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## **Meanings of Information: The Assumptions and Research Consequences of Three Foundational LIS Theories**

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### **Abstract**

This article addresses the question “What is information?” by comparing the meaning of the term “information” and epistemological assumptions of three theories in library and information science (LIS): the “Shannon-Weaver model,” Brookes’ interpretation of Popper’s World 3, and the DIKW (Data-Information-Knowledge-Wisdom) model. It shows that the term “information” in these theories refers to empirical entities or events and is conceptualized as having causal powers upon human minds. It is argued that the epistemological assumptions have led to the negligence of the cultural and social aspects of the constitution of information

(i.e., how something is considered to be and not to be information) and the unquestioned nature of science in research methodologies.

## **Introduction**

The discussion of the term “information” is not new in library and information science. To name a few works published in the 2000s: Capurro and Hjørland (2003) present a comprehensive review of the concept of information, including its uses in the natural sciences, humanities, social sciences, and information science; Day (2001) performs a critical analysis of the information discourse in European documentation, cybernetics, and the age of the “virtual”; Frohmann (2004) attempts to deflate information; Braman (2009) conceptualizes information as a constitutional force of society for the discussion of information policy; Floridi (2010) discusses the diffusion of information in every aspect of human lives; Saab & Riss (2011) recognize information as a sense-making and meaning making process; Marchionini (2010) ponders information in the cyberspace; Glecik (2011) traces information from drumming to quantum computing; and of course, there has been the debate between Bates (2005, 2006, 2008) and Hjørland (2007, 2009) on the nature of information.

Why is it important to ask questions about information? It is because the meanings of the term “information” vary in different situations: information could be the news about the plummeting values of the US Government Bonds, or a lecture in Heidegger’s phenomenology, or a small talk about your neighbor’s dog. The meaning of the term “information” seems ambiguous because it is usually used for

representing a wide variety of things, events, and expressions, and sometimes knowledge about these things, events, and expressions. When we use the term “information” in our day-to-day conversation, we usually do not think about or clarify what it means; indeed, we usually understand the meaning of the term “information” without thinking about it. The term is likewise deployed in some research studies and conceptualizations. The meanings of the term “information” and their assumptions vary in different texts and situations. Hence, it is important to ask questions about information because the ambiguity of the meanings of the term may imply that: (a) the term “information” has been used without clarifying what it actually refers to or what it means; (b) what “information” means in some contexts may have been misunderstood by connotations; and (c) the use of the term “information” may be ideological in the sense that it may have masked or distorted the “actual meaning” by its connotations.

This article approaches the question “what is information?” by examining the ontological and epistemological assumptions of concepts of information in three foundational LIS theories: the Shannon-Weaver model (Shannon & Weaver, 1964), Brookes’ interpretation of Popper’s World 3 (Brookes, 1980), and the DIKW (Data-Information-Knowledge-Wisdom) model (Ackoff, 1989; Shedroff, 2001). This article brings these three theories together in order to compare the differences of meanings of “information” between them and to suggest their similarities in terms of their ontological and epistemological assumptions and commitments. It argues that the problem is not that of a plurality of meanings or conceptions of information, but rather, that this variety actually belies their common ontological and

epistemological assumptions and commitments, which may have led to the negligence of the constituents of information (i.e., how something is considered to be and not to be information) and the unquestioned nature of science in research methodologies.

### **The Shannon-Weaver Model**

Claude Shannon's paper, "A Mathematical Theory of Communication" has usually been recognized as a foundational text in information theory. The concept of information and the accompanying measurement unit, "bit" (binary digit), has had substantial influence in the realm of quantum theory in theoretical physics and the development of digital computing and quantum computing, for example, John Wheeler's proposal of "it from bit" (Gleick, 2011; Greene, 2011; von Baeyer, 2003). Most readings of information theory in LIS, however, are based on Warren Weaver's exposition of Shannon's theory. In 1983, Shaw and Davis already stated that "[M]uch theoretical work in information science is based on the Shannon-Weaver model of communication" (p. 71). More recently, Kalbach (2009) claims that Shannon and Weaver are the "fathers of modern information and communication theory" and that the concept of uncertainty in their work "underlies most aspects of our lives" (p. 48). Notice, though, both papers do not refer to the information theory, but rather the "Shannon-Weaver model"—an indicator that interpretations of concepts in information theory are based on Weaver's essay. Hence, it is necessary for us to understand how Weaver expounds Shannon's theory into a general theory of

communication such that we can understand the concept of information that then informs LIS's use of these texts.

Shannon and Weaver's *The Mathematical Theory of Communication* is not actually a co-authored book. The book consists of two essays: Weaver's "Recent Contributions to the Mathematical Theory of Communication" and Shannon's, earlier paper, with the new title "The Mathematical Theory of Communication." Shannon's essay was reprinted from the *Bell System Technical Journal*, July and October 1948, and a condensation of Weaver's essay was originally published in *Scientific American*, July 1949 (Shannon & Weaver, 1964). The themes of the two pieces serve different audiences: Shannon writes on the technical engineering problem of the transmission of messages (for example, how a string of symbols can successfully be transmitted from one machine to another), while Weaver attempts to propose a *general* theory of communication based on Shannon's paper.

Insert Figure 1 here

Shannon's communication system theorizes the problems of the transmission of messages from an information source to a destination through a channel (Figure 1). The technical problem is to select the best messages (i.e. symbolic representation for encryption) and to minimize noise that may interrupt the transmission process, for example, during a telegraphy transmission from one terminal to another. Shannon states in the introduction to his essay:

“The fundamental problem of communication is that of reproducing at one point either exactly or approximately a message selected at another point. Frequently the messages have *meaning*; that is they refer to or are correlated according to some system with certain physical or conceptual entities. These semantic aspects of communication are irrelevant to the engineering problem” (Shannon & Weaver, 1964, p. 31, emphasis in original).

Although Shannon clearly states that semantic aspects of communication are irrelevant for the technical problems, Weaver, however, sees this technical model as the bases for a general theory of communication and a “real theory of meaning” (Shannon & Weaver, 1964, p. 27) for both machines and humans. In other words, Weaver tries to appropriate human communication into the mechanical model, in which the semantic problems are assumed to be resolved.

To generalize the technical model into a general theory of communication Weaver suggests that the effectiveness problem is concerned with the *effects* of communication: “it is clear that communication either affects conduct or is without any discernable and probable effect at all” (Shannon & Weaver, 1964, p. 5).

However, Weaver does not explain how an identity or correspondence of meaning is achieved between the sender and the receiver. The understanding of meanings in the model seems to be presupposed, as if human communication is equivalent to the transmission of messages between machines. In other words, the semantic problems in human communication are not in question.

For Weaver, human communication becomes a matter of “all the *procedures* by which one mind may affect another” (Shannon & Weaver, 1964, p. 3, emphasis

added). Consequently, understanding, as a product of successful transmission and the effectiveness of communication, is determined by whether the hearer does exactly what he or she is told by the sender. In Weaver's communication model, the receiver does not and cannot negotiate, but conforms to the sender's articulation of "desired conduct" (Shannon & Weaver, 1964, p. 5).

For Weaver, communication is not dialogical, but procedural and unidirectional, leading from a self-evident intention to a self-evident behavior. Successful communication is understood by cause and effect, not by negotiating meanings.

### *Information in Information Theory*

Weaver agrees that the contribution of Shannon's theory is "really the basic theory of cryptography," yet he argues that the theory also "contributes to the problem of translation from one language to another, although the complete story here clearly requires consideration of meaning, as well as of information" (Shannon & Weaver, 1964, p. 25). Weaver's generalization of the technical problems to a general communication theory involves explaining certain concepts and one such important concept is "information." As we will see, Weaver discusses "information" in various meanings, some consistent with the Shannon's concept of information, some not.

The concept of information in Shannon's information theory has little to do with being informed or being meaningful as in our common usage of the term. Weaver (Shannon & Weaver, 1964) states that information "is used in a special sense that must not be confused with its ordinary usage. In particular, *information* must not be

confused with meaning” (p. 8, emphasis in original). To make this point clear, he adds, “two messages, one of which is heavily loaded with meaning and the other of which is pure nonsense, can be exactly equivalent, from the present viewpoint, as regards information” (Shannon & Weaver, 1964, p. 8).

This above-mentioned meaning of information is consistent with the technical use of that in Shannon’s essay, that information is an algorithm for maximizing the capacity for the transmission of message given the capacity of a channel. Weaver explains: “the amount of information is defined, in the simplest cases, to be measured by the logarithm of the number of available choices” (Shannon & Weaver, 1964, p. 9). While this meaning of information is useful for technical transmission of messages, it is a problematic analogy to human communication in Weaver’s exposition. Particularly the denotations and connotations of terms such as “information” and “uncertainty” are radically different in natural sciences and engineering discourses from their common usages.

Based on the mathematical model, encryption is designed to control information for the reduction of uncertainty during transmission. The encryption needed depends on the capacity of the communication channel. As such, the statistical characteristics of a signal should be optimal for the capacity of the communication channel. Applying the same understanding to human communication and language, however, results in a mechanized communication model, which neglects the very nature of human language, that is, that almost every word carries multiple meanings, not to mention the non-literal use of words in analogies, metaphors, or jokes (Lakoff & Johnson, 1980).

The analogy of machine communication and human communication in Weaver's text leads to problematic interpretation of the concept of information. When he states that "uncertainty" in information systems created by information has good connotations as compared to the uncertainty created by noise, which has bad connotations, the terms "uncertainty," "good," "bad," and "information" are usually misinterpreted as psychological and moral terms, despite that, technically, it means to produce a precise and concise encryption in a technical system.

The use of a technical model for human communication and the vocabularies deployed in Weaver's text lead to misunderstanding of the concept of information in information theory in terms of an intentional or objective cause for effects—one that elicits desired human behavior and one that creates psychological uncertainty—which is radically different from the strictly defined probabilistic measure in its original mathematical expression. This misappropriation of Shannon's information theory and the resultant conceptual ambiguity to the word "information" leads to the misconception that "information," not human beings, is the active agent that leads to a wide variety of information behavior and events.

Moreover, the distorted model of human communication in Weaver's text also leads to conceptualizing human communication and understanding according to a "conduit metaphor" (Day, 2000b; the term originates in Reddy, 1993). As we recall, the semantic problems are largely neglected in Weaver's exposition of information theory. However, most communicational or informational activities that occur in libraries and information systems involve human-human or human-system interactions. The design of information systems and the education of information

professionals depend upon a sound theory of communication, one that describes and explains how humans really interact with each other and how meanings are constructed through acts of understanding.

In sum, Weaver's proposal of a general theory of communication puts forth a distorted picture of human communication by the following inherent assumptions: first, communication is a one-way process; dialog is absent in Weaver's model. Second, the identity of meaning is assumed or taken for granted. And last, communication is understood as an instrumental or strategic act, in the sense that its understanding or the event of meaning is a product of the supposed fulfillment of causal intentions by supposed behavioral effects. With the misconstrued concept of information, Weaver's general theory of communication neglects the complexities in human communication.

### **Popper's World Three**

In 1980-1981, B. C. Brookes published a series of four articles entitled "The Foundations of Information Science." In these articles, Brookes discusses information science as an academic discipline, first, by drawing the line between information science and library science, and second, by showing how information science can and should be "scientific." Brookes' articles, particularly the first part, "the philosophical aspects," have been influential in information science and have been regarded as one of the foundational papers in information science,<sup>1</sup> while there have also been criticisms of Brookes' articles, in particular of his interpretation of Popper's three-world theory and whether there is an actual need for Popper's

theory in library and information science discourse (see, for example, Rudd, 1983). We will focus on the concept of information suggested and implied in Brookes' discussion of "the philosophical aspects."

Part I of the "Foundations of Information Science" series is a discussion of philosophical and theoretical issues, in which Brookes attempts to ground information science as a scientific discipline. Brookes (1980) argues that the murkiness of information science as a discipline and as a science has been due to the lack of theoretical and practical foundations. His central argument is that information science should be viewed as a "science" in the sense that phenomena should be analyzed in an *objective* manner, which generally means that phenomena should be observable by multiple parties and can be measured quantitatively. The aim of situating information science as an objective science translates into the following mission: "...of all the social sciences, information science is most intimately concerned with the interactions between mental and physical process or between subjective and objective modes of thought" (Brookes, 1980, p. 126). Brookes (1980) suggests that Popper's theory of the three worlds can be viewed as the starting point for constructing a theoretical foundation for information science, particularly in constructing a foundational understanding of information and knowledge. He explains Popper's three worlds:

(1) World 1: The physical world, the cosmos in which Earth, vital though it is to us, is but an insignificant speck in the immensity of the universe of radiation and matter;

- (2) World 2: The world of subjective human knowledge or ‘mental states’;
- (3) World 3: The world of objective knowledge, the products of human mind as recorded in languages, the arts, the sciences, the technologies – in all the artifacts humans have stored or scattered around the Earth.

In Brookes’ understanding, “objective knowledge” is knowledge that is embodied in artifacts, such as documents, music, the arts, and the technologies. Knowledge is objective because the artifacts can be accessed and their “contents” judged by multiple persons. Brookes argues against theories of knowledge that are “subjectivistic.” His rationale is that studies cannot be carried out objectively when knowledge is subjectively stored in human minds. For Brookes, knowledge (and information) can only be studied when it is “objectivized,” that is, embodied in physical, accessible forms. In Brookes’ interpretation, for example, contents in a book are products of human thoughts, and more importantly, are “objective knowledge” in the sense that they are “accessible to all who care to study them” (Brookes, 1980, p. 128). He then further claims that “the fundamental entities of World 2 and 3, as fundamental to these worlds as matter and energy are to World 2, are *information* and *knowledge*” (Brookes, 1980, p. 132, emphasis added). It is important to note this analogy of information and knowledge to matter and energy because it is this analogy of phenomena in the “subjective” world (World 2) and the cultural and social world (World 3) to the natural and physical worlds that helps us understand Brookes’ empiricist conception of information implicated in the model of interactions between World 2 and World 3.

Brookes (1980) argues that although the practical work of library and information scientists is “to collect and organize for use the records of World 3” (p. 128), it is not the theoretical task of information science because organization of documents alone does not give information science the status of science and because there are “no common assumptions, implicit or explicit, which can be regarded as its theoretical foundations” (p. 125). For Brookes, the theoretical task to “describe and explain them [World 2 and 3] if they can and so to help organize *knowledge* rather than *documents* for more effective use” (Brookes, 1980, p. 128, emphasis in original).

### *Information in Popper’s World 3*

For Brookes, a “scientific” discipline is recognized by the research methods used, particularly the view that the truth of propositions can only be explained by way of observations and experimental and quantitative methods. His analogy of matter and energy for information and knowledge suggests that information should be an observable object, or hypothetically observable object. “Information” refers to “products of human thoughts” and is conceptualized as objective entities—contents—embodied in physical forms.

The interactions between World 2 and World 3 are expressed in a pseudo mathematical expression, a function of information:  $K[S] + \Delta I = K[S + \Delta S]$  (Brookes, 1980, p. 131). The equation indicates how knowledge structures in human minds can be modified by changes in “information.” The equation means that “knowledge structure” in human minds can be modified by either an increasing or a decreasing

amount of human thoughts embodied in artifacts. It is as if the human minds—the so-called “knowledge structure”—do not play a role in cognition.

More importantly, the equation implies that information can actively interact with knowledge structures (World 2), so as to cause a change in “knowledge structure.” “Information” is conceptualized as a type of causal entity for altering human minds. The reduction of cognition to an equation and the causal relationship between information and mental states blinds us to how humans really *learn* by reading books, listening to music, and other “mental” or intellectual activities. For, learning is an activity, just as being informed and knowing are, and so they cannot be studied as the causal relationship between two nominal or pseudo-empirical entities. Rather, being informed and knowing must be examined as situated activities as cognitive, cultural, and social phenomena simultaneously.

The meaning of information in Brookes’ interpretation of Popper’s World 3 is different from the Shannon-Weaver model. For Brookes, information refers to “products of human thoughts” that are embodied in physical forms such as books and other kinds of artifacts, not as a measure as in the Shannon-Weaver model. The “interactions” between World 2 and World 3, however, are also conceptualized as a unidirectional causation process; that is, information changes human minds but not the other way around. This should remind us of the procedural communication model as well as the emphasis upon the effectiveness of information proposed by Weaver.

### **Data-Information-Knowledge-Wisdom (DIKW)**

The third, and last, meaning of information to be discussed in this article is that of the DIKW (Data-Information-Knowledge-Wisdom) model. While researchers in the field of knowledge management generally regard R. L. Ackoff's presidential address to ISGSR (International Society for General Systems Research<sup>2</sup>) in 1998 as the origin of the DIKW model (see, for example, Frické, 2009; Rowley, 2006), it is believed that this model at least dates back to the 1960s, though likely without the top level of "wisdom." In 2007, Zins published a survey of the definitions of data, information, knowledge, and wisdom provided by researchers worldwide in the field of information science. It shows that despite the controversial definitions of these terms, there is a general acceptance of it as one of the most well-known models in information science.

The DIKW model is often illustrated as a triangular shape with data at the bottom and wisdom at the top. Shedroff's (2001) presents the model as overlapping circles but it also presents a similar learning/understanding process. Despite the shapes and sizes of the DIKW model, the model is commonly regarded as a representation of the progression of data to wisdom in human minds. Ackoff (1989) writes, "Wisdom is located at the top of a hierarchy of types, types of content of the human mind. Descending from wisdom there are understanding, knowledge, information, and at the bottom, data" (p. 3, emphasis in original). This representation presents human thought and learning as data-processing events. The representational view of knowledge treats thought and learning as quantitative events and thus suggests that they can be empirically studied as such: "Data are symbols that represent properties of objects, events and their environments. They

are products of *observation*. To observe is to sense” (Ackoff, 1989, p. 3). He then adds, “Information, as noted, is extracted from data by analysis in many aspects of which *computers* are adept” (Ackoff, 1989, p. 3, emphasis added).

The DIKW model, while useful for thinking about data flow in information processing machines, depicts a limited view of human learning. As Machlup (1983) notes, when we talk about data in information science, we basically refer to “things fed into a computer” (p. 647). He aptly points out the very weakness of the DIKW model: “Information takes at least two persons: one who tells (by speaking, writing, imprinting, pointing, signaling) and one who listens, reads, watches” (Machlup, 1983, p. 645).

In contrast to an data processing model, many would argue that for humans, information and knowledge are not processed data; rather, we learn by being situated within and understanding complex webs of relations of persons, events, social and political structures, and many other things. Further, we seek agreement with each other on what things mean through learned social and cultural tools and categories. Human learning is not the same as data processing because humans developmentally learn through communication using social and cultural affordances, while machines largely process data according to programmed processes. The analogy of data to human stimuli and machine process output to knowledge is a bizarre analogy that obfuscates rather obvious difference between designed and organic agents. Again, as with Brookes’ model and with the LIS appropriation of Shannon’s information theory through Weaver’s text, we must ask

serious questions about the rather recent conceptual histories that have shaped such beliefs, theories, and models.

### *Information in DIKW*

The meaning of information in the DIKW model needs little explanation. Information is simply understood as meaningful or otherwise “processed” data. Ackoff (1989) claims that since information systems “generate, store, retrieve, and process data... information is inferred from data” (p. 3). The meaning of information Ackoff, and many others as quoted in Zins’s (2007) article, is clearly based on how information systems work, but then this systems view of information is used as an epistemological model for understanding the workings of human minds and human learning. This analogy of machine processing and human thought and communication is yet another example of one of the two fundamental flaws that plagued Weaver’s exposition of information theory and Brookes’ understanding of Popper’s three worlds theory. The other fundamental error, namely that of causal reasoning, is implicit not as an issue of method, but as an issue of epistemology: data is the “cause” for information, information is the “cause” for knowledge, and knowledge is the “cause” for wisdom. The causal relationship would remind us of the implicit assumptions of “causality” lends to the model of a similitude of science in both Weaver’s (Shannon & Weaver, 1964) prescription of a general theory of communication and Brookes (1980) empiricist cognitive model.

Beyond this, the most explicit similarity between the Shannon-Weaver model and the DIKW model is their emphasis on effectiveness. Ackoff (1989) makes this

his “critical point”: “*wisdom is the ability to increase effectiveness*” (p. 5, emphasis in original). For Ackoff, the DIKW model shows an increase in effectiveness at each of its levels. The triangular form in which the DIKW model is often shown suggests that there is a consolidation of power or potential “effect” from the lower levels to the upper levels. The inverse logic of this is that the more data one has, the more information, knowledge, and wisdom one can generate for improving effectiveness. Knowledge and wisdom thus become understood as products of data processing, rather than learning and experience. Further, understanding is explained in terms of teleological processes of systems processing and design: “To increase efficiency is either to increase the probability of producing a desired outcome with fixed resources or to decrease the amount of resources required to produce it with a specified probability” (Ackoff, 1989, p. 4). Here, again, the DIKW model resembles the technical reductionism for understanding and communication that is the hallmark of Weaver’s exposition of Shannon’s information theory.

There are, however, ontological differences between the two models: the Shannon-Weaver model depicts a model of communication, whereas the DIKW model depicts a theory of knowledge, echoing a tradition of empiricism and metaphorically relying upon an data-processing, rather than a communicative model for shaping its concept of information. The DIKW model relies heavily on sense perception and the collection of data as the initial stages in the production of knowledge. It shares the assumption of an empiricist epistemology that sense perceptions are the source for human understanding. In brief, while the DIKW model may well model the machine processing of data, in terms of human

understanding it remains epistemologically grounded in a version of empiricism with a technical metaphor added on. If we remove the technical metaphor, the resulting conception of information would to by-pass research into language, communication, and learning in human beings in the past three centuries.

### **Discussion: Meanings, Assumptions, and Research Consequences**

The term “information” is often used to represent a variety of things, events, or expressions. In other words, the term “information” cannot be interpreted as the things, events, or expressions themselves unless it is situated within a context and is understood meaningfully. This fact holds true in our daily use of the term as well as the conceptual construct in the three theories discussed. It may be because of this flexibility in meaning, many different senses and connotations of the term arise. Furthermore, conflation of meanings is not uncommon, and some of which lead to ideological uses. For example, the common understanding of “information” in Brookes’ (1980) article—the products of human thoughts embodied in physical form—often carries with it the connotations of a measurable entity, as something that can be coded, and of a cause for cognition. The ambiguous conflation of different meanings and senses, particularly when grounded within empiricist epistemologies, has given to the word “information” a remarkable power not only in professional discourse, but also in modern culture and societies.

The meanings of information in the three theories discussed above are different from one another. In the Shannon-Weaver model, information refers to a probabilistic measure. Indeed, it is a scientific term however misconstrued by many

that it refers to meaningful messages that may alter human behavior based on a distorted model of human communication. In Brookes' (1980) foundational paper, information is conceptualized as human thoughts that are embodied in physical forms. In the DIKW model, information is understood as organized and processed data. Despite the various meanings, the conceptualizations of information are very similar in terms of the empiricist epistemological commitments that underlie them.

In the three theories discussed, information is conceptualized as entities or units that can be objectively measured (Shannon-Weaver model), observed (Brookes' "information"), or processed (DIKW model). Consequently, informational phenomena are assumed to be measurable in terms of causal effects. In other words, a certain notion of physical or logical causality is read upon the human pragmatics of understanding and communication so that these latter can be understood "scientifically," and so, consequently, the disciplines that understand them must be scientific with corresponding methods (Day, 2000a).

The social consequence of this last point is that social "effectiveness" becomes understood deterministically and, further, through the implicit or explicit machine metaphors circulating in these texts, in terms of the teleology of designed, technological systems. Human learning and understanding are understood as if they were analogues to technological systems and processing and technological systems may be seen as necessary or sufficient enablers of this. In contrast to all this, however, it has been widely understood that human communication and cognition are developed as results of experientially based learning and development in specific environment using social and cultural norms and tools, as well as available

materials. The notions of “data,” “information,” and so forth, as held in the theories discussed, as well as their deterministic causal models and tools, hardly address this universal understanding.

### **Conclusion: What is Information and What Makes It Information?**

One research consequence of the conceptualization of information as “objective” and as having causal powers is the negligence of the human, cultural, and social constituents of information. Whether a study presents the processes of information seeking, information behavior, algorithms for improving information retrieval, or citation patterns, one question is often left unanswered in these research studies: What is information and what makes it “information”?

Case’s (2007) survey of information behavior research presents an interesting case. In his survey, Case (2007) categorizes the huge volume of information behavior research by occupation, by social role, and by demographic group, but not by “information.” What are people of different occupation, social roles, and demographic groups actually looking for? As we remember, the term “information” is often used to represent a wide variety of things. Information is not self-evident.

Buckland (1991) has suggested that “what is or is not reasonably treated as information depends on agreement, or on at least some consensus” (p. 357). This situational view of information has been shared by some in the field (see, for example, Ekbia & Evans, 2009; Hjørland, 2007; Ma, 2010); we have yet, however, asked questions about the constitution and decontextualization of information: what are the processes that lead to the consensus of what is (and is not) information

and the ideologies that may be involved in the social world (see also Benoit, 2001)? And how do the uses of the term “information,” or the appropriation of the meanings of it, in settings or texts other than the original meaning or conceptualization (Weaver’s exposition of the information theory is one such example) may affect the information discourse.

On the one hand, analyses of the constitution of information is essential for improving information services and information systems design because such analysis would clarify the reasons for how something is considered to be or not to be information, as well as the reasons that obstruct the identification, production, and use of certain types of information. In other words, what information *is* in different situations and settings and the process of its constitution would be made clear. On the other hand, the analysis of the decontextualization of information investigates the appropriation of “information” that may be ideological and may have escaped explicit awareness of producers and users of information. In other words, such analysis aims to reveal the misconstrued and misused concepts of information and their reasons, implications and consequences.

Another research consequence of the epistemological commitments underlying the three theories is the unquestioned application of a certain notion of scientific method. If information is something always observable and measurable like a rock in the physical environment, research methods used in the physical science can be considered to be reasonable because the validity of such kinds of research studies can be evaluated by anyone with a proper education background and training. When Brookes (1980) states that information and knowledge should be studied like

matter and energy in the physical world, he assumes that information and knowledge are observable, measurable, and relatively stable over time and across cultures. The problem is, again, that the term “information” refers to a wide variety of things and phenomena; the interpretation of its meaning or referent depends on the situation and context. Therefore, research methods used to study it should be chosen accordingly.

For example, information may refer to the physical description of a book, or a discussion about the future of books. The nature of the description of a book is similar to that of a rock: unchanging, observable, and measurable, whereas a discussion of the future of books is transient, not observable or measurable after the discussion is over. Moreover, factors such as human intentions and language, cultural norms, institutional practices, economic conditions, and social structures may have influenced the occurrence of and the interactions in the discussion. Research methods that are suited for studying the complexities of the social world are required for the study of information, in the sense that the constitution of information involves opinions, intentions, desires, as well as cultural forms and social practices. Methodological analyses such as Davenport’s (2010) evaluation of research methods commonly used in information behavior research, particularly on the dualism of sciences (i.e., the bifurcation of the sciences and the humanities) and the usefulness and effectiveness of research methods are long overdue in information science research.

In this article, the meanings of the term “information” in the Shannon-Weaver model, Brookes’ interpretation of Popper, and the DIKW model and their

assumptions and research consequences have been discussed. It has been shown that the concept of information in these theories is that it is a quantitative entity or event that has causal effects upon human beings. It has been suggested the assumptions lead to: (a) the negligence of the cultural and social construction of information and (b) unquestioned use of “scientific” research methods. However, this article does not imply that the research consequences of adhering to empiricist epistemology have been gone unnoticed over the years. In fact, the various turns of information science (Cronin, 2008) quietly respond to the insufficiencies of the various epistemological paradigms. System-centered or user-centered, research in scientific information or everyday life information seeking, all aim to improve information system design and propel positive social change. What have gone unnoticed are the epistemological assumptions of foundational concepts and their relations to research methods. This article has examined the concepts of information in three foundational theories and has discussed their assumptions and research consequences with the hope of opening up epistemological and methodological discussions in the future.

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<sup>1</sup> See, for example, Belkin (1990) and Saracevic's (1999) definition of information science.

<sup>2</sup> Now "International Society for the Systems Sciences"