Information: Fundamental positions and their implications for information systems research, education and practice

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ARTICLE INFO

ABSTRACT

Information is an important concept for the "information age", the "information society" and the discipline of Information Systems (IS). However, different conceptions of information often make incommensurable assumptions about what information is. This essay introduces a 'consequential framework' revealing different assumptions made about the nature of information and the consequences following from these assumptions. According to this consequential framework four stances on the existence of information can be distinguished: (1) A first stance assumes information to exist independently of humans as part of the physical world, for instance, in the structure of the universe or the transmission of signals; (2) a second stance assumes that information exists in signs but in a observer independent way, such as in objective facts about things; (3) a third stance assumes that information exists only in relation to a subject, so that the same document, report or data will convey different information to different individuals; (4) a fourth stance assumes information to exist within a sociocultural setting, as lawyers, doctors or accountants differ in what is information to them. Each of these four stances makes vastly different assumptions about how information can be accessed and used by humans. This has further consequences for how information can be researched and how related concepts, such as data, signs, technology, or social context can be related to the study of information. The consequential framework introduced offers conceptual clarity regarding a central but largely ignored concept for IS and its reference disciplines.

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1. Introduction

Academic fields require shared agreement about concepts that are central to their research as they provide the "theoretical glue" that helps different branches of a field to relate to each other and form a coherent whole (Whetten, 1989). One central concept that is of apparent importance to Information Systems (IS) is the concept of information. However, to date, engagement with information at a theoretical and conceptual level in IS is limited (Baskerville, 2010; Lee, 2004, 2010). This is despite repeated calls by IS researchers over the last four decades to engage more thoroughly with information as a concept (e.g. Boland, 1987; Checkland & Holwell, 1998; Galliers, 1987; Lee, 2004, 2010; Mingers, 1995; Stamper, 1973).

In order to overcome the lack of thorough conceptual engagement with information, IS researchers require greater conceptual clarity as to the range of existing conceptions of information, how conceptions differ from each other in their assumptions about what information is, and subsequently what conceptions are useful for different research purposes. This is important as

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conceptions of information are grounded in diverse fundamental assumptions about how information exists and is accessible by humans. Proper engagement with existing conceptions of information is thus essential for developing conceptual clarity (Lee, 2010). Moreover, understanding how conceptions differ is necessary for identifying approaches to information that are appropriate and promising for advancing engagement with different IS research problems.

This essay addresses the need of IS scholars to more effectively deploy information as a key concept in their research. The aims of this essay are thus: (1) to assist IS scholars in orienting themselves within the existing body of literature that engages conceptually with information within IS and its reference disciplines; and more importantly, (2) to reveal how conceptions of information differ in their assumptions as to how information exists and thus becomes accessible and approachable for IS research, practice, and education. By providing a structured framework of the range of existing conceptions of information this essay empowers IS researchers to develop greater conceptual clarity as to what information is and how it can be used productively as a concept for IS research. Instead of defining one 'correct' or 'best' conception for understanding information the framework introduced here equips IS researchers with meta understanding of the information concept in order to support them in the development of new and diverse conceptions to information for IS.

A prerequisite for IS to advance its conceptual engagement with information is therefore organized awareness of the wealth of existing conceptions of information. However, the body of literature in IS reference disciplines engaging with information at a conceptual and theoretical level is immense (Bates, 2010; Zaliwski, 2011) and currently no structured overview exists that can assist IS researchers in understanding the complete range of existing conceptions of information and how they are different from each other. Published surveys of information, within IS, are scant and only provide limited coverage of the range of currently existing conceptions to information. Mingers' (1996) review focuses on the relationship between information and meaning, and McKinney and Yoos (2010) taxonomy is limited in its coverage, as it is an application of their own conception of information rather than something that is grounded in the literature on information.

To support IS researchers in engaging with information in their own research this essay does three things: Firstly, through an extensive survey of existing conceptions of information taken-for-granted assumptions underlying different conceptions of information are revealed. The essay thus develops 'meta-knowledge about the subject area' (Schwarz, Mehta, Johnson, & Chin, 2007) as it distinguishes four fundamentally different stances for understanding information among existing conceptions of information. Based on this a framework is developed that supports an accumulative research tradition in IS as differences and nuances among conceptions to information are compared and researchers can thus more easily build on conceptions of information provided by others.

Secondly, revealing that each of the four stances makes different assumptions about the nature and existence of information the essay discusses consequences following from each of the four different stances. That is, different stances on information have implications for understanding other important IS concepts such as data, knowledge, signs, human beings, social context, and technology. The essay thus introduces a 'consequential framework' disclosing how a particular stance on information has consequences for understanding other central IS concepts.

Thirdly, the consequential framework also acts as a gateway into the wider literature on information as it indicates how different branches of IS research may start advancing their conceptual engagement with information by working with particular stances present within the existing literature. Specifically, design science, behavioral research, and socio-technical IS research differ in their assumptions regarding the role and importance of technology, cognition, or organizational context for their research. Different branches of IS research therefore take different directions when looking at IS phenomena and are thus likely to approach information differently. The consequential framework of existing conceptions of information thus provides actionable suggestions on how to improve conceptual engagement with information in a wide range of IS research, while explicitly advocating diversity by acknowledging that researchers will and should bring different assumptions to their work. Doing this, the consequential framework contributes towards greater conceptual clarity regarding information and at the same time, responds to calls for more diversity in conceptualizing information in IS.

2. Existing meta-knowledge on information in IS

How information is described at a meta-level, that is how information is conceptualized and described across different research publications, is important as such meta-knowledge guides how the concept of information can be understood and used for IS research, practice, and education. The following section critically reviews the current state of established meta-knowledge of the information concept in IS.

At a broad level two conceptions for understanding information dominate IS research and teaching. The first conception understands information as data that is processed. In a survey of the current use of the information concept in IS research McKinney and Yoos (2010) argue that most IS research adopts a 'token view' of information according to which information is an "undifferentiated commodity of data bits that are processed" (McKinney & Yoos, 2010, p. 331). As data processed at some point may be further processed at another point this raises the question of how much processing is needed to convert data into information (Brier, 2004; Buckland, 1991; Mingers & Standing, 2014; Stamper, 1985). Furthermore, as there is no clear understanding of how information is different from data, the conception of information as processed data conflates the concepts of data and information (Lee, 2010). This restricts the ability to employ information as a separate and powerful concept in IS research (Lee, 2004, 2010).

The second conception introduces information as the middle ground between data and knowledge and sometimes also wisdom as part of the so called 'DIKW' hierarchy. This conception for understanding information is prevalent in IS textbooks

where the different levels of the DIKW hierarchy are described as increasing levels of understanding or order (Rowley, 2007). While the DIKW conception can offer an intuitive starting point for classroom discussions about information and its difference from data and knowledge, it has been critiqued as imprecise and as insufficient foundation for research (Bates, 2010; Davenport, 1997; Fricke, 2009). For instance, the DIKW conception takes data as objective (Mingers, 1995) and unproblematic, however, data itself can be seen as something that requires knowledge for its creation (Kettinger & Li, 2010; Tuomi, 1999). This therefore questions the existence of distinct hierarchical levels among data, information, and knowledge and therefore the very foundation of the DIKW hierarchy (Saab, Riss, & Uwe, 2011; Stenmark, 2001).

It is important to engage with alternative conceptions of information, beyond the two discussed above. For this IS can draw from an existing rich and diverse body of primary literature conceptualizing information (Bates, 2010; Zaliwski, 2011). Within this extensive body of primary literature different assumptions are made about information, such as, how information exists and becomes accessible to humans. As IS research is interested in a range of different phenomena, different conceptions of information will be useful for advancing different streams of IS research. Rather than advancing one particular notion of information IS researchers should be encouraged to explore and work with different conceptions of information to be used by IS researchers interested in, for instance, design science, the adoption and use of technology, or socio-technical phenomena. A framework of the existing literature conceptualizing information is essential for this as it facilitates orientation and supports IS researchers in developing conceptual clarity regarding information.

Within IS attempts to provide an overview of the information concept are scant. Important exceptions are McKinney and Yoos (2010) and Mingers (1996) who both review different conceptions of information but fail to provide a framework organizing the broad range of existing conceptions of information.

The taxonomy introduced by McKinney and Yoos (2010) does not engage with the broader body of literature on information as it takes a particular conception of information to as its starting point: "Our taxonomy is not a descriptive attempt to cluster historical and current uses of the term information. That is, the taxonomy did not emerge from the literature. […] This taxonomy is the application of [our own] relational theory of information" (p. 330). Therefore, McKinney and Yoos do not provide an exhaustive overview over existing conceptions of information as their taxonomy leaves out, for instance, sociocultural conceptions of information.

Mingers' (1996) review compares different semiotic conceptions of information with the aim of identifying the most promising conception for IS. For this, Mingers evaluates different conceptions regarding a) their potential to accommodate semantic and pragmatic aspects; b) their applicability to non-linguistic material such as maps or events; c) if conceptions are consistent with other disciplines and with common usage; and d) the relation of information to meaning, as "any account of *information* must also deal explicitly with its relationship to *meaning*" (p. 189, emphasis in original). Mingers, therefore, is selective in his engagement with the extensive primary literature on information. Furthermore, Mingers' focus on identifying the best conception for IS and thus overlooks that different conceptions of information have different strengths and limitations for conceptualizing information and consequently different conceptions may be applied as analytic lenses to different research problems in IS.

Both, McKinney and Yoos (2010) and Mingers (1996), therefore, do not engage with the broader range of existing conceptions of information and thus cannot critically examining the assumptions underlying different conceptions of information. As a result there is currently no framework that can help IS researchers, practitioners, and students when they seek general orientation into how information can be conceptualized. Thus, IS researchers currently lack orientation, conceptual clarity, and a gateway into the complete range of primary literature on information. The consequential framework provided in this essay addresses this need for an exhaustive and critical assessment of the range of existing conceptions of information.

3. Research approach

In this work meta-knowledge about the information concept was developed through three steps. The first step involved extensive reading of different writings on information in order to gain a thorough understanding of the range of existing conceptions of information and their key claims. The second step developed a framework for ordering this literature by engaging with key assumptions underlying different conceptions of information. The third step assessed the framework of the literature to ensure that the aims of developing a clear and applicable framework are met.

3.1. Step 1, identifying literature

There are literally thousands of publications discussing information on a theoretical and conceptual level across IS and its reference disciplines (c.f. Bates, 2010; Zaliwski, 2011). Relevant literature on information was thus reviewed in a way that ensured appropriate *breadth* in the coverage of the broad range of existing conceptions of information, while also ensuring *depth* in covering particular conceptions of information that are of interest to IS. The hermeneutic approach for conducting literature reviews (Boell & Cecez-Kecmanovic, 2014) was used for achieving these aims of breath and depth (Hart, 1998). Following this approach, breadth and depth are the result of an ongoing understanding process through the dialectic engagement with relevant literature as the review iterates between a deepening understanding of a whole body of literature and individual publications forming its parts. As the review progressed, deeper understanding of the literature and its boundaries was built by contrasting and comparing different conceptions of information with each other, which in turn enabled the location of further relevant literature (c.f. Boell & Cecez-Kecmanovic, 2014).

To further facilitate breadth in the coverage of the literature we made use of existing literature reviews on information from a wide range of disciplines. This enabled extending the scope of understanding of the concept of information beyond a particular disciplinary boundary, drawing from reviews on information published in: IS (McKinney & Yoos, 2010; Mingers, 1996); library and information science (Bates, 2010; Capurro & Hjorland, 2003; Cornelius, 2002); economics (Boisot & Canals, 2004; Golan, 2006), psychology (Collins, 2007); philosophy (Floridi, 2009; Lenski, 2010); the natural sciences (Fischer, 1993); information theory (Martignon, 2001; Ritchie, 1986); computer science (Aspray, 1985); and a cross-disciplinary review in communications (Rice, McCreadie, & Chang, 2001). In addition to these reviews, understanding was further broadened through an extensive glossary of information-related terms published by Bitrum (Diaz Nafría, Pérez-Montoro, & Salto Alemany, 2010) and through the interdisciplinary journal 'Information' established in 2010 (Lin, 2010). Depth in coverage was achieved by investigating the information concept in original publications including books and articles identified by different reviews and through further searches in databases.

3.2. Step 2, developing the framework

Thorough analysis of this literature provided the foundation for developing a framework that offers orientation within the range of existing conceptions of information. This meta-knowledge of the information concept was developed as a result of a classification of the literature based on a set of explicit rules. The result is a framework that allocates conceptions of information to four different stances and is introduced in detail in the next section. Allocation of a conception to a stance is based on four rules that allow a thorough classification of the literature (Jacob, 2004; Marradi, 1990). Based on careful reading and thorough assessment of the whole range of different conceptions of information four criteria for distinguishing individual approaches to information were established: (1) A conception of information was allocated to the 'physical stance' on information if the conception relates information to physical concepts or the physical world in general. (2) A conception of information was allocated to the 'objective stance' on information if, the conception relates information to human understanding and signs where information is understood as existing objectively independently of a recipient. (3) A conception of information was allocated to the 'subject-centered stance' on information if the conception requires the appropriation of information by a subject. And (4) a conception of information was allocated to the 'sociocultural stance' on information if information is conceptualized as dependent on a wider sociocultural dimension. Allocation of publications to stances is based on how information was explicitly defined or described. In few cases where alternative or multiple definitions were given publications were allocated according to each definition.

3.3. Step 3, assessing the framework

The resulting framework was then evaluated to ensure that the overall aim of introducing a framework of different conceptions of information was achieved. One important aspect of this was that all conceptions of information found in the literature were included in the framework. The framework was also assessed to ascertain that it reveals key differences in assumptions made about the existence of information, in a way that is helpful to IS researchers for orienting themselves in the extensive body of literature. This involved presenting the framework to IS scholars, and in order to ensure wide applicability, to scholars from relevant reference disciplines. In particular feedback was sought on the clarity of the different stances introduced by the framework. Based on this feedback the framework was revised into its current final form where the framework is broadly considered to be revealing 'obvious' differences in the extant literature.

4. Stances on information

This section provides an overview of the framework of different stances on information developed using the steps outlined above. It summarizes key claims about information in the literature distinguishing four broad stances on information: physical stance, objective stance, subject-centered stance, and sociocultural stance. Before the framework of different stances on information is introduced in detail, it is important to clarify some basic concepts. Generally, two roles can be differentiated in the discussion of information: on the one hand, there is a provider of information who is sometimes referred to as the informant, provider or sender. On the other hand, there is a recipient of information who can also be referred to as the informee. For consistency, the terms 'informant' and 'informee' are used here to refer to these two roles. In addition, when not explicitly referred to otherwise, 'information' refers to that which is being exchanged between an informant and an informee (Fig. 1). However, at points it will be necessary to differentiate between that which is being provided by an informant and information. In these instances, the term 'message' is used to describe what is being exchanged between an informant and an informee. As a note of caution, while the model in Fig. 1 implies linearity, in everyday communication, the exchange of information is usually the result of a reciprocal process. In such instances, the roles of the informee and the informant can change seamlessly between communication partners. Moreover, while the model implies a one-to-one relationship, this does not necessarily have to be the case as information can
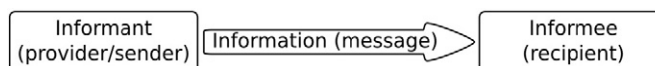

Fig. 1. Information, information, informee.

be conveyed from one informant to many informees, or one informee may be informed by a complex network, composed of several of these information dyads.

The following four sections will now introduce in detail the four different stances to information differentiated by the framework. A critical examination of all four stances regarding their underlying assumptions and implications for understanding other important concepts for IS will be provided in the section following this one. If desired, readers are encouraged to follow the pathways laid out here into the wider literature landscape to further explore different conceptions of information more closely as they see fit for their particular interests and endeavors.

5. The physical stance on information

The first stance of conceptions to information is labeled 'physical stance on information' because all conceptions within this stance relate information to physical concepts or the physical world. Information is seen as a physically measurable unit or as related to physical entities, such as structure. The physical stance on information is possibly the most prevalent stream of conceptions in the extant literature on information.

Generally physical conceptions understand information as something that exists independently of humans as part of the physical world. None of the conceptions within the physical stance relate information to meaning or signs. A physical stance on information is advocated in numerous publications on information often in, but not only, physics, engineering, signal processing and other 'hard' sciences. Several, at times partially overlapping, approaches for conceptualizing information can be differentiated within the physical stance. The firsts approach understands information as a **fundamental physical construct**, a second relates information to **structure**, a third links information to **structuring processes**, and a fourth approach links information to the **transmission of signals** (Table 1).

5.1. Fundamental physical construct

Some authors argue that information is as fundamental to the physical world as are matter and energy: "the only thing in the universe that does not contain information is total entropy; that alone is pattern-free," (Bates, 2006, p. 1033). Therefore Stonier (1989) argues that information should be given similar importance as other fundamental physical concepts such as matter and energy (Stonier, 1989). Others go even further by claiming that information is more fundamental to understanding the make-up of the world than the concepts of matter or energy (Landauer, 1996; Wheeler, 1990). Conceptions of information as a fundamental physical construct often relate information to the concept of thermodynamic entropy (e.g. Leff & Rex, 2003), arguing that while entropy is a measure of disorder, information is a measure of order (Stonier, 1989).

5.1.1. Structure

Structural conceptions of information argue that information is related to a particular structure formed by entities in the physical world. Simply put, the same group of physical objects can be arranged in different ways and information is that which is required to describe the number of different ways in which objects can be arranged in a particular setting (Zaliwski, 2011). Bates (2005) thus argued that one possible definition for information is "the pattern of organization of matter and energy". This view is also contained in the more abstract definition found in cybernetics stating that, "the amount of information in a system is a measure of its degree of organization" (Wiener, 1961, p. 11).

5.1.2. Structuring process

Other physical conceptions have linked information to a structuring or ordering process rather than to structure as such. For instance Losee (1997) argued that all types and usages of information can be described as the outcome of a process and therefore abstractly defines information in terms of a process: "[i]nformation is produced by all processes and it is the values of characteristics in the processes' output that are information" (Losee, 1997, p. 256). Other similarly abstract definition of information are "[i]nformation is that which is capable of transforming structure" (Belkin & Robertson, 1976, p. 198), Karpatschof (2000) who

Table 1
The physical stance on information.

Information as…	Description	Exemplary definition
Fundamental physical construct	Information is seen as a fundamental property of the material world.	"Information is more fundamental than space [sic] time and energy." (Mukhopadhyay, 2008, p. 27)
Related to structure	Information is the way in which the world is structured.	"Information is the pattern of organization of matter and energy." (Bates, 2005)
Linked to structuring process	Information is the process by which the world is structured.	"Information is produced by all processes and it is the values of characteristics in the processes' output that are information." (Losee, 1997, p. 256)
The transmission of signals	Information are signals transmitted between a sender and a recipient.	"a unit for measuring information […] may be called binary digits, or more briefly bits," (Shannon, 1948, p. 380)

defines information abstractly as any kind of 'release mechanism', or Colgate and Ziock (2011) who argued that information is something that has been selected.

Abstract definitions of information can relate information to any kind of structure or structuring processes, potentially beyond physical ones. However, by offering a flexible and far reaching definition, a definition loses some of its ability to precisely capture what information is. In the end many things beyond information can be described, for example, as outcome of a process or as capable of transforming structure. This begs the question how one can differentiate among information and other outcomes of a process, such as a car coming off a production line?

5.1.3. Transmission of signals

Probably the best known and influential conception of information is Shannon's (1948) mathematical theory of communication (MTC) which is also often labeled 'information theory'. Importantly, while the label 'information theory' implies a general theory of information, this was actually not Shannon's intention, as his primary interest was not information, but the transmission of physical signals in the presence of noise. Shannon argued that the smallest amount of information that can be transferred between an informant and an informee is the ability to differentiate between two states, which he called a 'binary digit' or 'bit' for short. Together with this measure, Shannon introduced a model of communication which differentiates several aspects that affect the transmission of messages from an informant to an informee (Fig. 2): on the sender's side, a message will need to be encoded first; it is then sent as signals as a sequence of symbols through a channel where it is subject to noise that can distort the signal; and finally, on the receiver's side, the signal has to be decoded again. Shannon's contribution was the development of a calculus for estimating the amount of information that can be sent through a channel given a specific degree of noise resistance. Those interested can find a comprehensible introduction to Shannon's (1948) calculus in Floridi (2009). Importantly, Shannon himself noted, as he was interested in the accurate reproduction of the signals that were initially sent, the question of whether a transmitted message is actually meaningful, relevant or useful is irrelevant as such concerns are not part of his theory (Shannon, 1948, p. 379). Two aspects related to Shannon's work have become influential in the wider literature regarding information. Firstly, Shannon linked information with the concepts of uncertainty and information entropy (which is not to be confused with physical entropy). And secondly, Shannon's model of communication was quickly picked up as a more general model of human communication and information exchange (Shannon & Weaver, 1949).

Finally understanding information as the physically processing of signals John von Neumann (1951) developed a general theory of automata and Turing (1936) theorized the limitation of the computability of problems in his theory of computation. Further introduction to the contributions of Turing and von Neumann is provided by Aspray (1985).

5.2. The objective stance on information

The second and the following stances of conceptions relate information to signs where signs are understood in Peirce's sense as: "something which stands to somebody for something in some respect or capacity" (Peirce, 1955, p. 99). Importantly this is in contrast to the transmission of signals discussed above, where the interest is in the physical reproduction of signals irrespective of if they stand to somebody for something or not.

The objective stance on information therefore encompasses conceptions that understand information as contained in signs in an observer-independent way. Authors use different approaches to argue for an objective stance on information in relation to signs. Some argue that information is objective as it is contained **observer independently in sign-vehicles**. Others seek to **differentiate information from meaning**, or to define meaning as something that is independent of a subject. And finally, some emphasize that there needs to be a correspondence between information and what is objectively the case thus arguing that information are **objective facts** (Table 2).

5.2.1. Observer independent sign-vehicles

One way of arguing for an objective stance on information is to point out that signs conveying information are bound to a medium that exist independently of a particular observer. Information is therefore a thing (Buckland, 1991) that can be contained in sign-vehicles in an objective way. Information is objective as such sign-vehicles are regarded as existing independently of a subject thus making information "any physical form of representation, or surrogate, of knowledge, or of a particular thought, used for communication" (Farradane, 1979, p. 13). As indicated by Farradane such a conception of information often makes use of a contrast between objective information and subjective knowledge. The following provides an example of a conception that expresses what information is by contrasting it with knowledge: "Information is not knowledge. We consider the former is what exists 'out there' beyond our senses; it lives in nature, in print, on hard disks, in the air. Knowledge is that which exists 'in here' behind our eyeballs" (Thorngate, 1995, p. 197). Information is thus seen as objectively existing in sign-vehicles independently of the minds of subjects. Conceptions of information as objective sign-vehicles or 'stimuli' is common in psychology but also shared by numerous
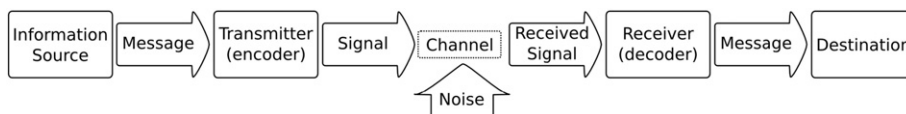

Fig. 2. Shannon's model of communication.

Table 2
The objective stance on information.

Information as …	Description	Exemplary definition
Observer independent sign-vehicles	Information is seen either as stimuli or knowledge that exists independently, outside of humans.	Information is "any physical form of representation, or surrogate, of knowledge, or of a particular thought, used for communication." (Farradane, 1979, p. 13)
Different from meaning	Information is distinguished from its interpretation. Thus meaning is created from information.	"Information is different from meaning. […] Meaning, however, is generated from information by interpreters through a process of digitalization that abstracts only some of the information available. […] humans can never experience or interact with it [information] in an unmediated way, it is literally untouchable." (Mingers, 1995, p. 295)
Objective facts	Information is facts or propositional knowledge statements that exist independently of an observer.	"Information can be regarded as a piece of knowledge of an objective kind: details about an event or a situation in the past, the present or the future, or an indisputable scientific fact such as pi = 3.14." (Wikström & Normann, 1994, p. 11)

authors outside of psychology (e.g. Kogut & Zander, 1992; Lenski, 2010). For instance, in the context of IS, systems can then be understood as storing representations of knowledge in a sense that sees information as the product created by knowledge workers (Schultze, 2000) similar to physical products created by manufacturing workers. On this view information is something that can be stored by system whereas knowledge cannot be stored.

5.2.2. Differentiating information from meaning

Other objective stances of information make use of a contrast between information and meaning. On this view, what is different for different individuals is not the information they obtain, but the meaning they generate from it (Freeman, 2000). The argument here is that while information exists objectively, it is the meaning ascribed to information when it is interpreted that is subjective (e.g. Brown & Duguid, 2000). These conceptions therefore separate information from meaning, arguing that subjective meaning is generated from objective information:

"Information is different from meaning. […] Meaning, however, is generated from information by interpreters through a process of digitalization that abstracts only some of the information available. […] humans can never experience or interact with it [information] in an unmediated way, it is literally untouchable" (Mingers, 1995, p. 295).

In contrast to this conception is Floridi's General Definition of Information (GDI) where he defines information as "syntactically well-formed and meaningful data" (Floridi, 2009, p. 19). This, however, leads to a seeming contradiction between Floridi's conception for an objective definition of information and conceptions that specifically separate information from meaning. The resolution to this contradiction is found in Floridi's particular conception of 'meaning' which he argues can exist without a subject that ascribes it, thus arguing for the existence of objective meaning in sign-vehicles and therefore objective information.

5.2.3. Information as objective facts

A final group of objective conceptions of information argue for the existence of objective state of affairs and facts to which they then relate information. Bar-Hillel and Carnap (1953) for instance argue that it is possible to assess the semantic information contained in a statement by comparing the number of different states of the universe which it excludes. The more possibilities are excluded, the greater the amount of information contained. Information is therefore conceptualized as a fraction of subject independent knowledge. Of course this is in contrast to the first group of objective conception which argues that knowledge is something that is generated from information by a subject. Dretske (1981) called statements about the world that reflect what is the case the 'informational content' of a message or sign requiring that information needs to be true, a demand shared by others (e.g. Floridi, 2004, 2009; Mingers, 2010). Facts are according to this view not open to interpretation but they are objective and so is information: "Information can be regarded as a piece of knowledge of an objective kind: details about an event or a situation in the past, the present or the future, or an indisputable scientific fact such as pi = 3.14" (Wikström & Normann, 1994, p. 11). Similar conceptions that relate information to objective facts are found in situational theory (Barwise & Perry, 1983; Israel & Perry, 1990) and channel theory (Barwise & Seligman, 1997) both of which employ a logical approach to develop a generalized account of Dretske's (1981) 'informational content'. Information is therefore sometimes associated with the smallest possible units of understanding. For instance, Devlin's (1991) extension of situation theory introduced the 'infon' as the smallest possible 'quantum of information'.

5.3. The subject-centered stance on information

The subject-centered stance on information understand information in relation to a subject. Information depends on a subject as they regard different messages as relevant or comprehensible and therefore as information to them. Subject-centered conceptions therefore commonly argue that information is something that is appropriated by a subject, which makes information something that can only exist in relation to a subject.

Different approaches for a subject-centered stance on information can be distinguished. One way for developing a subject-centered stance on information is to argue that information is something that has **meaning**, where meaning is understood as something that is not inherent in a message but something that is given by a subject. A second group of conceptions describes

information as an **internal shaping** of a subject. Yet other conceptions link information with knowledge, where knowledge is understood as something that is bound to a subject. One move is then to understand information as a subject's **change in knowledge**. Another move is to define information as a subset of **knowledge that is relevant** in a specific situation to a particular subject (Table 3).

5.3.1. Meaning

Possibly the most common way of arguing for a subject-centered view on information in IS is to link information to meaning, where meaning is understood as something that depends on a subject. In contrast to objective stances of information that separate information from meaning, subject-centered conceptions of information closely relate information and meaning as they argue that information is something which has meaning for an informee (Denning, 2001; Kuhlen, 2004). Often such conceptions also refer to data, as they see information as data plus meaning (e.g. Checkland & Holwell, 1998; Davis & Olson, 1985; Galliers, 1993; McLeod & Schell, 2007). The essence of these conceptions is thus that: "information is the meaning someone assigns to data. Information then exists in the eyes of the beholder; the same data can be nonsense to one person and gold to another" (Denning, 2001, p. 20). Defining information in terms of data as part of a hierarchical chain among data, information, knowledge and sometimes also wisdom (Ackoff, 1989) is currently the most common conception of information conveyed in IS textbooks (Rowley, 2007).

5.3.2. Internal shaping

Other subject-centered conceptions of information relate information to internal shaping of a subject, often understood as a mental shaping process of an informee. Information is thus something that alters or forms a specific informee internally, thus making information unique, individual and subjective: "[i]nformation is an inward-forming. It is the change in a person from an encounter with data. It is a change in the knowledge, beliefs, values or behavior of the person" (Boland, 1987, p. 363). As Bateson (1972) stated it, information is not simply a detectable difference, but "a difference which makes a difference" (p. 459) as information triggers 'neural pathways' as it travels along them (p. 459). In IS Langefors (1980) proposed an interactive model according to which information is the result of the interaction of data with a mental structure at a specific point in time. More generally it is argued that information should be understood as 'in-formation' (Boland, 1987; Cole, 1994) or as 'inward-forming' (Pratt, 1977). These conceptions therefore claim that they relate information to its Latin root 'informatio' (Capurro, 2009), where 'in' refers to in/within and 'formare' to shaping or giving form (Pratt, 1977). Hence information is seen as an internal shaping of a recipient.

5.3.3. Change in knowledge

Conceptions linking information to a change in a subject knowledge are often related to conceptions of information as internal shaping. However they are more specific as they explicitly state that what is shaped is a subject's knowledge. This relation of information to knowledge change was most succinctly expressed by Brookes (1980) who abstractly stated that a knowledge structure 'K(S)' is altered by the encounter with information 'ΔI', or simply: 'K(S) + ΔI = K(S + ΔS)', which can be paraphrased as: information is a "message understood by the informee and which changes that person's knowledge base" (Meadow & Yuan, 1997, p. 705). From this conception of information follows that if an informee already knows something it cannot be regarded as information (Paisley, 1980). Furthermore what also follows is what MacKay (1969) called 'conditional readiness' or 'state of conditional readiness' (SCR), namely that an informee's predispositions will determine their ability to be informed by particular messages. Accordingly what is regarded as information will depend on an informees prior knowledge and understanding.

5.3.4. Knowledge that is relevant

The last group within the subject centered stance understands information as a subset of knowledge that provides the possibility of taking action (Galliers, 1987; Mason & Mitroff, 1973). However, this does not make information a mental concept, but it emphasizes that subjects frequently need to find out, compare or assess reports, accounts, or data in order to make decisions and take action. Information is thus "the subset of knowledge which is needed by but not available to a specific person in a concrete situation in order to solve a problem" (Kuhlen, 1991, p. 98). This understanding of information as specific knowledge that is of relevance to a subject in a particular situation is made by several authors. For instance, information is described as something

Table 3
The subject-centered stance on information.

Information as …	Description	Exemplary definition
Linked to meaning	Information is data that are meaningful to a recipient.	"information is the meaning someone assigns to data. Information thus exists in the eyes of the beholder; the same data can be nonsense to one person and gold to another." (Denning, 2001, p. 20)
Internal shaping	Information is an inward forming process of a subject.	"Information is an inward-forming. It is the change in a person from an encounter with data. It is a change in the knowledge, beliefs, values or behavior of the person." (Boland, 1987, p. 363)
Change in knowledge	Information is a change in the knowledge of a subject.	Information is "[a] message understood by the recipient and which changes that person's knowledge base" (Meadow & Yuan, 1997, p. 705)
Knowledge that is relevant	Information is action or goal-related knowledge.	"It [information] is the subset of knowledge that is needed (but for the time being unavailable) for solving a problem." (Fischer, 1993, p. 230)

that: provides guidance (Davenport, 1997); is useful (Lewis, 1991; Machlup, 1983); is needed to fix problems (Taylor, 1986); as relevant to a problem (Capurro & Hjorland, 2003; Fischer, 1993); or as answers to specific questions (Alfino & Pierce, 2001). Due to its emphasis on the relevance of information for action, this view of information is also labeled as the 'pragmatic view' (Kuhlen, 1991). One can argue that the enterprise of researching, developing and building IS is driven by such a pragmatic view of information. IS are valuable precisely because they produce information that guides decision, or can help in fixing problems.

5.4. The sociocultural stance on information

Sociocultural stances on information point out that information depends on a wider sociocultural setting. Information is thus conceptualized at the group level rather than the individual level (Ciborra, 2002), as information "cannot be understood at the level of the individual, that is, at the cognitive level of individual psychology, because it arises through ongoing interactions among members of a group" (Goguen, 1997, p. 34). Sociocultural conceptions, therefore, emphasize the importance of society and culture as necessary for signs to become meaningful and relevant and therefore for information to exist. Information (systems) only exists within this sociocultural background and therefore cannot be separated from it. What is considered as significant, technologically possible, or the things for which one has labels, categories and words, and thus can connote information, will change from sociocultural setting to sociocultural setting. Information is therefore at least as dependent on sociocultural 'context' as much as it is dependent on an individual's 'cognition' (Tabak, 2014).

A Sociocultural stance on information is argued for in different ways. One group of conceptions emphasize that information depends on a **shared social setting** within which information can exist, for instance for lawyers, engineers or doctors. Other conceptions look further and relate information to a **shared life world** within a cultural setting. Yet others take a **historical view** as they look at information over time as new technologies, ways of thinking, or practices emerge and change what is understood to be information (Table 4).

5.4.1. Shared social setting

Social conceptions to information argue that what can be considered as information is based on a shared understanding of the world by a particular group in a particular setting (Capurro & Hjorland, 2003). Information "is a social construct, [it] is created and tailored on purpose by somebody for somebody else or collectively, accepted, believed, or propagated through social interactions" (Castelfranchi, 2002, p. 381). Information is thus related to inter-subjective meaning-making based on what a group of social actors agree to be meaningful and relevant in a particular social setting (Beynon-Davies, 2011) or a given situation (Cooper, 1992). For instance, the social dimension of information is evident when looking at what is considered as information by different actors within an organization or department. Information will depend on work roles and social status (Davenport, 1997). Furthermore, information will depend on training and education as well as on one's legal, political and economic entitlement (Rice et al., 2001). This group of sociocultural conceptions of information is thus build around the argument that information cannot be fully conceptualized without considering information as having a social dimension (Alfino & Pierce, 2001; Hakken, 1999; Introna, 1997; Liebenau & Backhouse, 1990; Romm, 1997; Stamper, 1991).

5.4.2. Shared life-world

Another approach to argue for a sociocultural stance on information is made by relating information to culture. The key difference to social conceptions is that a cultural context is understood to be much wider than a social context in the sense that "[i]nformation is impossible without a society and its shared culture" (Stamper, 1992, p. 32). Conceptions approaching information through culture therefore argue that cultural context is important in determining what information is and can be (Cornelius, 1996). This cultural dimension opens up, and also restricts, the space for the possibility of the existence of information. For instance, cultures differ in the way how they are open to critical or rational argumentation and therefore to what extend a critical assessment of a problem will be regarded as information or can even be expressed (Fuchs, 2009). In particular, the wider cultural dimension of information is evident in language (Blair, 2006). Words do not simply refer to the "same" thing in different languages, but instead evoke some concepts in one language that can be completely absent in another (c.f. Hjorland,

Table 4
The sociocultural stance on information

Information as …	Description	Exemplary definition
Shared social setting	Information is specified by a social context determining what is regarded as information.	"[a]n item of information is an interpretation of a configuration of signs for which members of some social group are accountable." (Goguen, 1997, p. 31)
Shared life-world	Information is determined by cultural factors that provide the foundation for the possibility of information.	"information is properly seen not as an objective independent entity as part of a 'real world', but that it is a human artifact, constructed and reconstructed within social situations. […] every bit of information is only information when understood within its own cultural packaging which allows us to interpret it." (Cornelius, 1996, p. 19)
Historical	Information is made possible on the basis of inventions, discoveries, economic developments and technologies.	"Hence what counts as 'information' will never be static, or subject to only one definition; it too will be in a state of flux." (Checkland & Holwell, 1998, p. 238)

2007). Information is therefore not contained in words but something that arises through the cultural practices that put these words into use (Wittgenstein, 1953). Therefore, what counts as a symbol and therefore is accepted as worthy to be symbolized in the first place will depend on a wider cultural context within which symbols are used (Brier, 2004).

5.4.3. The historical view

A final group of conceptions to information underline the sociocultural dimension by looking at information from a historical perspective (e.g. Borgmann, 1999; Wright, 2007). The way information is created, collected and disseminated is influenced by political, technological, social and economic forces at work at particular times in history. Information is sociocultural, as how one is informed and therefore what information is requires understanding of information practices existing at a particular point in history (Frohmann, 2004). An obvious example is the invention of the printing press using movable type. This technology not only dramatically changed the economics for the production and distribution of written material, but also by making newspapers possible, completely changed the ways in which people become informed and thus what is considered to be information (Wright, 2007). Other conceptions taking a historical perspective point to the development and use of different formal notation systems. Such notation systems do not simply represent specific information that existed prior to them, but instead have a profound effect on what and how things are perceived as information by cultures and societies (Borgmann, 1999; Hjorland, 2007). One example used by historical perspectives it the use of clay tokens in Mesopotamia (Beynon-Davies, 2009). It is argued that these clay tokens not only gave rise to the invention of writing and the alphabet, but by doing so profoundly changed what can be information to humans (Borgmann, 1999).

5.5. Differences and implications of stances on information

The four stances on information differ fundamentally in their assumptions about the existence of information. That is, each relies on different claims about the nature of information. Awareness of these differences is important as they influence how information becomes accessible to humans and therefore how the concept of information can be fruitfully employed in research (Table 5 - existence of information in the world). Hence the notion of a *consequential framework*, as stance on information are not just different, but as different consequences follow from these differences.

A physical stance on information conceptualize information as existing objectively and independently of humans as part of a measurable physical world. Information exists without human observation or intervention. Processes of signal transmission or

Table 5
Comparison of Differences among the Four Stances on Information.

Depiction of information regarding	Physical stance	Objective stance	Subject-centered stance	Sociocultural stance
Existence of information in the world	Information exists independently of a human observer as part of the physical world.	Information exists independently of an observer in the sense of true facts or physical inscriptions of knowledge.	Information exists as cognitive process resulting from an observation and often in regards to a purpose.	Information exists as shared sociocultural understanding of the importance of differences.
Condition for existence	'Raw' information is acquired from the world or specified in regards to objective physical units.	Information needs to be an accurate representation of reality.	Information needs to be meaningful and relevant to a human being.	Information needs inter-subjective agreement about meaningful difference within a specific context.
Data	Data are the result of recording 'raw' information.	Data and information are often not clearly differentiable.	Data are the input from which information is generated.	Data are physical inscriptions created on the basis of a particular social, cultural and technical understanding.
Knowledge	Is not considered.	Information is atomic 'nuggets' of knowledge or physical inscriptions of knowledge.	Is created or altered as a consequence of information.	Is created through sociocultural interaction with the world and shapes how information can emerge.
Signs	Are not considered.	Are the carrier of (contain) information in an objective sense.	Are interpreted into information.	Evolve as result of inter-subjective agreement and affect what can constitute information.
Human beings	Are not considered.	Create meaning from information.	Are appropriators of information.	Are creators or interpreters of information within a sociocultural context.
Social context	Is not considered.	Is not considered.	May be present as a background.	Is considered an important aspect of information.
Technology	Captures, encodes or decodes information.	Captures, stores, process' and transmits information.	Providing input that may become information for a subject.	Are devices that can provide meaningful outputs on the basis of a shared practice.
Relevance to IS research	Research interested in the development of IT.	Research interested in the design and modeling of IS.	Research interested in behavioral and cognitive aspects of IS.	Research interested in socio-technical and sociomaterial aspects of IS.

structuring can occur at an atomic or biological level independently of whether humans existed or if humans are there to observe them. A physically stance therefore sees information as pre-given in the physical world. 'Raw' information can be captured from the world or specified unambiguously in terms of objective physical units. As information exists in the physical world the processes of capturing, measuring, storing and processing information in physical form is of particular interest.

In comparison, according to the objective stance, information exists in signs in an observer independent and objective way. That is, information is related to signs, and this relation exists independently of a particular group or individual. This makes information something that exists objectively in the world, as signs contain information independently of individuals. The objective stance therefore requires that information is an accurate representation of reality. In this sense, physical inscriptions of signs are understood as containing information in an observer-independent way. Subsequently some objective conceptions of information demand a truth condition for the existence of information as they argue that only something that is true can be information. Information can, therefore, be researched as an objectively existing artifact, with a particular interest being in the accuracy of representations enabled or captured by IT artifacts.

According to the subject-centered stance information can only exist if signs are meaningful, understandable and relevant to a subject. The existence of information, therefore, requires a subject to whom signs are comprehensible and relevant as information can only exist after signs are appropriated by an individual. Subsequently, information itself can only be something that is meaningful, understandable, or comprehensible to a subject. Research on information therefore focuses on a subject for whom representations may or may not be information. What is of interest is how representations become meaningful, relevant or actionable for an individual.

A sociocultural stance on information underlines that information always involves an informant and an informee and therefore a social process (Lenski, 2010; Machlup, 1983). Signs used in social settings for exchanging information require a social and cultural background within which they can stand for something to somebody. The existence of information is therefore impossible without a sociocultural background that enables an informant and an informee to share meaning and relevance. According to the sociocultural stance shared understanding among members of a social group is essential for the existence of information. Information thus can only be what members of a group agree upon, at least tacitly, to be meaningful and relevant to them in particular situations. What is of interest is therefore how representations emerge and become meaningful within particular social settings, and how these negotiated meanings manifest and change over time.

Furthermore, the four different stances on information also differ in their implied relation to other important concepts. Table 5 provides an overview regarding other concepts that are of particular interest to IS: data, knowledge, signs, human beings, social context, and technology. For instance, according to many objective conceptions, data and information are indistinguishable. In contrast, according to subject-centered accounts, data leads to information, as humans can only encounter information after data is appropriated by them. Different conceptions to information, therefore, not only have implications for the understanding of information itself, but also for understanding of concepts related to information. Importantly, this indicates a two-way relationship. On the one hand, the way information is understood has an effect on the understanding of related concepts. This is indicated in Table 5 when looking at how different views on information are closely linked to particular understandings of, for instance, data or knowledge. On the other hand, the understanding of related concepts affects the conception of information. For instance, if technology is seen as devices that capture, store or process representations about organizational reality, this is likely to imply or require an objective understanding of information.

6. Discussion

The consequential framework of information above has implications for research, practice and education in IS. Regarding IS research the consequential framework indicates that different stance on information offer appropriate starting points for deeper conceptual engagement with information for different IS research projects. Furthermore, the consequential framework supports IS practice by offering a means for communicating about practical problems among a diverse group of practitioners. Finally, IS education can benefit from a more thorough and nuanced engagement with information.

6.1. Relevance to IS research

"within the IS field we find people making very different assumptions about [information], either consciously or implicitly, and this leads to the very different schools of thought in IS work." (Checkland & Holwell, 1998, p. 40)

Different IS research topics require engagement with different conceptions of information and are therefore likely to draw from different parts of the information literature. The consequential framework introduced here supports IS researchers when faced with the decision of choosing a particular conception of information for a research project.

Three broad schools of IS works are commonly recognized. One interested in the development of IT artifacts, another interested in the cognitive processes of the adoption and use of IT artifacts (Hevner, March, Park, & Ram, 2004; Kwan, Chan, & Lam, 2012), and a third looking at IT artifacts within a wider organizational or societal context (Cecez-Kecmanovic, Galliers, Henfridsson, Newell, & Vidgen, 2014; Mumford, 2006). These three areas, very roughly can be characterized as design science IS, behavioral IS, and socio-technical IS. Design science IS may find a good starting point for theorizing information in objective stances on information. Behavioral IS researchers may set out by engaging with subject-centered stances on information, and

socio-technical IS may draw from sociocultural stances on information. While these stances on information are offered as possible starting points for deeper conceptual engagement with information they should not be seen as end points. Exciting research may also be founded by adopting other conceptions of information than the ones outlined here as starting points, or by combining different conceptions as analytic lenses for looking at a particular research problem.

Design Science IS "creates and evaluates IT artifacts intended to solve identified organizational problems" (Hevner et al., 2004, p. 77). Design science research is, for instance, interested in the development of design principles (e.g. Chaturvedi, Dolk, & Drnevich, 2011) or theory guiding the improvement, invention or exaptation (adopting solutions to new problems) of IT artifacts (e.g. Gregor & Hevner, 2013). One exemplary problem faced when designing artifacts is how to efficiently create and interrelate representations during the modeling stage. Generally, design science conceptualizes the manipulation of tokens by systems as ontological independent of particular social actors. This understanding of observer independence is close to objective stance on information discussed above, which may, for instance, help in engaging with the problem of how to efficiently create and interrelate representations for modeling. In particular, conceptions to information as factual may reveal possible novel ways for approaching how information is captured and transmitted by IS. Research may thus build on factual conceptions of information by Dretske (1981, 1983), situation theory (Barwise & Perry, 1983), situation logic (Israel & Perry, 1990) or channel theory (Barwise & Seligman, 1997).

By contrast, behavioral IS studies how individuals make sense of, use and adopt technology. It seeks "to predict or explain phenomena that occur with respect to the artifact's use (intention to use), perceived usefulness, and impact on individuals" (Hevner et al., 2004, p. 77). Research is, for instance, interested in the efficient use of technology (e.g. Burton-Jones & Grange, 2013), or the acceptance of technology (e.g. Hess, Mcnab, & Basoglu, 2014). Two important concepts frequently researched in this context are the 'usefulness' and 'ease of use' of IT artifacts. However, such concepts require a human actor for whom technology becomes useful or easy to use thus generally considering subjects as important to researched phenomena. This understanding is shared with the subject-centered stance on information, which therefore may contribute to theory development for behavioral IS. For instance, behavioral IS is currently lacking deeper engagement with users needs and traits and could advance theorizing around technology related conceptions such as 'ease of use' and 'usefulness' by drawing from information needs and information behavior research (e.g. Case, 2012; Pirolli, 2007).

Socio-technical IS conceptualizes technology within a social context, being generally interested in phenomena emerging at the intersection between the technical and the social. Theories within this stream of IS research are, for instance, interested in the role of technology in organizational change (e.g. Leonardi, 2011), the role of power and rationality in IS practice (e.g. Avgerou and McGrath, 2007), or how groups of users can differ in what they desire an IS to capture, process and store for them (e.g. Faÿ, Introna, & Puyou, 2010). Generally, socio-technical IS research considers technology as meaningful and relevant in relation to a shared practices among social actors. This understanding of the importance of shared social practice is also central to sociocultural stances on information. Thus, research on how information is related to specific situations or the members of a particular group (Cooper, 1992; Goguen, 1997) can support IS in investigating how users differ in their expectations regarding what an IS should capture and provide for them.

Finally, physical aspects of computation are important for the development of information technology (IT). For instance, the development of integrated circuits vastly changed IT, and quantum computing may do the same. However, physical aspects of computation are generally not of direct concern to IS, as IS specifically links IT to use (Paul, 2010). Thus the body of literature engaging in information from a physically grounded perspective (e.g. Stonier, 1989; Vedral, 2010) is only of limited use to IS despite its relative prevalence in the general literature on information. Nevertheless, when physically grounded conceptions are formulated abstractly they become applicable to a range of other domains of theorizing in IS. For instance, IS research may be able to abstract ideas in the literature approaching information as structure or as structuring processes in innovative ways. Furthermore, while it is not central to IS, aspects related to the performance of IT can still be relevant to some IS research projects.

6.2. Relevance to IS practice

The primary relevance of the framework for practice is that it reflects the range of different understandings of information that IS practitioners bring to their work. When professionals speak of and work with 'information', depending on their roles and responsibilities, they often mean different things. The reason for this is that while IS professionals generally deal with IT they also differ markedly in their orientation towards technology. For instance, practitioners dealing with IT in terms of signal processing and algorithmic aspects generally share a scientific orientation towards information as physically measurable bits and bytes. System analysts and conceptual modeling professionals assume that processes objectively exist in the world and thus objective information about them can be discovered, captured and made available independently of individual users. In contrast, practitioners interested in the implementation and adoption of IT share a psychological conception of information according to which users, depending on their backgrounds, attitudes, and expectations, derive different information from the output provided by an IT system. Finally, practitioners managing IT infrastructure such as social media engage with IT as enabler of "real" organizational change and strategy, understand information as dependent on social processes, the culture of an organization and broader technological and societal changes.

The framework organizing different stances on information is thus also reflective of IS practice and how practitioners deal with information in different ways. Theoretical accounts of information capture orientations towards information evolving in practice as they emerge in response to increasingly broader aspects of IS practice. A practical interest in the efficient transmission of

messages via electrical signals gave rise to Shannon's (1948) physical account of information and not the other way around. Similarly, subjective accounts of information can be seen as a response to practitioners' interest in the acceptance and use of technology.

As the framework reflects orientations to information from practice, it is also offers a tool for communication that can be applied by practitioners. When evaluating an issue different aspects of information will show up as important for the success or planning depending on the stance on information that is applied to look at the phenomena. Thus the framework can be used as a lens to bring out different views of information that will suggest taking different actions. Take the case of an organization developing an app to support its business. What the app is about when it is designed will depend on how different practitioners view information enabled by technology. From a physical stance questions regarding information are in terms of the physical access to information, such as information architecture regarding where information is stored, processed and how it is transmitted. From an objective stance it becomes important to consider what information is required in different use-cases of the app. Taking a subjective stance one aspect is the design of the user interface as it is important to consider how different users are interacting with the app in different situations as part of their work. Finally, according to the sociocultural stance what becomes relevant to consider are cultural aspects such as the importance of managerial hierarchy when displaying, confirming and approving information.

6.3. Relevance to IS education

In a survey of IS textbooks Rowley (2007) found the dominant conception of information to be a hierarchy that links data, information, knowledge, and wisdom (DIKW) through an increased level of understanding (Ackoff, 1989). This view, however, is widely criticized, for instance, as being imprecise (Davenport, 1997; Stenmark, 2001); as not serving any scientific purpose (Stamper, 1985); as not allowing any deeper theorizing (Bates, 2010; Ma, 2012); or for not being able to explain why the same data can lead to different information (Fricke, 2009; Kettinger & Li, 2010; Mingers & Standing, 2014). A second conception dominating IS is one that more or less equates data and information as being the same thing (c.f. Lee, 2010). Consequently there is a need for IS to engage with alternative conceptions of information that go beyond DIKW and a token or data-like understanding of information (Lee, 2010). For instance, the aforementioned conceptions of information are limited for classes engaging with information in the context of organizational change. Neither the DIKW nor token conception can offer an explanation or tool for analysis in the context of complex social interactions among different stakeholders in an organization for whom different content will be considered information. Sociocultural stances on information may offer a much better tool for classroom debates here. Similarly hedonic IS, such as in gaming would benefit from alternative subject-centered stance on information that take into consideration emotions, moods and flow-like experience.

Moreover, discussion of different stances on information can be useful for IS education as it can support students in learning to distinguish different branches within the body of IS research and help them in analyzing problems from a practice perspective. Different understandings of information can provide orientation within the body of IS research as design science IS, behavioral IS, and socio-technical IS frequently draw from different approaches to information. Engagement with information and fundamental assumptions about information therefore can provide a way for conveying appreciation of the variety, yet coherence of the IS field and its research. Furthermore, different conceptions to information can help break down the complexity of IS problems in practice. Engagement with different perspectives can thus be used in classrooms to analyze a particular case or problem for revealing new perspectives when shifting the underlying understanding of information. Different stances of information can thus be used to structure the introduction of practical and research related IS knowledge in classrooms.

6.4. Limitations and future research

Given the abundance and richness of existing conceptions to information, a necessary first step into the direction of furthering conceptual engagement with information in IS is an extensive review and classification of existing conceptions to information. Finding diverse assumptions made about the nature of information and the ability of humans to gain access to it, the consequential framework introduced here is structured along these differences. While this enabled a thorough overview of existing conceptions other frameworks may be possible. Future research can thus build on the high-level picture provided by this consequential framework by reviewing specific conceptions of information for a particular purpose in more detail. For instance, by reviewing more specifically subject-centered conceptions of information in the context of behavioral IS research.

More importantly, the consequential framework also opens up the space in two important ways. Firstly, the framework provides a foundation for IS researchers for building unique IS conceptions of information. With a wide spectrum of available conceptions of information providing opportunities for advancing theorizing in IS, the possibilities for future research engaging more deeply with information are immense. Secondly, the framework enables IS academics to employ information more clearly in their research, lectures, textbooks and for consulting in practice. IS can therefore be self assured about being the discipline of *information* systems as thorough engagement with information becomes a more central part in IS research and education.

7. Conclusion

Schwartz (2014) suggest, one means towards disciplinary development in IS is to take "*information* as our central artifact" (Schwartz, 2014, p. 10, emphasis in original). However, already in 1987 Boland observed that the failure of IS researchers to

explore the concept of information itself is "a problem that has plagued research on information systems since the very beginning. The problem is the elusive nature of information itself, and the way we as researchers have failed to address the essence of information in our work" (p. 363). Unfortunately, in the decades following Boland's observation, not much progress has been made (Baskerville, 2010; Carter, Petter, & Randolph, 2015; Lee, 2010). This essay set out to help overcome this stalemate by lowering the threshold for IS academics to orient themselves within the range of existing conceptions of information and thus being able to engage with information more seriously in IS research.

To achieve this aim the essay developed a consequential framework of existing conceptions of information within IS and its reference disciplines, thereby overcoming incomplete coverage of the information concept by earlier reviews in IS (McKinney & Yoos, 2010; Mingers, 1996). Furthermore, the consequential framework introduced offers orientation as to how stances on information differ from each other in their assumptions about the existence of information. This framework therefore provides orientation to a vast, and potentially confusing, body of literature by introducing four different stances covering the range of different stance on information available to IS researchers. Based on the introduced consequential framework the essay lays out potential avenues how the information concept may be fruitfully appropriated by different bodies of IS research in the future.

Revealing taken for granted assumptions about information, the framework contributes to better conceptual clarity as it reduces implicit assumptions made about information (Lee, 2010). The framework therefore supports a cumulative research tradition as stance on information become clear and researchers can more easily build on each other's work. Furthermore, by outlining how different branches of IS research may draw from different conceptions of information, the framework also provides a gateway into the wider literature on information beyond what is currently used in IS. By doing so, the review addresses calls to the IS community to further its theoretical development (Gregor, 2006; Grover, Lyytinen, Srinivasan, & Tan, 2008; Weber, 2012), engage more thoroughly with central IS concepts (Baskerville, 2010; Davison, 2010; Galliers and Currie 2011; Lee, 2010; Straub & del Giudice, 2012), and diversify and transform IS research (Bryant & Land, 2012; Constantinides, Chiasson, & Introna, 2012; Hassan, 2011; Yoo, 2010). Finally, the framework supports IS in enhancing its standing as a reference discipline (Baskerville & Myers, 2002; Grover, 2012; Straub, 2006) by engaging with information as an important transdisciplinary concept (Mingers, 1996, 2010).

The framework of different stances on information is also of interest to IS practitioners and IS education as it provides a framework for breaking down complexity of IS phenomena. The interest of IS in information is multifaceted, looking at information not only from a technical, cognitive, or social perspective, but from all of these perspectives simultaneously. Different stances of information can therefore help to augment understanding of IS phenomena to encompass multiple relevant angles in practice, as exemplified above for the areas of information security and usability. Moreover, by showing the complexity of the concept of information beyond the commonly used DIKW hierarchy and data-like conceptions, the review encourages debate and a more nuanced and critical engagement with information as a concept. A more thorough engagement with information in IS can thus inspire debates around questions such as what information is, to what extent information is dependent on a goal or situation, or if information is dependent on the perspective or activities of particular actors.

Acknowledgements

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