should be emphasized that the vertical and horizontal information needs are conceptual and analytical research constructs, and not necessarily something that people readily relate to in carrying out their work. The following sub-sections address information needs at each vertical level along with the associated horizontal information needs.

### *3.1 Information needs at professional level – motivating needs*

The professional context is the most general of the vertical levels in our framework. At this level, we identify information needs as *motivating needs* that define the scope of the work-task context (cf., Byström, 2007; Byström, 2002; Ingwersen & Järvelin, 2005). Table 2 shows the level of professional context with example tasks related to scholarly writing and travel reimbursement tasks.

Table 1. Vertical and horizontal information needs

<b>Vertical task-based relationships</b>	<b>Horizontal task-based relationships</b>
<b>Professional practice:</b>	
<p><i>Motivating needs</i> Information needs at the level of professions and work roles – high-level view</p>	<p><i>Contextual understanding</i> Needs for knowledge about the historic-cultural framing and “ways of working”. Needs to implement organizational traditions. Shared needs and practices.</p>
<b>Work task:</b>	
<p><i>Driving needs</i> Work-task related information needs –process level view</p>	<p><i>Operational comprehension:</i> Needs aiming to understand what tasks are required and how they are conducted. Needs considering what kinds of subtasks are required.</p>
<b>Information-seeking task:</b>	
<p><i>Triggering needs</i> Information-seeking task related information needs – moderate level view</p>	<p><i>Targeted requests</i> Topical, problem solving and procedural information needs. Needs related to information source/channel selection.</p>
<b>Information search tasks:</b>	
<p><i>Intents</i> Information-search task related information needs – low level view</p>	<p><i>Queries and questions</i> Needs expressed as queries into single or various systems or as questions to a person / various persons.</p>

Whereas work tasks are the main driver for information needs, these tasks themselves are situated in the context of a workplace. In this context, different social and professional norms, as well as societal and organizational regulations, frame what

counts as work and what work task are included, how the tasks are defined in order to be conducted and what results to aim for (Taylor, 1991).

This means that work tasks belong to a setting, predefined by cultural-historical values and conventions (Byström & Lloyd, 2012; Byström et al., 2017; Taylor, 1991). One consequence of this framing is that the person carrying out a work task is accountable to her profession and the workplace. Part of such accountability involves understanding what kinds of goals are desirable for work. This understanding involves recognition of valid information needs and valid information sources, based on context-specific focus and scope that are shared with others in the same profession and workplace. This pushes the task performer to emphasize certain goals, legitimizing both information needs and information sources in order to be accountable in front of their peers. Thus, information needs and their operationalization at the point of interaction with a source, grow through reoccurrence into a practice that guides actions in similar situations.

Table 2. Professional level information needs

<b>Vertical level – <i>Motivating needs</i></b>	
Information needs at the level of professions and work roles – high-level view	
<b>Horizontal level</b>	<b>Examples</b>
<p><i>Needs related to contextual understanding:</i></p> <ul style="list-style-type: none"> <li>- the historic-cultural framing</li> <li>- “ways of working”</li> <li>- organizational traditions</li> <li>- shared goals/values</li> <li>- information environment</li> </ul> <p><i>per se</i></p> <ul style="list-style-type: none"> <li>- etc.</li> </ul>	<p><i>Scholarly article:</i></p> <ul style="list-style-type: none"> <li>What are high-quality journals?</li> <li>What requirements do they set?</li> <li>What journal is most suitable for the present manuscript topic?</li> <li>Who are the most influential theoreticians in this field?</li> <li>What schools of thought are there in this area?</li> </ul> <p><i>Travel expenses reimbursement:</i></p> <ul style="list-style-type: none"> <li>How does the reimbursement system work?</li> <li>What expenses are possible to get compensated?</li> </ul>

The recognition of motivating needs are not demarcating *per se* but facilitating work by indicating acceptable results and making some work tasks predictable, i.e., performed similarly among peers. For “old” professions – like physicians – work practices, including the motivating needs, are rather stable, whereas for “new” ones – like influencers – the practices are still not established. Nevertheless, all work practices undergo externally and internally prompted changes.

The more common the work task is for a profession and a workplace, the more routines are involved in its performance. This includes the information-related activities: formulation of information needs, scope of information seeking and interaction with information sources. Routine activities are learned and carried out repetitively and are taken for granted in due time. However, practices effectuate through individuals’ actions and the power of practices may be contested by choosing to act differently to expectations, either by unfamiliarity, ignorance or consideration. In all cases, the outcome may, or may not, lead to changes in the practice and motivating needs (cf., Wenger-Trayner & Wenger-Trayner, 2015). In this sense, the motivating needs of a profession and the workplace resemble, to a certain degree, given and objective, forming a set of implicit or explicit information requirements to achieve a legitimate result.

The practices influence information-related activities in two ways. First, as in carrying out work, awareness of what information requirements need to be addressed is growing through learning. Second, the results are assessed by others, such as peers and management. Thus, the accountability to peers and management reinforces certain kinds of information needs and, often, even the use of certain kinds of information sources. Each time that they are promoted, these collectively shared understandings feed into the level of work tasks reinforcing the practice. Thus, motivating needs are often subtle, unspoken and spun over many topics creating a net of horizontal needs. Their long-lasting and general scope makes them less likely to lead to actual information needs as defined in this article

### 3.2 Information needs at work task level – driving needs

The next vertical level of analysis consists of information needs that keep the work activity in motion, that is, to facilitate completing the task (see Table 3). We term these information needs ‘driving needs’ (cf., Savolainen, 2017). Driving needs are related to processes and goals connected with the work task, which stem from shared knowledge structures and associated practices, and are interpreted and acted upon by the task performer. This makes the driving needs – and other information-related activities – responsive to both contextual and personal characteristics (Vakkari & Huuskonen, 2012). If the task performer can immediately identify the information requirements, determine the process ahead and envision the result, then the task is perceived as a simple task, instigating no, or few, relatively straightforward information-related activities, including information needs.

Table 3. Work-task level information needs

<b>Vertical level – <i>Driving needs</i></b>	
Work-task related information needs – process-level view	
<b>Horizontal level</b>	<b>Examples</b>
<p><i>Needs related to operational comprehension:</i></p> <ul style="list-style-type: none"> <li>- main questions/issues/problems</li> <li>- task-specific informational requirements</li> <li>- procedural requirements</li> <li>- accepted resolution</li> <li>- etc.</li> </ul>	<p><i>Scholarly article:</i></p> <p>Get an overview of previous research</p> <p>How does our view on information needs differ from others?</p> <p><i>Travel expenses reimbursement:</i> Complete all details for the entire trip</p>

The more ambiguous the task process, or its goals are perceived, the more information needs involved (Byström and Järvelin, 1995). Several kinds of information may be identified as necessary to collect. This entails subject-oriented information that

is task-specific (e.g., an account code) and/or domain-general information (e.g., regulations for travel), as well as procedural information (e.g., how to use the travel reimbursement system). The ambiguity may be a result of the low knowledge level and capacities of the task performer (uncommon task for the task performer), or the ambiguity may be inherent in the context (uncommon, altered or new task for the profession/workplace), or both.

Work tasks, as well as their subtasks, are normally considered to consist of three phases: initiation, actual performance and completion (Byström & Järvelin, 1995). The first phase focuses on defining the task goal(s), the second on activities to reach the goal(s), and the third to determine if the goal(s) are met satisfactorily and the result is good enough. Similarly, the task may be divided into pre- and post-focus phases (Kuhlthau, 1993; Vakkari, 2001). Each phase may necessitate acquiring information, thus keeping the process moving forward. In the initiation phase, information may be needed to define task goal(s) and even the task process (Saastamoinen, Kumpulainen, Vakkari, & Järvelin, 2013). Relating to the discussion above, these (pre-focus) information needs may, if present at all, require little to extensive efforts depending of the ambiguity involved. As the clarity of the goal(s) and process is reached, attention and efforts are directed towards goal-relevant (post-focus) information needs. A comprehensive work task benefits from setting sub-tasks with specified goals (Saastamoinen & Järvelin, 2017), e.g., formulation of thematic or “itemized” information needs that together are expected to provide grounds for reaching a suitable resolution for the work task. These driving needs may vary in their focus and scope, form horizontal relationships to each other, be more or less intertwined with each other, but are all geared towards completing the work task. At the final phase, information may be needed to confirm that results arrived at provide a satisfactory resolution for the work task. Information needs identified at this phase are usually of a complementary and verifying nature, but sometimes they necessitate returning to the previous tasks phases. The overall goals for the work task always remain as a basis for assessment for the relevance of the information gathered, keeping the driving needs at close propinquity to the (already satisfied) motivating needs, reflecting the norms and expectations as interpreted through the individual perception and capacity.

This means that several, parallel and subsequent information needs may be formulated throughout one work task, creating a net of vertically and horizontally related information needs. There may be several thematically, interlinked or separated, information needs at all phases of the work task, and each of them may be further divided into subsequently smaller specifications (Byström & Hansen, 2005), creating intra-vertical relationships. The parallel, horizontal information needs may be, to varying degrees, interdependent of each other. These work task-bound driving needs may instigate one or more information-seeking tasks, which are considered in the next section.

### *3.3 Information needs at information seeking level – triggering needs*

Information-seeking tasks are subtasks for a work task describing and treating the thematic information needs identified at the work task level (Byström & Hansen, 2005). At this level, the information needs are seen as triggers, prompting information seeking on their specific sub-goals and expectations (cf., Locke & Latham, 2002; Savolainen, 2017). The thematic information needs facilitate task-performance by addressing different topics related to the progress in the work task, such as the use of new library services, the review of previous research, and terminological issues. Table 4 presents examples about how they may form even more tightly horizontal relationships, as is the case for reviewing previous research that can be further divided into horizontal sub-topics, such as earlier reviews, previous models and existing definitions.

The selection of sources (e.g., documents and human sources) is enacted by the task performer's knowledge about the sources and their expected usefulness (cf., Byström & Lloyd, 2012; Byström et al., 2017). Task performers gravitate towards sources that they expect to give the best return for effort and tend to ignore others. During the course of past and present task performances, people learn about the legitimate information requirements, as well as the material and structural contents of their information environment (e.g. existing search tools, knowledgeable colleagues and available documents and data), and how to manage them (cf. workplace information literacy).

Table 4. Information-seeking level information needs

<b>Vertical level – Triggering needs</b>	
Information-seeking task related information needs – moderate level view	
<b>Horizontal level</b>	<b>Examples</b>
<p><i>Needs as targeted requests:</i></p> <ul style="list-style-type: none"> <li>- topical information</li> <li>- domain information</li> <li>- procedural information</li> <li>- etc.</li> </ul>	<p><i>Scholarly article:</i></p> <p>How to use the new library service for systematic searches?</p> <p>Earlier reviews on information needs</p> <p>Previous models including information needs</p> <p>Existing definitions of information needs</p> <p>Meta-theoretical trends in the fields of IB, IIR and IR</p> <p>What are suitable terminological solutions?</p> <p><i>Travel expenses reimbursement:</i></p> <p>How is use of own car regulated?</p> <p>What does "posting" mean?</p> <p>How do you fill out the reimbursement form?</p>

Thus, information seeking and information needs are similar to the work tasks themselves, to a certain degree routine, where the awareness of existing, available, information sources, not only make them more often turned to, but also affect what information is sought in the first place (Byström et al., 2017; Lloyd, 2010; Widén & Karim, 2018).

At this level, the notion of relevance is related to the anticipated usefulness of the selected channel or source. It entails assessing whether the source contains possibly useful information, the type and timeliness of the contents, and the accessibility of the source, etc. If the source qualifies, then searching for the information begins. Once the requested information is extracted, its relevance is assessed against the triggering need in the information-seeking task, and ultimately by whether they are considered to contribute to reaching an appropriate work-task resolution. The actual interaction with

the information sources, information-searching task, is the finest level of granulation on our vertical scale, and is addressed in the following section.

### *3.4 Information needs at information searching level – intents*

The most specified formulations of information needs, intents, are connected to the information-searching task (see Table 5). They have been defined as "[...] a separable fraction of an information need through a single consultation of a source or sources; a task performer searches for information from one or more sources during one consultation process or search episode" (Byström & Hansen, 2005). Information searching happens at the point of interaction with an individual source in order to collect normally a fraction of necessary information to cope with the work task. The thematic descriptions are transferred into one or several intents aimed at a specified information source. The intents (cf., Jansen, Booth, & Spink, 2008; Lewandowski, Drechsler, & von Mach, 2012) are formulated for systems as queries and to people as questions; the task performer is approaching the source in a manner that the source is able to cope with, in Taylor's terms, with a compromised need (Taylor, 1968). This means using appropriate language and terminology. Whereas an expert in information science can relatively easily conceptualize information seeking and information searching as two different phenomena, an expert in computer science may consider them to be synonyms related to user involvement in information retrieval. Alternatively, an information retrieval system operating with free text search is approached differently than a system requiring search terms from a controlled vocabulary.

As part of work-task performance, the intents often operationalize fractions of larger information needs, which are submitted, sometimes parallel, sometimes sequentially, to various information sources (cf., Kumpulainen, 2014), depending what is considered reasonable to get hold of from each source. Some sources are considered more versatile than others; a database consisting of articles reporting empirical studies is not expected to have an opinion of the next scientific innovation, whereas a university professor might deliver both the statement and a host of relevant articles.

Table 5. Search task level information needs

<b>Vertical level – Intents</b>	
Information-search task related information needs – low level view	
<b>Horizontal level</b>	<b>Examples</b>
<p><b><i>Needs as queries and questions:</i></b> Needs expressed as queries into single or various systems or as questions to a person / various persons.</p>	<p><i>Scholarly article:</i> Re-find Taylor’ information need article on my desktop Find other articles on the topic in IB and (I)IR fields in a database Talk with a colleague about the trends and terminology</p> <p><i>Travel expenses reimbursement:</i> Find the person who handles these processes on intranet, and ask what to do with days off-duty in connection to the travel Ask colleague how to fill out a post in the form Find the account numbers for expenses in an old email, or ask the manager</p>

Intents for search tasks are typically classified as either lookup or exploratory types (Marchionini, 2006). Lookup means factual requests (e.g., find the publication year for Bates’ Berrypicking article); navigational (e.g., get to the library’s website), known item (re-find Taylor’s information needs article) where there is a precise resolution. The latter kinds of intents leading to exploratory searches are more complicated, entailing learning and investigation. They may include wide topical investigations (e.g., what is already known about information needs?) and comparisons between different types of approaches and synthesizing them (Marchionini, 2006). Common to all search tasks is that they are geared towards the expected information contents of the sources. In some cases, the same intent can be presented to several sources (e.g., searching email to find the correct account numbers for expenses, and simultaneously calling the manager to ask her). The work task phase indicates how specified the intents are: during the initiation stage, there is more ambiguity and exploration, in the later phases of the task,

there are more exact known-item and topical searches (Vakkari, Pennanen, & Serola, 2003).

The relevance and usefulness of information gathered are first assessed against whether it helps in reaching the search-task goals, but also whether it is contributing to the information-seeking task, and finally to the work task. This requires all types of notions of relevance. Information may even be topically irrelevant but still useful in the task performance, e.g. it may help to understand what kind of information is actually not needed, and therefore help in formulation the focus and understanding the task requirements, which are critical components of success (Vakkari & Huuskonen, 2012).

From the task performer's point of view, any intent is affected by current understanding of (i) the search-task goals (task knowledge), (ii) where and how to search (procedural knowledge), and (iii) the existing information sources (source knowledge) in their work-task contexts (Taylor, 1991). Increased contextual awareness in any of these aspects helps to understand the task itself, clarifies the intents, and, in return, leads to more focused searching (Vakkari, 1999), as well as re-connects to work practices by aligning or contesting them. Thus, all levels of task-based information needs are intertwined, both vertically and horizontally, as well as being present even at the simplest and shortest information-search tasks.

#### **4. Discussion**

We have, in this article, aimed to highlight relationships between task-based information needs themselves and their (work) context, which have, so far, been fairly undifferentiated and unspecified in information studies. Our goal has been to enrich conceptualizations of information needs in relation to (work) tasks. In pursuit of this goal, we have added an explicit consideration of information needs as an activity among other task-based information activities. This view opens up an opportunity for more explanations for information needs' formulations than the individually and mainly cognitively oriented ones based on, for instance, pre- and post-focus phases in task performance, or Taylor's information needs' levels.

We note here that affective, as well as purely embodied, dimensions are excluded from the present conceptual analysis, mostly to keep the already complex analysis focussed. However, we do not see these dimensions in contradiction with the dimensions addressed to, and look forward to also incorporating them on the framework of information needs (cf., Ruthven, 2019). Another important discussion excluded in the present article is the consequences on research methods, which deserve, and require, an article of their own.

We have placed emphasis on vertical and horizontal relationships of information needs, and considered both the social and cultural dimensions in addition to the cognitive dimension. As a result, information needs are considered on different levels of granularity, which feed in to specified goals at the points of interaction with an information source (e.g., an information system or a colleague), and which create a net of information needs in vertical and horizontal relation to each other. Compared with prior views on information needs, ours differs in two notable ways: First, we acknowledge that any work task may have many and different kinds of information needs, instead of only one that evolves throughout the task (cf., Kuhlthau, 1993; Vakkari, 2001). Second, the intents are operationalized fractions of larger, perceived information needs, not necessarily being direct transformations of any 'original' visceral need waiting to be discovered and attended to, as in the idea of compromised needs (cf., Cole, 2011). In addition, we see information needs as an activity subjected and inseparable from both individual and contextual agency.

Expectations related both to the work task and to the information sources chosen for use create an anticipated intent at each point of interaction with any given information source. Therefore, previous experiences, social norms, situational conditions and information already available for the task, all lead to information needs that are not necessarily unique, but certainly specific in the actual point of interaction. Information needs are manifested and operationalized in these intents, but without connection to the other levels, i.e. vertical needs, they lack meaningful purpose and remain exercises in diligent information acquisition. Moreover, the separate points of information interaction during a work-task performance are related to each other also at the horizontal level, and may address the same information need; sometimes addressing different aspects, sometimes the same, sometimes closely related, yet at other times,

hardly at all but still tied together by the work task. Thus, the information needs of one work task may be several, on and within different levels of granularity, where the sequential relationships (e.g., pre and post focus) are accompanied by vertical and horizontal relationships.

We argue that through *vertical relationships between task-based information needs*, the overall work context, consisting of material (e.g., available information sources) and intellectual structures (e.g., norms and regulations) of a workplace and a profession, give a framework to *motivating information needs*. Motivating information needs influence goals attached to individual work tasks, which provide ground for *driving information needs* that are accentuated in the processes of carrying out work, in concert with the task performer's competence and contextual accountability in relation to the task. Driving information needs feed specified *triggering information needs* that concentrate on thematically coherent subject matters that are considered necessary to address in order to complete the work task. There may be one or several such triggering information needs of which each is treated as an information-seeking task, but only being meaningful when furthering the task performance. Triggering needs instigate consultations with one or more information sources that are expected to provide information necessary for completing the work task. When moving into the actual interaction with an information source, triggering needs are operationalized into *information intents* aligned towards the chosen sources. In our interpretation of Savolainen's (2017) driving and triggering information needs, driving needs are keeping information seeking on-going towards the task completion, whilst triggering needs prompt information seeking towards a specific subject. We have placed driving information needs on the same level as work-tasks feeding into triggering needs on the level of information-seeking tasks, and have complemented them with more general motivating information needs and more specific information intents. The vertical relationships of task-based information needs facilitate task performance by meaningful informational transformations between different levels of activity. Such vertical relationships are indicated, but not fully explicated in some previous models (e.g., Byström & Hansen, 2005; Byström & Lloyd, 2012; Ingwersen & Järvelin, 2005).

In addition, we argue that there are *horizontal relationships between task-based information needs*. Through these relationships, intents addressing (fractions of)

thematic triggering needs are organized into information-seeking tasks and are linked to each other, as well as the thematic triggering needs initiated by the driving needs for the work task, which are considered alongside each other throughout the task performance. An information-searching task is defined as the interaction between a source identified as potentially useful for acquiring a more or less vaguely defined piece of information as part of an information-seeking task. An information-seeking task may, in some cases, equal an information-searching task if only one source is consulted in connection with a theme. In other cases, an information-seeking task includes several information-searching tasks – that is, one triggering need leads to several intents (cf., Kumpulainen, 2014). Intent is the most specific kind of information need, fully focussed towards a chosen information source. It is formulated in relation to what is considered possible to collect from the chosen information source (i.e. a query to an information retrieval system), whereas the same topic leads to another intent when consulting some other source (i.e., a question to a colleague). The information-searching tasks work in concert, interdependent of each other, from work-task initiation to its completion. Such horizontal relationships are indicated in previous work by only a few, for instance Kumpulainen and Järvelin (2010), Blomgren, Vallo and Byström (2004).

Figure 1 depicts the components of the work task process that hosts the information needs in relation to the context of profession and workplace, the phases of the task-performance process and its subtasks information seeking and searching. As an activity, work-related task-based information needs are always goal-directed and indicate an action of acquiring information. They are fluid, multilevel constructions that are individually perceived and socially legitimized, and that concretize into informationally delimited information intents at the point of the interaction with an information source. Moreover, they are part of a (work) task performance, in which they emerge throughout the process of attending to the task and the information acquired as part of it. As activities of a workplace, the social, historical and professional conventions, all frame what information and what sources are perceived as legitimized and valued for carrying out work. They do not only validate the resolution arrived at, but are in play already when it is anticipated, that is, when the goals are set and related information needs initiated.

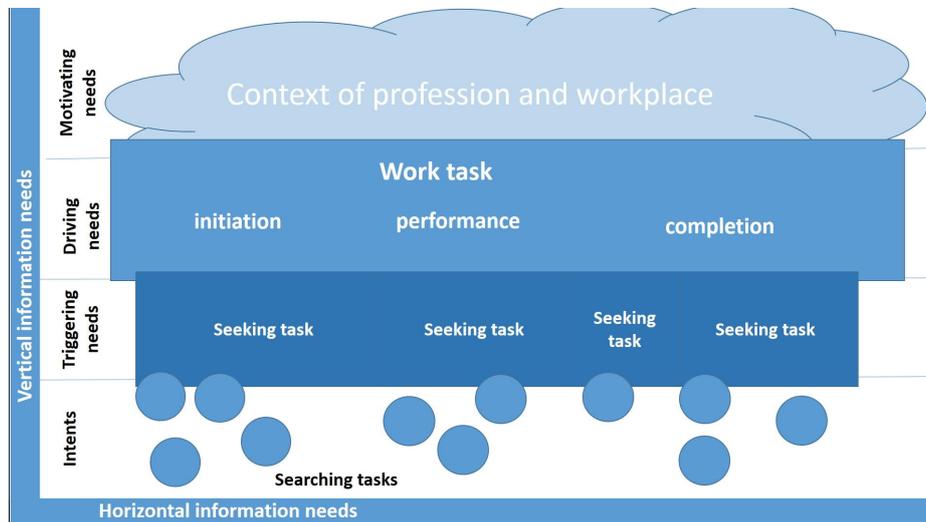


Figure 1. Information needs in a context of work task performance.

However, and not in contradiction of workplace practices, skills and preferences of the individual performing the task also play a role in what information needs emerge. Prior knowledge on the matter in hand, and the resources available, has been acknowledged in, if not many, at least a good number of studies. Additional, nearly non-attended, aspects are experiences, aims and motivations that are not necessarily formally connected to the matter in hand, but have informal relevance connected to, for instance, political issues at the workplace or personal goals.

The analysis of vertical and horizontal relationships of information needs have shown that information resources available are better understood as integrated to each other through anticipated and actual use. Since information needs related to a work task may target a multitude of information, they are necessary to divide into fractions anticipated suitable to be retrieved from available information sources, such as peers, databases and other information repositories, as well as physical, observable or embodied phenomena. These, again, are turned into a series of consultations, where success and content in finding information affect the following or parallel actions. It is likely only in routine work tasks that all information is anticipated to be acquired from one single source, be it a colleague, a web search engine or any other type of source.

The identification of vertical and horizontal relationships between task-based information needs have many implications for research carried out in the fields of information behaviour and interactive information retrieval. We argue that too narrow a view may lead to superficial, or even invalid, findings. Understanding information needs at the point of interaction with one information source requires taking into account their vertical and horizontal relationships. At the very least, studies making use of the concept of information needs ought to reflect upon the consequences of:

- prerequisites of the (work/professional) context,
- individual accountability in the situation,
- multiple useful information sources of all kinds, and
- relevance assessments taking place both in- and outside of the immediate information acquisition, and in relation to both progress and content.

In all fairness, the comprehensive contexts for performing real (work) tasks is neither possible, nor meaningful, to include in every individual research design, but fully ignoring the relationships between information needs, risks leading to limited, short-sighted and possibly false results. Consequently, applications introduced to the real world may lack validity.

## **5. Conclusion**

In this article we have proposed a conceptual framework of task-based information needs for research analytical purposes. The framework accounts for both vertical and horizontal relationships between information needs as fluid activities in work-task performance. The vertical relationships denote information needs at different levels between the workplace context and interaction with an individual information source, and the horizontal relationships between parallel information needs at the same vertical level. These relationships enrich the conceptual understanding of information needs in information studies, which previously, if considered at all, has focussed on sequential relationships. We see sequential, vertical and horizontal relationships as an analytical network that allow moving away from the black-box depiction of information needs.

We urge every study using the concept information needs – carried out in experimental or in real-life settings – to explicitly consider the following three aspects whilst constructing their research design:

*Information needs definition:* The first step to moving away from a black-boxed view on information needs is to explicitly define the concept. In order to make conclusions that have real value for future work, it is necessary to be able to compare results with an actual understanding of the referred information needs.

*Partial information needs/multiple information sources:* There is a need to acknowledge that one (work) task does not necessarily relate to one single information need. Many tasks consist of several information needs that are directed towards different goals and different information sources. It is unrealistic to expect that all parts of the overall information needs are sought from one information source. If only a single information source/system is under study, it is necessary to relate it to other information sources. The participants should, at least, be provided with a change to ponder what other sources they would likely use if in a real situation. Such data indicate not only the role of studied source/system in connection to other sources/systems, but also possibilities to develop its content and connections to other sources.

*Participants' context:* Carrying out (work) tasks is about learning and becoming aware. In real-life, work tasks are part of interaction among peers and superiors at the workplace, making information needs and information resources part of – socially constructed and materially supported – shared understandings of what is (in)appropriate and what is (not) useful. In routine tasks, the participants rely on past learning whereas in complex tasks, learning is more explicitly present. The actual capacity of managing tasks affects both the perception and treatment of information needs. For instance, being able to determine what is a good enough resolution for a task appropriates set goals and invested efforts in information seeking and searching. This means that research designs need to consider the (lack of) real consequences for the information-related activities studied. For instance, properly calibrated experimental tasks help to diminish the risk of superficial and unrealistic participation, as well as the risk for invalid results.

To summarize, we present the following implications for future research using task-based information needs as one of their basic concepts:

1. Relevance of information collected from a source may be assessed outside its immediate acquisition, e.g. in relation to the work task and its context, as well as in relation to other interactions and collected pieces of information.
2. Usefulness of information collected from any source is always assessed against the perceived progress towards the goals of the primary (work) task.
3. One information source may offer all information required to reach a resolution for the primary (work) task, but often, several information sources are consulted in concert, which moderates what information is expected from any one source.
4. Work-task requirements and resolutions are legitimized in the workplace context, which means that certain information needs and ways to attend them are biased towards socially accepted ones.
5. Carrying out work includes becoming aware of both what information is preferred and from which sources.

The first three statements (1-3) have direct implications for the research field of interactive information retrieval relying on task-based information needs. The three last ones (3-5) have implications for re-introducing (task-based) information needs as a concept within the research field of information behaviour. All five of them facilitate comprehensive conceptualization of information needs and richer empirical findings. We are convinced that several research fields within information studies, such as the fields of information behaviour (IB) and interactive information retrieval (IIR), will benefit from treating one of their most widely used concepts in a more conscious, versatile and reflexive manner than is currently the case.

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