Information as a construction

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Information as a Construction

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Abstract

The purpose of this review paper is to outline the constructivist approach to the notion of information from two perspectives. The first perspective explores the role of 'constructed' information in the 'constructivist niche'—a common name for the appropriate viewpoints in different science fields, such as cognitive and neuroscience, psychology, cybernetics, and biology of cognition. The second perspective considers Library and information science (LIS) papers in which information is treated as a constructed entity. This paper assumed the origin of the notion of information to be a construction as defined in the 'constructivist niche' that is based upon communication theory and cybernetics. Conversely, the origin of the notion of information as a construction as per LIS can be found in Bateson's definition of information as a "difference which makes the difference," as well as in the 1970s LIS definition wherein information is associated with the direction of a cognitive viewpoint, as in a 'cognitive turn.' The study showed that "information as a construction," except in a few cases, did not play a significant role in the constructivist theories as well as in LIS. LIS researchers reduce the concept of information to a subjective, socially-constructed entity which inherently results in different interpretations.

Keywords

information, constructivism, library and information science (LIS), cognitive system, cognitive domain.

Introduction

Until the 19th century, physicists have proposed at least two candidates as the 'building blocks' of the entire 'outer world': *particles* and *force fields*. However, the distinction

between the two concepts was proven artificial in the 20th century largely thanks to quantum theory. Meanwhile, two more candidates have been suggested: *relations*, which refer to how 'things' relate to one another, and *properties*, which refer to other relational features of 'things'. Both *relations* and *properties* are used to construct meaning (Kuhlman, 2016).[1]

Designating *particles* and *force fields* as the 'building blocks' of the 'outer world' or 'reality' arises from the belief that such a 'world' can be perceived in an 'objective manner'. Advocates of *relations* and *properties* as the constituents of 'reality' doubt that premise but still suppose that the 'outer world' comprises some kind of 'objectivity'. Constructivists strongly oppose both propositions. They argue that all four proposed types of the 'world building blocks', in some way, arise from the cognitive domain of the human observer. They suppose that all such 'things', like *particles* and *fields* and especially *relations* and *properties*, if they exist, 'exist' as a psychic or cognitive construction in the observer's cognitive domain as a consequence of an extraordinary event, which physicists take as default: the encounter of the observer with an unknown environment. Constructivists often refer to this 'encounter' as 'perturbation'.

To be clear, constructivists do not deny the existence of such a 'thing' as the 'outer world'. They only argue that we have no basis for using the belief in 'objectivity' of the 'outer world' to validate our scientific arguments (Von Foerster, 2003). What could be an 'objective world', "...as if there were such a thing..." (Von Foerster, 2003: 248), in this way, is irrelevant, because we always construct the world we see. One of the most prominent radical constructivist, E. von Glasersfeld, claims that knowledge is a picture that represents something else and cannot be the mirror of the 'outer world' in any sense (Glasersfeld, 1984). In the same manner, Einstein and Infeld state that we can never be quite sure if this "...picture is the only one which could explain... observations" (Einstein and Infeld, 1967: 31). The 'outer world', as the result of our inferences, is immediately externalized once it is constructed, so it appears as independent of the subject's mental or cognitive activity. Because of that, the focus of research in radical constructivism becomes the study of second order systems (the observers).

Now, we may ask, how do we know anything if the 'outer world' is our construction? In Library and information science (LIS), for example, the description of the knowledge acquisition process is indivisible from the terms of data, information and implying knowledge. In natural and technical sciences, one may say that overall knowledge relies mostly on the operation of data processing (Hayes, 1969). In that sense, the information could be 'only' "a well-formed, meaningful, and truthful data" (Floridi, 2011: 31). For example, in particle physics, what is important for confirming or denying a physicist's theories and increasing overall knowledge is processing billions of data that physicists take from the Large Hadron Collider (and others supercolliders) and

use to perform their experiments.[2] On the other side, constructivists rarely use the terms of data and information to describe the same process from their perspective. From their point of view, the process of cognition is based only on "computation of the descriptions of the 'reality'" (von Foerster, 2003: 216). In other words, the cognitive processes "... do not compute wristwatches or galaxies, but compute at best descriptions of such entities" (von Foerster, 2003: 216).[3]

"...'out there' there is no light and no color, there are only electromagnetic waves; 'out there' there is no sound and no music, there are only periodic variations of the air pressure; "out there" there is no heat and no cold, there are only moving molecules with more or less mean kinetic energy, and so on. Finally, for sure, "out there" there is no pain" (von Foerster, 2003: 233).

Although the terminology of these areas varies considerably, as is expected, it should be emphasized that the term information appears in in both kind of theories -- non-constructivist (or realist) and constructivist theories. According to the 'objective', 'realistic', non-constructivist viewpoint, information is taken "...as something objective, quantitative, and mainly associated with data..." (Robinson and Bawden, 2014: 131), which holds the 'outside world' together in pervasive interaction with matter and energy, enabling the growth of our 'objective' knowledge about that 'world'.[4] In an opposite, 'anti-realistic', 'subjective' and constructivist point of view, information is considered "... as subjective, qualitative, and mainly associated with knowledge, meaning, and understanding" (Robinson and Bawden, 2014: 131). However, in both camps of research, in the practical sense, it seems that the term information does not play a great role.

This paper aims to explore the concept of information as a construction in a constructivist niche, as well as in LIS. The term 'constructivist niche' provides a common name for the appropriate directions of thought in different science fields, such as cognitive science and neuroscience, psychology, cybernetics, and biology of cognition. Accordingly, the paper's first section provides a short overview of the constructivist viewpoint. The following chapter outlines the scientific approach to the notion of information within LIS, which is followed by a short review of the origins of constructive thought within the same field. "Information as a construction in constructivist niche" constitutes the paper's next part, which mainly discusses the notion of information in radical constructivism, possibly the most prominent kind of constructivism, together with a discussion regarding the question "Could Information Encode 'Reality'?" This section also emphasizes the approaches to the same concept by the prominent constructivists Niklas Luhmann and Heinz von Foerster. "Information as a Construction" denotes the paper's final section before the conclusion and closing remarks.

'Constructivist Niche'

The word 'enormous' is not sufficient to describe the breadth of the constructivist viewpoint in almost all fields of science. The literature shows a colorful list of different types of constructivism, such as radical, moderate, social, cultural and critical. As an area of scientific efforts, constructivism is crowded with theories and applications. For example, constructivism appears in several scientific contexts, including learning theory (Jean Piaget), biology (Humberto Maturana and Francisco Varela), psychology (Ernst von Glasersfeld), cognitive science (Heinz von Foerster) and sociology (Niklas Luhmann). Recently, Gordana Dodig-Crnkovic (2014) developed a special kind of realist constructivism, which she called info-computational constructivism.

Next to the learning theory (Piaget, 1954), many researchers claim that work conducted by the Chilean biologists Humberto Maturana and Francisco Varela can be used as the foundation for radical and other types of constructivism; we strongly agree with this assertion. According to Maturana and Varela, the cognitive system of the observer is a system with an established subset of possible interactions within the system (i.e., internal interactions) as well as with the environment (i.e., external interactions) (Maturana and Varela, 1980). Interestingly, the cognitive system is able to react to perturbation from the environment *only* through a predefined set of interactions, but at the same time, with many representations (Maturana and Varela, 1980). The mechanism of this process is based on the principle of undifferentiated coding. Originating from Johannes Mueller, this principle "...tell[s] us that it is not the stimulatory agent that produces the sensation we experience; it is the nervous system" (Segal, 2002: 18). Furthermore, the signals resulting from interactions are quantitively the same and may represent only the quantitative aspects of a stimulus—specifically, its intensity. However, the causes of the same "intensity of stimulus" could be entirely different (Glasersfeld, 1995). Accordingly, the observer lives in a domain of descriptions and through his rich representations of interactions with the environment, he can indefinitely increase the complexity of his cognitive domain. On the other side, an autopoietic system is a network of processes that can regenerate themselves by producing the components that reproduce those processes whose boundaries are determined by the system itself (Maturana and Varela, 1980) and "...remain open to the flow of matter and energy through it" (Burgin and Stewart, 2004: 329). Thus, from a constructivist perspective, we are unable to directly experience an autopoietic system that is not directly involved in our cognition. This means we may only infer its existence through the appropriate representations that appear within a cognitive domain. This is the shortest possible description of *autopoiesis*, a relatively newly proposed mechanism in the biology of cognition. In that manner, the cognitive and autopoietic systems form the basis for living organisms. Consequently, "...living as a process is a process of

cognition. This statement is valid for all organisms, with or without a nervous system" (Maturana and Varela, 1980: 13).

Generally speaking, the radical constructivists claim that there are no observations, as well as information, natural laws, external objects and similar things, which are independent of the observer. "Logic of the world is the logic of the description of the world... the primary aim of the constructivist is not to find fault with traditional epistemologies, but to account for cognition, the totality of our mental faculties, without first assuming an independent reality" (Segal, 2001: 1). In this way, constructivism defines the limits of what can be known. The outer world as a whole is independent of human minds, but knowledge of that world is always some kind of mental construction (Crotty, 1998).

Despite all the diverse constructive viewpoints, all constructivism considers information an observer's mental construction. Before considering the notion of information as a constructivist phenomenon, the next section will explore a scientific approach to the notion of information in LIS and the development of the constructivist viewpoint in this field.

Toward the Constructivist Approach to The Information in LIS

Scientific Approach to the Notion of Information in LIS

There are many papers with detailed considerations of the concept of information in LIS in general (btw. Cornelius, 2002; Capurro and Hjørland, 2003; Furner, 2004; Case, 2007; Marchionini, 2010, Ibekwee-Sanjuan and Dousa, 2014). Certain LIS authors have explicitly offered new concepts and definitions of the phenomena of information (e.g. Belkin, 1976; Brookes, 1980; Buckland, 1991; Bates, 2006). Only some of them, however, consider information in a constructivist context.

T. Saracevic (1999) believes that we lack the intellectual frame to engage various experimental, theoretic, philosophic and practical considerations regarding information. He also points out that "...we can and do provide various lexical definitions of information, and we have an intuitive understanding of its meaning that we apply daily and widely... But that does not provide for a deeper and more formal understanding and explanation" (Saracevic, 1999: 1054). Donald O. Case also ponders on whether there should even be a universal definition of information. Although there is no widely-accepted definition of information, there are agreements on its types. Susan Artandi (1973) explains that only thing we need is useful conceptualization of information.

Nicholas J. Belkin (1978) believes that an individual is not troubled by a definition of information, but rather by a concept. A definition indicates what a phenomenon is, while a concept is a way of seeing or interpreting a phenomenon or situation.

It is entirely possible that we will never come to a satisfactory definition of information that would be acceptable to every scientist, and information will continue to be discussed in a metaphorical sense (Rowley, 2007; Frické, 2009; Bosancic, 2016), regarding the documents and memory institutions (Hjørland, 2000), in terms of its measured effects (Burgin, 2010), regarding the documentation (Day, 2014), through the semiotic analysis (Thellefsen, Thellefsen, and Sørensen, 2018), or closely related to experience (Gorichanaz, 2017). However, information theory is still being developed, and it includes several directions of which constructivism is just one.

The Origins of Constructivist Thought Within LIS

Even in the 1950s, there was a shift from Shannon's mathematical-statistical approach (1949) to a semantic understanding of the concept of information. Yehoshua Bar-Hillel and Rudolph Carnap claim that mathematical-statistical aspects of information theory should not be used to conceptualize the notion of information in social sciences. In other words, the human transmission of information should not be understood as a technical process (Bar-Hillel and Carnap, 1953). Following up Bar-Hillel and Carnap's discussion, Donald MacKay, in his book, *Information, Mechanism, and Meaning* (1969) states that the concept of information is inseparable from the concept of meaning. That is, while meaning is always a subjective concept, the individual, in a specified semantic context, is always in a social situation (MacKay, 1969).

One of the origins of the constructivist approach regarding the notion of information can be found in papers written by the anthropologist Gregory Bateson. Since the beginning of the 1950s up until late the 1960s, Bateson's attitude regarding the concept of information was mostly based on the mathematical theory of communication. In the late 1960s, the absence of meaning in the mathematical theory of communication prompted him to develop a new understanding of information. At the same time, in his papers, Bateson uses the cybernetic model to describe the human mind, accentuating its closure and obstruction of environments, which affect human comprehension. He explains, "...people are self-corrective systems. They are self-corrective against disturbance..." (Bateson, 1972: 429).

Before developing his own definition of information, Bateson ascribed to the notion that a difference that makes a difference is *a part of information*. A year later, in his speech "Form, Substance and Difference", Bateson is even more audacious: "What we believe as information, meaning the effect of information is a difference creating a

difference" (Bateson, 1972: 453). According to him, the outer world is based upon forces, objects and influences while the inside world is based upon differences and ideas. Bateson equalizes the differences between physical, psychological and social worlds with Kant's differentiation between '*ding an sich*'[5] and forms of knowledge: the 'outer world' is made up of an infinite number of differences and of those we choose a countable number of differences which, for us, generate information. In this way, Bateson states, the brain does not think on its own but what does think is a brain inside a human who is a part of a system that includes the environment. At the same time, Bateson rejects concepts of information as matter, energy or objects that can drift inside and outside of the cognitive world. Thus, the mind is a closed system that does not include physical objects, only cognitive categories, and the mind must be a self-referring system because it contains instructions for creating images and categories (Bateson, 1991). With these ideas, Bateson made headway to a constructivist approach to the notion of information in the social sciences and humanities as well as in LIS.

In the mid-1970s, on the trail of the hastened development of cognitive sciences, information sciences started to develop their own approach to the problem of defining the term of information known as *cognitive turn* (Belkin, 1990). This approach loosens the claims of a brain being an information-processing machine. A key component of this point of view is that information is mediated via the receiver's background knowledge. In this way, knowledge is a belief based on true information (Cornelius, 2002: 406). This way of thinking in developing information theories resulted in stressing the mind of an individual and not the information systems. Cognitive turn in approaching information theory is stated in papers by Bertrand C. Brookes (1977, 1980), Marshall De Mey (1977, 1980), Nicholas Belkin (1980, 1984), Peter Ingwersen (1982), T. D. Wilson (1984) and other authors. "In information science, as in other disciplines. taking the cognitive viewpoint has led to consideration of the phenomena and situations of relevance in terms of representations (usually mental) of knowledge, intentions, beliefs, texts and so on, and of interactions among such representations" (Belkin, 1990: 12).

For Talja et al. (2005), constructivism arises from the 'cognitive turn' approach in LIS. Although cognitive turn can indicate a direct incentive to a constructivist approach to information, it is important to emphasize that constructivism grew up in opposition to the idea of a cognitive viewpoint because the idea of objective knowledge was not acceptable among socially conscious LIS researchers. Cornelius noted that "the importance of the social in the construction of information...has been...laboriously established by critics of the cognitive viewpoint" (Cornelius, 2002: 412).

The next chapters will show how one could consider information as a construction in both directions—in the "constructivist niche," as well as in LIS.

Information as a Construction in a 'Constructivist Niche'

The origin of the notion of information as a construction within the broad area of the constructivist niche stems from cybernetics and even communication theory as proposed by Shannon and Weaver. As Ashby states, "Cybernetics might, in fact, be defined as *the study of systems that are open to energy but closed to information and control*—systems that are 'information-tight'" (Ashby, 1956: 4). From there we can conclude that information in a cybernetic system is something internal rather than external. By the same token, in Shannon's theory information becomes the property of communication signals and refers to informativeness a pre-encoded choice or message that depends on a pre-defined set of choices or messages (Shannon and Weaver, 1949). In that sense, the term 'pre-encoded' could correspond to the term 'constructed.'

As mentioned earlier, radical constructivists such as Ernst von Glasersfeld or researchers of biology of cognition - Humberto Maturana and Francisco Varela, use the term "information" only sporadically in their theories (von Glasersfeld 1984, 1995, 2001; Maturana and Varela, 1980). Thus, there is no significant theorization of the notion of information in constructivists theories and, equally, the term information may not stand side-by-side in terms of prominence to typical constructivist terms such as *self-reference*, *self-organization*, *autonomy*, *autopoiesis*, *second-order cybernetics*, *observation, and second-order observation*. If information is solely the product of social practices or mental construction of the observer, in a strict sense, according to Varela, information does not even exist (Varela, 1979). "The notion of information refers to the observer's degree of uncertainty in his behaviour within a domain of alternatives defined by him, hence the notion of information only applies within his cognitive domain" (Maturana and Varela, 1980: 54). "...[T]he listener creates information by reducing his uncertainty through his interactions in his cognitive domain" (Maturana and Varela, 1980: 32). Interestingly, even in the cases when radical constructivism is applied to communication sciences, as in the paper "Radical Constructivism in Communication Science" (Scholl, 2010), the concept of information is completely left out of the discourse.

Maybe the reason for such claims lies in a particular and widespread meaning of information as something that is capable of 'encoding reality' or ' informing' an organism about its environment (Glasersfeld, 1995, Maturana and Varela, 1980). In their papers, H. Maturana, F. Varela and E. von Glasersfeld, similar to Bateson, often mentioned this meaning of information as untenable: "The notions of acquisition of representations of the environment or of acquisition of information about the environment in relation to learning, do not represent any aspect of the operation of the nervous system" (Maturana and Varela, 1980: 133). Glasersfeld agreed: "...it is an

unfortunate distortion when people say that the signals we receive through our senses are a 'code' that conveys information about reality" (Glasersfeld, 1995: 115).

However, there are theorists of constructivism who consider the notion of information in a significant manner even though information constitutes "only" a mental construction. These theorists include sociologist Niklas Luhmann and cyberneticist, physicist, philosopher and neuroscientist Heinz von Foerster.

In his complex system theory, German sociologist Niklas Luhmann relies greatly on Maturana's and Varela's theory of *autopoiesis*. His intention is to generalize the concept of *autopoiesis* by dividing into biological, psychological and social components.[6] According to Luhmann, a message is something that contains information, statements, and interpretations, and is an intrinsic part of the message in a self-referential, autopoietic communication system (Luhmann, 1995). In a paper from 1988 cited in Qvortrup (1993), he points out that the external world looking through the 'glass' of autopoietic reproduction exists as an irritation, disorder, or even noise; this world only derives meaning by being linked to a decision-making system. Although information is always an outcome of the system, it exists only by virtue of observation. Moreover, a system cannot freely produce information as its own product. It is constantly being "attacked" by the environment, and through its network of decisions, transforms these "attacks" into information to be used as a guide for decision-making processes (Luhmann 1988, Qvortrup, 1993). Therefore, information is "...an internal change of state, a self-produced aspect of communicative events and not something that exists in the environment of the system and has to be exploited for adaptive or similar purposes" (Luhmann, 1990: 10). In the same manner, for Helga Nowotny "information is a purely system-internal property" (Nowotny, 1990: 230), i.e. the system itself determines if something is information or not. "Externally there is only data; it is the system that makes it information" (Cornelius, 2002: 399). In that sense, a boundary must be drawn so that self-observation becomes possible (Luhmann, 1990).

For Luhmann and other theorists of constructivism, observing systems are closed and "self-referential". Consequently, the concepts of communication and information should be revised. The possibility of environment existence for a "self-referential", "observing" system is valid only if its construction leads to the conclusion that any observation is self-observation. For that matter, von Foerster's approach argues that information is neither a thing or difference, nor is it a "difference which makes a difference" (Bateson, 1972). Information is only an observer's mental construction. Von Foerster incorporates a critical discussion of the concept of information into his own definition of the specified term. He states that information is a relative concept that assumes meaning only when related to the cognitive structure of the observer (Von Foerster, 2003). Connected to a description of segments of reality, information depends

on an observer's ability to draw conclusions. Therefore, "the environment contain no information; the environment is as it is" (Von Foerster, 2003: 252). Von Foerster's approach to the notion of information is not only different from Shannon's, but also from Bateson's approach. While Bateson's ideas are related to those of Kant, von Foerster states that the meanings of the "thing in itself", as well as other ideas such as "the eter", "the phologiston" and finally "the reality", have been lost (Von Foerster, 1984; Qvortrup, 1993). He believes that the environment is independent of the observer and must possess the structure. But, contrary to Luhmann, information as the observer's construction does not represent the difference in mind, which coincides with the difference in the outer world. We cannot discuss the "difference in outer world" at all. We can only describe our experiences with the environment, which we may express through the "language of information".

In his paper "The Controversy Over the Concept of Information" (1993), Lars Qvortrup suggests that in the literature, it "...should be possible to identify four concepts of information" (Qvortrup, 1993: 3). First, information can be understood as some kind of "thing" or "substance" that exists in the external world, such as heat and electricity; thence, information may be defined as a *difference in reality*. This view of the information corresponds to the viewpoint of information as a particle in an objective manner (Stonier, 1990). Second, information can be defined as differences in the external world, which cause difference in the person's cognitive system. Bateson's definition of information as a *difference which makes a difference*, effectively conveys this view of information. Third, information can be understood as the difference in the person's cognitive system that has been stimulated by the difference in the external world – or a *difference which finds a difference*; according to Qvortrup, this constitutes Luhmann's position. Finally, information can be defined as cognitive difference that exists only in the human mind (psychic or social construction) as claimed by von Foerster (Qvortrup, 1993). It is obvious that the last two concepts of information comply with the constructivist viewpoint.

During the 1990s, the computer scientist Joseph Goguen developed a concept of "socially embedded information" (Bates, 2009: 2353.), which is much closer to the approach of LIS researchers than one might expect. He states: "An item of information is an interpretation of a configuration of signs for which members of some social group are accountable" (Goguen, 1997: 31).

Finally, in the recently developed Dodig-Crnkovic info-computational constructivism, information is the central concept. Following Floridi's informational structural realism, in info-computational constructivism, information is "the fabric of the universe," and is referred to as *potential* or *proto* information (Dodig-Crnkovic, 2014). As Dodig-Crnkovic states "...everything that exists for an agent is interpreted as potential

information or proto information... Clearly, if there are no cognizing agents in the world, the world remains proto information, 'das Ding an sich', and never turns into actual information for an agent" (Dodig-Crnkovic, 2014: 230).[7]

Information as a Construction in LIS

The constructivist approach to the notion of information in information science explicitly appears in papers by Dervin (1983), Cornelius (1996a, 1996b, 2002), Wersig (1997), Talja, Tuominen and Savolainen (2005), Bosancic (2016) and others.[8] On the one hand, the constructivist approach to the concept of information within information science is based, as constructivism itself, on the biological concept of *autopoiesis*. In that manner, Rafael Capurro and Birger Hjørland in a review paper regarding the concept of information notice, "According to biologists like Humberto Maturana and Francisco Varela..., as well as cyberneticians like Heinz von Foerster..., information is the observer's construction of a mental difference that makes and/or finds a difference in the external world" (Capurro and Hjorland, 2003: 371). On the other side, the most constructivist-minded researchers in information science hold information to be a social construct. Information is cognitive, but also social construction, and in that way, information and knowledge are products of our social practices (Cornelius, 1996; Wersig, 1997). Namely, "constructivists" in LIS support the idea that mental structures, such as comprehension, perception and even behaviour, actively build up knowledge and thinking of an individual, rather than passive acquisition.

Dervin is one of the pioneers of constructivism in LIS. In 1976, early in her research career, she published a paper which she differentiated a three-way formulation of information: information$_1$ as "the innate structure or pattern of reality"; information$_2$ as "the structures imputed onto reality by people"; and, information$_3$ as "the procedures by which people acquire what they didn't previously know; by which people are informed or instructed." (Dervin, 1976: 326). In later papers, she increasingly focused on the third concept, leading her to a constructivist view of the notion of information. Just preceding the idea of sense-making theory, in a paper entitled "Information as a User Construct: The Relevance of Perceived Information Needs to Synthesis and Interpretation," she openly highlighted claims about the constructivist nature of information. While according to Dervin, information is "a personal construction created by human observers" (Dervin, 1983: 5), Savolainen contends that "[Dervin] nevertheless takes a clear constructivist stance" (Savolainen, 1993: 18). From that point, the main context for Dervin's reflection, information seeking, and use, can be considered to be constructivism. In other words, Dervin finds information in the behavior of the user itself. We can conclude that Dervin's 'sense-making' information refers to procedures and

behaviors that allow an individual to move between external and internal information to understand the world and behave accordingly.

I. Cornelius postulates information and knowledge as products of our social practices. Such a way of thinking opens the possibility of establishing a model of knowledge acquisition in cognitive organisms based on experiences. He claims that information is not "...an objective independent entity as part of a 'real world,' but that it is a human artefact, constructed and reconstructed within social situations" (Cornelius, 1996: 19). From his interpretative approach to information he came to conclusion that "information is generated as meaning by the development of shared views and accounts of practices" (Cornelius 1996a: 11). Moreover, Cornelius believes that meaning "...is negotiated in interaction in relation to other meanings..." (Cornelius, 1996b: 27). He also highlights a typical constructivist attitude that theorizing is part of a practice (Cornelius, 1996a).

Gene Wersig (1997), in his encyclopaedia article on information theory, transferred the existing division of constructivism in philosophy and science (on moderate and radical) to a constructivist approach to the notion of information. Moderate constructivists believe that "...under the same conditions, we come to the same conclusions" (Wersig, 1997: 223); in this way, all knowledge does not have to be entirely subjective. In contrast, radical constructivists believe that "...even with the same information people can come to different conclusions"; in this way, all knowledge is intersubjective, or "...a product of our social practices" (Wersig, 1997: 223). Accordingly, the process of exchange of information is also completely subjective. Referring mainly to Luhmann's papers, Wersig defines information as a reduction of complexity (Wersig, 1997).

According to Talja et al. (2005), "Kuhlthau's Information Search Model and early version of the Sense-Making Theory significantly influenced the development" of the constructivist position within LIS (Talja et al., 2005; 81). This position was called cognitive constructivism and differs from social constructivism, a learning theory based on the ideas of Vygotsky (1978). Describing the position of cognitive constructivism with regards to the notion of information as a construction, Talja et al. state that "information is not a pill an individual can swallow in order to become informed, but a plastic substance that can be shaped in many ways" (Talja et al., 2005: 83).[9]

According to Günter Mahler (1996), information is a "contextual concept" (Mahler, 1996: 117); thence, "information is not a pure observable, but a theoretical construct. It is 'interpreted data'" (Capurro and Hjørland, 2003: 362). Fritz Machlup (1983) believes that information is addressed exclusively to the human mind, and Erhard Oeser considers information as "a system-relative concept" (Oeser, 1976: 86).

Most recently, in a constructivist manner, Bosancic (2016) proposed the replacement of the static model of the DIKW hierarchy by dynamic one, in a form of DIKW trees or 'tree of knowledge'.[10] According to a given metaphorical figure by the author, data is presented by the 'data ground', whose metaphorical concept coincides with the metaphor of complex data capture methods known in the computer science as 'data mining'. Furthermore, the information is represented by the sap flowing between roots and tree crown, while concrete knowledge is presented by the visible 'tree of knowledge' as a whole. The novelty in this picture specially refers to the replacement of the wisdom layer by the 'mind sun rays,' that symbolize man's mental or intellectual activity. From the picture it is apparent that the humanistic sciences are more energized with the ideas of so-called 'sun of the mind' than crude data from the so-called 'data grounds', while within the natural and technical sciences, the case is reversed. There is also a flow in the opposite direction out of the information flow - between the crown and the roots of the 'tree of knowledge' - that is the 'meaning sap' – which is considered as a tool for perceiving/binding information. Namely, in order to extract the raw data from the 'data ground/soil', it is necessary to vehicle these data through the knowledge tree by the information to a specific place in the tree crown. In the tree crown, data 'as information' may take its meaning - by mix with 'meaning sap', and become an integral part of the knowledge structure.

It is important to note that most LIS researchers do not consider information as a construction in the truest sense of the word but rather a subjective phenomenon in a wider sense. In the same time, these approaches do not say anything that has not already been said regarding information in existing constructivist papers by authors who are outside of information science – maybe except the claim that information is a product of our social practices.

The notion of information as a construction in a 'constructivist niche' and LIS – summary

In the table below (Table 1) are the assumed origins and theoretical foundations of the notion of information as a construction in a 'constructivist niche' as well as in LIS.

The origin of the notion of information as a construction in a 'constructivist niche' is based upon communication theory, wherein the information is recognized as a property of a communication signal that depends on the set of the communication signals it came from; that is, the informativeness of a pre-encoded choice or message depends on a pre-defined set of choices or messages (Shannon and Weaver, 1949). In that sense, information is not "an intrinsic property of the individual message" (Ashby 1956: 124).

Conversely, in examining the origins of the notion of information as a construction in LIS, we found Bateson's definition of information as a "difference which makes the difference," as well as information as the direction of a cognitive viewpoint (or 'cognitive turn') in LIS that came into play in the 1970s. The most common viewpoint in LIS regarding the position of information as a construction is the notion of information as a subjective, socially constructed entity which informs users' behavior.

Table 1 – The notion of information as a construction in a 'constructivist niche' and LIS.

| 'CONSTRUCTIVIST NICHE' | | | YEARS | LIS | | |
AUTHORS	WHAT IS INFORMATION?	CONTEXT		AUTHORS	WHAT IS INFORMATION?	CONTEXT
Shannon and Weaver*	"...defined as the logarithm of the number of choices" (1949: 10)	COMMUNICATION THEORY	1940's			
Ashby*	"...the information carried by a particular message depends on the set it comes from. The information conveyed is not an intrinsic property of the individual message" (1956: 124)	CYBERNETICS	1950's			
Maturana and Varela	"...the notion of information refers to the observer's degree of uncertainty in his behavior within a domain of alternatives defined by him" (1970: 54).	BIOLOGY OF COGNITION	1970's	Bateson**	"...difference which makes a difference is an idea. It is a 'bit' a unit of information" (Bateson, 1972: 272)	ANTHROPOLOGY
Von Foerster	"...a relative concept that assumes meaning only when related to the cognitive structure of the observer of this utterance (the 'recipient')" (orig. 1972) (2003: 251)	COGNITIVE & NEUROSCIENCE				

			1980's	Brookes	"information and knowledge are of the same kind... information is a small bit of knowledge... the same [information] have different effects on different knowledge structures." (Brookes, 1980: 131)	LIS (cognitive turn)
				Dervin	"a personal construction created by human observers" (1983: 5)	LIS (sense-making theory)
Luhmann	"...an internal change of state, a self-produced aspect of communicative events and not something that exists in the environment of the system and has to be exploited for adaptive or similar purposes" (1990: 10)	SOCIOLOGY	1990's	Cornelius	"a human artefact, constructed and reconstructed within social situations" (1996: 19).	LIS (social constructivism)
Gougen	"...an interpretation of a configuration of signs for which members of some social group are accountable" (1997: 31)	COMPUTER SCIENCE		Wersig	"a reduction of complexity" (1997: 225)	LIS (moderate constructivism)
			2000's	Talja	"...information is not a pill an individual can swallow in order to become informed, but a plastic substance that can be shaped in many ways" (2005: 83)	LIS (cognitive constructivism)

| Dodig Crnković | "Information is structure, which exists either potentially outside of the agent (as the structures of its environment) or inside an agent (in the agent's own bodily structures...) (2014: 225). | COMPUTER SCIENCE (info-computational constructivism) | 2010's | Bosancic | "...information is recognized as a subjective but impersonal, meaningless, mapped and encoded flow (because it always transmits somewhere), an invisible 'communication tool' between data and knowledge (2016: 952). | LIS (moderate constructivism) |

* The origins of the notion of information as a construction in a 'constructivist niche'.

** The origins of the notion of information as a construction in LIS.

Conclusion

The purpose of this paper was to outline the constructivist approach to the notion of information within the "constructivist niche," as well as in LIS. According to constructivist thinkers, there is no answer beyond Shannon's understanding of information as the "observer's degree of uncertainty in his behaviour within a domain of alternatives defined by him [...] within his cognitive domain" (Maturana and Varela, 1980: 54). While information does not play a prominent role in constructivist theories, there is also no evidence of the significant treatment of information as a construction within the papers of LIS researchers. Furthermore, most LIS researchers do not consider information as a construction in the truest sense of the word but rather as a subjective phenomenon in a wider sense, which is subject to different interpretations (Cornelius, 1996). Moreover, information and knowledge are products of our social practices. That is the main reason there is no evidence of such a 'thing' like a 'constructivist information theory' in the existing literature. However, the cognitive viewpoint seems to be a solid basis for considering its development.

Declaration of Conflicting Interests

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Notes

1. "...we may never know the real natures of things but only how they are related to one another... relation is all there is" (Kuhlman, 2016: 89). "What we commonly call a thing may be just a bundle of properties: color, shape, consistency, and so on... when we see and experience a ball for the first time, we do not actually perceive a ball, strictly speaking. What we perceive is a round shape, some shade of red, with certain elastic touch..." (Kuhlman, 2016: 91).
2. The Large Hadron Collider, located near Geneva, Switzerland, is perhaps the greatest technical achievement of humankind. On a daily basis, using its four particle detectors, it produces 25 PB (peta bytes) of data/information.

3. Computing indicates "any operation (not necessarily numerical) that transforms, modifies, rearranges, orders, and so on, observed physical entities ('objects') or their representations ('symbols')" (von Foerster, 2003: 216).

4. For example, biologist Tom Stonier believes that information has its own a special kind of particle, which he called 'infon' (Stonier, 1990) while Gene Harmon considers information "... as a residual or catalytic form of energy which regulates other forms of energy in natural and artificial systems" (Harmon, 1984: 193).

5. In his book, *Critique of Pure Reason* (1998), Immanuel Kant negates the possibility of cognition of a 'real world', or 'thing in itself' (Ger. *ding an sich*). According to Kant, the 'thing in itself' is not in the reaches of human experience and thus cannot be subject to cognition (Kant, 1998).

6. However, Luhmann's relationship with constructivist thought is somewhat doubtful. One of the creators of the theory of *autopoiesis* – Humberto Maturana – rejects the idea that his theory can also be applied to sociology (Riegler and Scholl, 2012). In their original paper, Maturana and Varela state that operations of *autopoietic organization* of molecular units "specify their own boundaries in the processes of self-production" (Maturana and Varela, 1980: 81); therefore, these entities are "biological" in nature. Hence, Luhmann's attempt of applying *autopoises* in sociology for Maturana is questionable.

7. At first glance, it is obvious that so-called potential or proto information outside the cognizing agents opposes the concept of information as a cognitive construction propounded in radical constructivism. However, despite criticism (Schroeder 2014; Gershenson 2014), it is quite certain that info-computationalism will find its place among other varieties of constructivism.

8. Papers by authors who did not specifically refer to the notion of information as a construction were not considered. These authors tended to consider constructivism itself in LIS, but not information through the lens of this constructivist viewpoint. For examples thereof, see the papers by Krippendorff (1991), Dick (1999), and Brier (2009).

9. Otherwise, Talja et al. (2005) follows Gergen's distinction (1999) between constructivism (or cognitive constructivism), social constructivism, and constructionism. Constructivism is "a view in which an individual mind constructs reality but within a systematic relationship to the external world" (Talja, Tuominen and Savolainen, et al. 2005: 81); that is, social constructivism "is a metatheoretical position which argues that, while the mind constructs reality in its relationship to the world, this mental process is significantly informed by influences received from societal conventions, history and interaction with significant others" (Gergen, 1999: 60); finally, constructionism represents a "...discourse as the vehicle through which the self and the world are articulated" (Gergen, 1999: 60).

10. The DIKW model was fully designed in the 1980s and aims to portray, as simply as possible, the relationships between the key terms in IS—data, information, knowledge

and wisdom (Rowley, 2007). Its most common representation is in the form of a pyramid or triangle.

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