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The philosophy of information as an underlying and unifying theory of information science

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Abstract

Introduction. Philosophical analyses of theoretical principles underlying these sub-domains reveal philosophy of information as underlying meta-theory of information science.
Method. Conceptual research on the knowledge sub-domains in information science and philosophy and analysis of their mutual connection.
Analysis. Similarities between conceptual cores and research questions of the two fields have been investigated. The consequent methods and knowledge domains of philosophy of information have been studied.
Results. As the underlying theory, philosophy of information discovers philosophical questions in all of the information sub-domains studied. In information retrieval, it studies ontological and epistemological. Knowledge organization implements philosophy of language. Theories of information management actualize classical epistemological issues in the context of organizational knowledge. Studies of information behaviour benefit from argumentation theory. Philosophical analyses may possibly investigate how the concrete rules of bibliometric models influence conceptions and evaluations of knowledge. The sub-domain of information literacy is significantly compatible with philosophical conceptions and techniques of critical thinking.
Conclusions. As underlying and unifying theory of information science, philosophy of information implements advanced abilities of critical thinking in the sub-domains, with respect to the role that information technology and the resulting knowledge structures, codes, languages and systems might have for the development of mind and world.

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Introduction

Philosophy of information is a relatively new endeavor. In the context of information reality, it analyses a group of classical philosophical problems - such as the principles, origins and structures of knowledge, the nature of existence, the problems of mind, logical structures of language and meaning, the principles of logical reasoning and critical thinking, theories of truth, and ethical issues (e.g., Floridi 2002, 2004a, 2004b; Adriaans and van Bethem 2008; Himma and Tavani 2008). Information science is also a relatively new theoretical field. It develops in several different directions and analyses thus different aspects of information reality, such as - to name only some of the relevant aspects - information retrieval, information systems, knowledge organization, information/knowledge management, information behavior, information quality, information literacy, bibliometrics and artificial intelligence.

Information science is not a discipline with clear boundaries that would in a unified way describe its research questions, theories and methods. It is rather a complex, dynamic field that addresses many different research problems grounded in a variety of theories and methodologies. This results in a plurality of *theoretical and methodological sub-domains of information science* (hereafter, simply, 'the sub-domains'). What is the relation between the knowledge bases of these sub-domains? Does information science necessarily develop through the plurality of theories and methodologies each of which analyses some particular dimension of information? Are these different approaches related to each other; and if so, in which way? Is it meaningful to see the diverse theoretical and methodological frames as sub-domains of a unified theory of information science? Is there any need for such a unifying theory of information science?

The need for a unifying theory of information science may be recognized in the literature (e.g., Mäkinen and Sandqvist 2003; Ingwersen and Järvelin 2005) and in the praxis of the field (see for instance the *CoLIS 2010 conference*). What might such a theory look like? Its nature does not seem to be a monologistic object-theory of information based on a particular theoretical and methodological frame suitable for explaining all the different dimensions of information. It might rather be a meta-theory that would study the ways in which the varying the sub-domains deal with the phenomenon of information. A unifying meta-theory would also analyse the possibilities of relating the different sub-domains, and their results, to each other.

A good candidate for such a meta-theory, due to its well developed methods of meta-theoretical analyses, is *philosophy of information*. Recent developments in philosophy of information, which all basically follow the prototype initiated by Floridi (e.g., Floridi 2002, 2004a, 2004b; Adriaans and van Bethem 2008; Himma and Tavani 2008), have been focused on relating the traditional philosophical problems to the phenomenon of information. The present article slightly differs from that prototype, in having a more specific focus. Its goal is to show that many of the classical philosophical problems may fruitfully be applied to the varying domains of information science. The article therefore initiates a comparative analysis of the knowledge sub-domains in information science and philosophy, and their mutual connection. Such an approach may lead to a twofold result. It may show:

1. That philosophy of information may function as an *underlying meta-theory* of each of the sub-domains. Such meta-theory would possibly reflect on the principles of approaching information in each of the particular sub-domains and relate each of these approaches to some of the traditional philosophical problems.
2. That philosophy of information may thus be a *unifying meta-theory*. Such meta-theory would possibly analyse how the specific sub-domains, because of their explicit or implicit approaches to philosophical problems of critical thinking and information literacy, may be unified.

Philosophy of information as the underlying theory of information

This part of the article analyses the philosophy of information as the underlying theory for some of the most relevant information science sub-domains: certain aspects of *information retrieval* (particularly the principles of *knowledge organization*), *knowledge management*, *theories of information behavior*, *bibliometrics* and *theories of information literacy*. (Some aspects of *artificial intelligence* are also considered briefly in the article.)

Philosophical issues in theories of information retrieval, knowledge organization and knowledge management

Every information retrieval system contains systems of knowledge presentation (Chowdhury 2004; Ingwersen and Järvelin 2005). The systems of knowledge presentation organize, structure and categorize given knowledge domains so as to enhance the effectiveness of information retrieval - in accordance to the assumed principles of the effectiveness. In focusing on philosophical aspects of knowledge organization, we concentrate on epistemological and ontological dimensions of the IS sub-domain; we also point out some principles of philosophy of language important for the development of knowledge-organization systems.

Without going through the complex development of epistemological theories in philosophy, we may describe *epistemology* as philosophical theory of knowledge concerned with the nature, sources, structures and limits of knowledge. Epistemology thus analyses different types of knowledge, the ways of acquiring knowledge, methods grounding the varying types of knowledge, criteria for differentiating knowledge from other types of experience, as well as criteria for differentiating scientific from non-scientific knowledge. It also studies conceptual structures underlying the varying contexts of knowledge. Elaborated contemporary studies of epistemology may be found in Huemer (2002) or in Sosa and Kim (2000).

Birger Hjørland's socio-cognitive domain analysis (2002a, 2002b) relates epistemology to information science. Hjørland has successfully shown that epistemological structures of every knowledge domain are grounded in the domain-specific conceptual structures and dominating theoretical paradigms, but also in practices of particular social groups and actors (such as researchers and teachers) and institutions (such as universities, schools and conferences), as well as in representative domain-literature established through the dominant

publishers, books, journals and databases.

Analyses of the epistemological aspects in systems of knowledge organization develop awareness of the domain-specific epistemological structures in information systems. The systems of knowledge and the systems of knowledge organization imply certain answers to questions of how knowledge is to be defined, what are the sources and the limits of knowledge, and what criteria that should be used for structuring knowledge. They may thus not be seen only as tools for information retrieval: they also stipulate certain epistemological views of the world. Philosophical meta-analyses of these systems develop awareness about the ways of defining and presenting epistemological structures of the world given in the systems for knowledge organization.

Many epistemological theories are already explicitly applied in the field of *information or knowledge management*. The most prominent theories of knowledge management (e.g., Nonaka 1994; Nonaka *et al.* 2008; Choo 2006) rely openly on the epistemological theories developed by the British polymath and thus philosopher Mihály (Michael) Polanyi, the British philosopher Gilbert Ryle, and those developed by the American philosopher Frederick Dretske, as well as on the philosophy of language advanced by the American philosopher John Searle. The theories of knowledge management make use of the varying epistemological analyses in their project of defining organizational knowledge and collective intelligence. The varying results from philosophical epistemological studies are rightly used when the authors writing on knowledge management distinguish between varying types of organizational knowledge (such as tacit, explicit and social), analyse the principles of constructing meaning and knowledge in organizations, the strategies of knowledge sharing, or the processes of turning organizational information into knowledge, as well as the processes of transforming different types of organizational knowledge into each other.

Ontology, another classical philosophical discipline, is usually defined as the study of being, the study of existence. It comprises varying analyses of the concept of being, focuses on questions of what exists, analyses different kinds of existence. It thus studies different forms of being, the ways of classifying the forms of being, investigates varying criteria for something to exist and studies the structure of being.

Even if the term *ontology* was created in 1613 (see Smith 2003), ontological analyses had been initiated already in ancient philosophy, particularly in Aristotle's metaphysics. Aristotle's ontological approach (1955) defines ten categories as the most general kinds of being: substance, quantity, quality, relation, place, time, position, state, action, and affection. Categories have a special ontological status: they are the most exclusive and exhaustive properties involved in the ontological structure of everything else that exists. Categories are also the constitutive linguistic units for denoting, describing everything existing: by means of these basic linguistic entities we construct more complex linguistic forms, meanings and true or false statements about the world, about the reality, about what it is:

> Expressions which are in no way composite signify substance, quantity, quality, relation, place, time, position, state, action, or affection.

> No one of these terms, in and by itself, involves an affirmation; it is by the combination of such terms that positive or negative statements arise. For every assertion must, as is admitted, be either true or false, whereas expressions which are not in any way composite, such as 'man', 'white', 'runs', 'wins', cannot be either true or false. (Aristotle 1955; 1a-1b).

After many ontological theories developed during the history of philosophy, the logico-linguistic analyses became a dominating ontological paradigm. That paradigm has resulted from the *linguistic turn* in the philosophy of language and logic, in the twentieth century. Some of the most significant philosophers and writings that have initiated the linguistic ontological turn are Frege (see Dummett 1981), Meinong (see Routley [Sylvan] 1980; Griffin and Jacquette 2009), Carnap (1928/2003), Russell (1980, 1988), Kripke (1981), Quine (1953, 1960), Davidson (2001), Grice (1989), Austin (1975), Searle (1996, 2002) and Lewis (1973, 1986).

Because of the insights and works of these logicians and philosophers, it became clear that language is not only an expression tool helping us to describe reality, but rather the ontological medium through which the reality is given to us. Language structures are constituted by and are constitutive for the structure of reality; any ontological analysis is already transcendentally grounded in language. The plurality of language structures is also exemplified in the variety of (scientific) theories and conceptual structures each of which explains some aspect of reality: that is the point of the Quinean insight suggesting that we cannot speak of any general ontology of the world. Every ontology is already grounded in a particular language of a given explanatory theory. In analysing the being, we meet plurality of explanations, that is, the plurality of ontologies grounded in and expressing the conceptual and explanatory language structures of various disciplinary and thus cognitive domains (Quine 1953; Hacking 2001).

Twenty first century initiated the information turn (Castells 1996-1998). The language of information systems has by now become the ontological language through which the varying knowledge and cognitive domains of reality are given. This is obvious in the development of ontologies as semantic conceptual knowledge structures. The most significant (and among the earliest) studies on the *ontologies as systems for knowledge presentation* are the theoretical and operational studies by *computer science and artificial intelligence* research

groups at Stanford University (Gruber 1992, 1993, 1995; Uschold and Gruninger 1996; Farquahar 1997; Vickery 1997; Soergel 1999; Chimaera; Fensel 2001; Baader *et al.* 2003). All these investigations agree that it is meaningless to define one method proper for constructing ontologies. Different theoretical and practical goals of varying knowledge domains influence construction of the corresponding conceptual structures. This results in the *plurality of ontological models* and leads to *the portability problem* (Gruber 1992, 1993). The portability problem identifies difficulties in obtaining a common understanding of a given domain, particularly with regard to multidisciplinary domains. The domain of logic (used in computer science, artificial intelligence, mathematics, linguistics and philosophy) and the domain of information science (used in library and information science, computer science and artificial intelligence) are good examples of such multidisciplinary domains.

> Portability is a problem because the parties to a common ontology may use different representation languages and systems... Thus the portability problem for ontologies is to support common ontologies over multiple representation systems. (Gruber 1993: 200)

Some solutions for the problem result in systems for translating expressive representational languages of related fields into restricted languages that preserve the declarative content and the logical structure of the domain (Gruber 1992).

Linguistic analyses of ontologies focus on linguistic, logical and philosophical aspects of the conceptual structures of knowledge, and provide concrete ontology instances. One such study comprises the theoretical assumptions of the *Logic and Language Links ontology* and assumes the most important results of the Stanford tradition (Caracciolo *et al.* 2002; Caracciolo 2006). Neither of these ontology studies takes an explicit library and information science point of view. Still, the studies on ontologies become significant as theoretical and operational tools for improving the quality of information retrieval in libraries (Denda 2005).

Theories of knowledge presentation in computer science, artificial intelligence, linguistics and philosophy explain ontologies as conceptual systems of knowledge presentation. This is the meeting point of the epistemological and ontological aspects of information science. Ontologies as knowledge-presentation systems assume that the being is given to us through the conceptual structures of different knowledge fields. Once when diverse achievements in philosophy of language have taught us to see words as objects, to understand that information is an object, a material we can share, structure, sell, own; it became reasonable to talk of ontologies as the word structures that show us the configuration and the nature of the world assumed in the semantic structures of diverse knowledge domains. Thus, they partly correspond to Hjørland's (2002a, 2002b) theory of domain analysis.

The fact that ontologies may be based on the various linguistic structures takes us towards some specific aspects of *philosophy of language* as another interesting dimension in the philosophical analyses of the systems for knowledge organization. The development of formal languages in logic and linguistics has demonstrated that the constitutive structures of meaning in formal languages are, exactly as in natural languages, grounded in a specific vocabulary and the corresponding syntactic, semantic and pragmatic structures. Svenonius (2000) has recently shown that the *Library of Congress Subject Headings* (hereafter, the *Headings*), a representative thesaurus system for knowledge presentation, may be analysed as a language, since the system's constitutive elements are given by means of its specific syntax, semantics and pragmatics.

According to Svenonius (2000: 23-26), the *syntax* of the *Headings* is defined with regard to the particular semantic and functional categories of terms as well as individual terms. Svenonius has in detail explained how concrete elements of these syntactic structures construct the syntax proper, that is meaningful, sentences in the *Headings*.

The *semantics* of the *Headings* language consists of category semantics, referential semantics and relational semantics. Category semantics defines classes of terms used by the language. The *Headings* presupposes five major classes of terms already determined in the categories of terms defined by the syntax: the class of main headings, the class of topical subheadings, the class of terms indicating the form of documents, the class of terms indicating historical periods for qualification of documents and the class of terms indicating geographic areas. (It is interesting to notice that each of these categories of terms can easily be related to some of the ten Aristotelian categories.) Referential semantics disambiguates different meanings of homonyms, or specifies the meaning of a word in some other way. The most common way in the *subject headings* is to provide contextual parenthetical qualifiers: for instance, the term *inference* as used in psychology or pedagogy is differentiated from more technical term *inference (logic)* as used in logical analysis of reasoning. Relational semantics specifies conceptual relationships allowed in the language: four types of conceptual relations typical for thesauri-structures are allowed; broader term (BT), narrow term (NT), related term (RT) and USE-relationship.

There are plenty of rules regulating the *pragmatics* of the *Headings*, but one of the important pragmatic rules is the *unique heading principle*, the rule of specificity that guarantees a direct and easy access to subject headings. Another pragmatic rule imposes that the subject headings should be coextensive with the terminology of the related documents and hence make it easy for indexers to describe these documents as accurately as possible. Yet another pragmatic rule is the *uniform heading principle*, which controls synonyms or words that have similar meaning so that they would not be unnecessarily multiplied and thus lower the level of the recall in the information

retrieval system: for instance, term *logic* should be used in the *Headings* both for the terms of *logic* and *argumentation*.

Languages of other systems of knowledge presentation, for instance some ontologies, may be grounded in different syntactic, semantic and pragmatic principles (Tomic 2008). Another interesting application of philosophy of language to information science is to analyse how the various principles of their vocabularies, syntax, semantics and pragmatics enhance the effectiveness of information retrieval (Tomic 2008). Moreover, studies of the systems of knowledge presentation as languages may show the way towards interesting and important insights into how these languages present and structure reality, the varying experiences of reality and different forms of cognition.

Philosophical issues in theories of information behaviour

In early theories of information behaviour (Belkin *et al.* 1982; Dervin and Nilan 1986; Kuhlthau 2004; Wilson 1999), as well as in their recent versions (Spink and Cole 2005), many traditional problems of argumentation and persuasion theory (an important part of philosophical logic) have been addressed. Thus, the theories of information behaviour entail the concepts such as information needs, emotional and cognitive states and spaces, intentions, actions, attitudes, problem situations, problem solving, anomalous states of knowledge, cognitive gaps and processes of sense-making. On the other hand, argumentation and persuasion theory have achieved valuable results concerning the factors influencing attitude forming and change which may be proven relevant for analyses of information behaviour where situations of problem solving, anomalous states of knowledge, the cognitive gaps, question-negotiation and the sense-making are considered. The results of the argumentation and persuasion theory may therefore provide further theoretical grounds to studies on information behaviour, but may also find an important field of application in these theories.

The meta-analyses (O'Keefe 1990, Jovicic 2006) of the *social judgment theory*, for instance, may clarify how the judgmental cognitive structure of the persons involved in information seeking influences their choices of information, strategies of information seeking and evaluation of the information obtained. Consequently, it may be relevant to analyse how a person's scope of acceptance (opinions that the person accepts or is inclined to accept), scope of rejection (the set of negatively evaluated or rejected opinions) and scope of non-commitment (the set of opinions towards which the person is indifferent), as well as the ego-involvement with the information seeking issues (Sherif *et al.* 1965) influence the person's information behaviour.

The information-integration models of attitude and *the theory of reasoned action* (Fishbein and Ajzen 1975), the models that much influenced philosophical belief, desire model of action, have been analysed in theories of argumentation and persuasion so as to understand the factors influencing evaluation of claims advanced in argumentative processes. Fishbein and Ajzen's model explains reasoned action as based on agents' intentions. Intentions are further explained as consisting of the attitudinal factors and the normative factors. The attitudinal factors are explained as belief strength and the belief evaluation of the agent towards a given object or action. The normative factors are analysed as the social reflection on the given behaviour expressed as the awareness of how other people important to the agent value certain action, and the appraisal that the agent ascribes to his/her own motivation to comply with the other important people's evaluation of the action. The model then defines principles for numerical analyses of the constitutive intentional factors for taking certain action. These analyses may be applied to studies of information behaviour so as to investigate how the varying elements constitutive for reasoned actions influence choice and evaluation of information as well as the corresponding choice of problem-solving actions in situations of information seeking and use.

Another approach from argumentation and persuasion theory that may be used in the meta-studies on theories of information behaviour is *the theory of cognitive dissonance* (Festinger 1957; Harmon-Jones 2002). The analysis of the argumentative and persuasive aspects of cognitive dissonance are directly related to the theories of information behaviour and the corresponding analyses of the anomalous states of knowledge (Belkin *et al.* 1982), cognitive gaps and sense-making (Dervin and Foreman-Wernet 2003), and the processes of problem-solving (Kuhlthau 2004). Some important results might be those arising from the analyses of the phenomenon of cognitive dissonance, explained as the unpleasant affective-motivational state initiated by sufficient magnitude of inconsistency between cognitive elements such as beliefs, attitudes, opinions or information. Other relevant results may be found in the analyses of the factors contributing to the initiation and the magnitude of cognitive dissonance, or in the analyses of the factors influencing the agents' conscious and unconscious choices of the ways of reducing cognitive dissonance.

It might also be interesting to apply the *elaboration likelihood model of persuasion* (Cacioppo *et al.* 1985). The model studies the factors that influence the likelihood that agents would elaborate, rather than passively accept or reject, information in persuasive situations. Another group of results concerns the relationship between the level of the elaboration likelihood and the persuasive success. The model may be applied to the analyses of information behaviour so as to study the elaboration likelihood factors that affect active choice of information sources, active evaluation of the amount, relevance and reliability of information obtained, elaboration of the strategies for information seeking and the choice of the ways of reducing cognitive dissonance arising in the situations of information seeking.

Since theories of information behaviour also focus on the development of models for structuring information behaviour and the human-

computer interaction, an important connection to relevant philosophical achievements may also proceed through the *models of dialogue logic* (Barth & Krabbe 1982; Krabbe 1992; Walton & Krabbe 1995).

Philosophical issues in bibliometrics

The results of bibliometric analyses have recently started to figure as important criteria on the basis of which politicians and the decision-makers in research foundations motivate the distribution of economic research sources. In that way, bibliometric studies have implicitly started to figure as one of the indicators of scientific quality, or at least of the quality of scientific production. The need for philosophical meta-analyses of the relationship between bibliometric models and the quality of scientific knowledge and production seems obvious. Such analyses would consequently investigate bibliometric models as one of the relevant epistemological structures constitutive for some dimensions of contemporary definitions and evaluations of knowledge.

The connection between bibliometric analyses and the epistemological analyses is rather obvious if we refer to Hjørlands explanation of epistemology as a philosophical discipline that analyses the cognitive and the social structures constitutive for different domains of knowledge (Hjørland 2002a, 2002b; see also the section about epistemological analysis in knowledge organization in this article). Hjørland has rightly pointed out the importance of scientific institutions, but also dominating publications, publication forms and databases in the relevant knowledge domains, as social factors constitutive for the conceptions and the development of knowledge. We may consequently realize that different bibliometric models, in grounding the studies on the quality of scientific publications in the specific selections of publication forms, databases and bibliometric parameters, explicitly contribute to definitions of knowledge and scientific quality. It is important, therefore, simultaneously with working on the development of bibliometric models, to work on the development of philosophical meta-analyses of the epistemological assumptions and consequences of the bibliometric models and their applications. The epistemological analyses of bibliometric models concentrate on the following questions:

- What are good results of scientific activities and knowledge?
- Are only publications the important results and indicators of scientific activities?
- Is scientific knowledge witnessed and distributed only through scientific publications?
- If publications can be defined as one kind of scientific results, which criteria might be used for defining publications of good scientific quality?
- Which criteria should be used to define publication channels of good scientific quality?
- Is it possible to define such critieria? Is it possible to define as universal such criteria?
- Which languages, and why, should be preferred in producing publications of good scientific quality?
- Is there a difference between national and international criteria for publications of high scientific quality?
- Is it possible to quantify the quality of scientific publications?
- Is it possible to measure the quality of good scientific publications?
- In which way do the bibliometric criteria for good scientific publications relate to the development and distribution of knowledge in varying knowledge domains, teaching and research practices?

For instance, the model based on works of Moed (2005); Moed *et al.* (1995); Schubert & Glänzel (1983) takes scientific publications as one of the important indicators of scientific quality, but does not discuss other such indicators. Concerning the criteria for defining the publications of good scientific quality, the model suggests that only papers published in international journals registered in one of the two most developed reference databases in the West (namely ISI's *Web of Science* or *Scopus*) - are relevant for analysing scientific production. Another indicator of scientific quality of a knowledge domain is the domain's international impact exemplified as a numerical value for the absolute citation frequency and the relative citation frequency for the selected articles, together with the number of unquoted published articles (where the relative citation frequency is calculated by means of the several bibliometric indicators, such as the *number of citations per publication, the journal-packet normalized citation level* - defined as the number of citations per publication relative to the mean journal citation score - and the corresponding *field-packet normalized citation level*).

The *Norwegian model* (Norwegian Association... 2004) also views scientific publications as one of the indicators of scientific quality (without discussing other such indicators). Nevertheless, it takes a larger class of scientific publications to be of the relevant kind. Besides papers published in international journals and registered in the two international databases stated above, the Norwegian model defines books, papers in journals or other periodicals and papers in anthologies as relevant scientific publications, provided that they have appeared in publication channels with national or international circuit of writers and registered in the Norwegian National Publication Database. Moreover, a system of applying bibliographic points is applied in the Norwegian model.

This short presentation of the two models makes obvious the fact that different bibliometric models assume varying criteria for defining the quality of scientific publications and may thus significantly influence the development of scientific knowledge, production and praxis. Philosophical meta-analyses of the epistemological assumptions of bibliometric models, the criteria and reasons for applying different models to varying scientific domains, as well as the (political) reasons for developing and using specific bibliometric models are therefore a

valuable contribution to a wise application of bibliometric analyses.

Philosophical issues in theories of information literacy turn philosophy of information into the unifying theory of information science

In previous sections, we have indicated the ways in which philosophy of information may function as the underlying meta-theory of some sub-domains. In a similar manner, philosophical theories of critical thinking may fruitfully be related to analyses of the sub-domain of information literacy. That aspect of philosophy of information figures therefore as another dimension of the underlying meta-theory. Nevertheless, the critical thinking dimension relates to a particular dimension of information literacy, something that Bruce (1997) has discovered as the wisdom conception of information literacy, and becomes thus a unifying theory of information science.

To be able to describe the philosophical issues in theories of information literacy (philosophy of information as the underlying theory of the information-literacy sub-domain) and philosophy of information as the wisdom conception of information literacy (philosophy of information as the unifying theory of information science), we would need to go through a brief analysis of information literacy and the corresponding dimensions of critical thinking.

Information literacy and the corresponding conceptions of critical thinking

Among a number of interesting studies on information and digital literacy (e.g., Bruce 1997; Bawden 2008, Johnston & Webber 2005; Martin & Madigan 2006), one of the most developed is still Bruce's dissertation from 1997. Bruce's elegant and well structured phenomenographic study (the method grounded in the philosophical hermeneutic paradigm of Hans-Georg Gadamer and the phenomenological paradigm developed by philosopher Edmund Husserl) has resulted in the seven conceptions of information literacy, stated below ((1) - (7)), that together provide a phenomenographic explanation of the phenomenon. We have related corresponding dimensions of critical thinking ((1') - (7')) to each of the seven conceptions of information literacy.

(1) The *information technology conception* approaches information literacy as the ability to use information technology effectively for information retrieval and communication. Information is seen as an objective construct, something outside the individual, dependent on different information technological devices and the technological ways of structuring information. The dominating category of the awareness structure in this conception is the ability of using information technology.

(1') The tradition of *critical system thinking* (Checkland & Scholes 1999) relates to critical thinking about information technology and, thus, to critical analysis of information literacy understood as effective use of information technology. Critical system thinking assumes technical knowledge of the principles of constructing information systems and focuses further on the plurality of human situations, goal oriented actions, as well as theoretical and practical problems that lead to and initiate construction of information systems grounded in specific technological features.

(2) The *information sources conception* explains information literacy as the ability to find information located in varying information sources. Accordingly, information literacy is grounded in knowledge of diverse information sources and their structures, knowledge of the ways of using these information sources independently, or awareness of the intermediaries who may assist in using the information sources. Information is seen objectively, as given and structured outside the individual in the varying sources of information. The dominating structure of awareness is the ability to find information in them.

(2') A specific subfield of critical thinking studies a particular form of plausible reasoning, namely reasoning based on expert opinion (Walton 1997). As a matter of fact, the diverse information sources are constructed as expert systems and have thus a role of information authorities. The ability to find relevant information in these information-expert systems requires critical analyses of the information sources and the personal intermediaries. Such critical analyses are based on the logical studies of the reliability of the information sources, the amount and the quality of information collected in them, the strength of the expert support for the information and the principles for decision making in the cases when different expert systems supply incompatible information. They further relate to logical analyses of the evaluative principles for relevance, reliability and strength of different reasoning forms on which information in the corresponding sources is based (see (5')). The logical analyses of the ways of selecting and combining the words and phrases in information searching strategies, for instance certain aspects of Boolean logic (see (5')), are also of relevance. Furthermore, this conception of information literacy deals with the logical analyses of linguistic, rhetorical and psychological aspects influencing the ways in which people choose particular information sources and evaluate the content of information provided in them (O'Keefe 1990; Jovicic 2006).

(3) *The information process conception* focuses on strategies that individuals use when confronted with a novel situation in which they experience a lack of and, therefore, a need for, information. This conception corresponds to the ability to successfully solve problem

situations resulting from changes in cognitive processes described in theories of information behaviour. Even if information is seen as an objective construct, the dominating structure of awareness is transformed towards the object-subject relation, where agents' problem-solving strategies in information processing are in focus. The dominating meaning structure is that the knowledge gaps and the anomalous knowledge situations initiate an information seeking process which results in corresponding (effective) actions, solutions and decisions.

(3') *Critical dialogue thinking* and *critical persuasion thinking* concerns critical analysis of information literacy understood as the ability to successfully carry out problem-solving information seeking processes. It thus contributes to reflection on the varying problem situations in information seeking and the corresponding cognitive states, ways in which the problem situations initiate attitude change, factors influencing conscious and unconscious choices of information-problem solutions (O'Keefe 1990; Jovicic 2006). It also analyses logical structures of information seeking dialogues and other types of dialogue forms (Walton & Krabbe 1995; Hintikka & Saarinen 1979; Hintikka 1981), which is of relevance for modeling the information-seeking interaction between people and systems.

(4) *The conception of information control* explains information literacy as ability to structure and save, and thus to control, information obtained. Information is still seen as an objective construct, but the subject-object relation is established through varying strategies of storing and organizing information. Thus, the awareness structure of this conception is focused on information control through the varying forms and abilities of storing and organizing information so as to be able to retrieve it from varying storages (such as human memory, digital memory in form of data bases, or filing cabinets) when necessary.

(4') *Critical thinking in the tradition of applied logic and philosophy of mind* relates to critical analysis of information literacy understood as the ability to control information. Particularly important are critical analyses of the ways of applying logical languages, systems and rules, as well as different theories and principles of categorization to the logical principles of constructing databases and other forms of storing, structuring and organizing information (Sowa 1999). Logical systems constructed particularly for applications in different fields of artificial intelligence are also of importance here. They contribute to building up computer languages and programs that implement the principles of storing and processing information, in accordance with the mind actions constitutive for distinctive dimensions of human consciousness and intelligence (Minsky 1968; Shapiro 1992; Russell & Norvig 1995).

(5) *The knowledge construction conception* explains information literacy as the ability to create new knowledge in an area of interest, out of varying information acquired from different information sources. Information is now seen as an object of reflection. The dominating category of the corresponding structure of awareness is information use exemplified through the varying ways of critically assessing and analysing information with the aim of new knowledge construction.

(5') *Par excellence theories of critical thinking* (Bowell & Kemp 2005; Johnson & Blair 1994; Priest 2000; Segerberg 2000; Smith 2003; Walton 2006, 2008) and *critical thinking on epistemological structures* (Audi 2003; Huemer 2002) interacts with information literacy understood as the knowledge-construction conception. These theories of critical thinking analyse logical criteria for transforming information into knowledge. Their focus is on the logically acceptable principles involved in the varying justification and verification principles that, in combining various information units, turn information into knowledge. They also relate to logical analyses of reasonable versus unreasonable reasoning forms on which information provided in numerous information sources is based. That tradition in critical thinking also investigates the specific elements constitutive for particular knowledge bases and domains. The studies of different types, conceptual structures and sources of knowledge, as well as the logical relations between them, which the *par excellence* theories of critical thinking analyse too, is also of relevance for the corresponding conception of information literacy.

(6) *The knowledge extension conception* views information literacy as the ability to work with knowledge and information analyses in creative ways, so as to achieve new insights, new personal perspectives and thus new knowledge. As in the previous conception, information is seen as a subjective construct, a complex mixture between information achieved from the outside world and specific subjective experiences. The structure of awareness comprises creative information use and intuition. According to this conception, an information literate person moves well through varying knowledge bases achieved through schooling processes and specific experiences, but is also capable of intuitive and creative insights, has abilities of, is trained and interested in creative thinking, which leads towards new specific ideas and solutions.

(6') *Theories on critical thinking versus creative thinking* (De Bono 1977, 1990) connect to information literacy viewed as the conception of knowledge extension and focus on the nature of creative thinking as well as on its significance in extending knowledge bases. Especially important are analyses of difference between critical and creative thinking, but also of the role that critical thinking has in initiating creative thinking. Studies about the forms of learning and training that contribute to development of critical and creative thinking are equally important for an elaborated theory of the information literacy described in the knowledge extension conception.

(7) *In the wisdom conception*, information literacy is seen as ability to use information wisely for the benefit of others. Information is understood as subjective construct, transformed by processes of analysis and reflection, but also by combining information with consciously selected values so as to initiate informational transformation of people. The structure of awareness is based on the dominating category of

wise information use, which presupposes social responsibility, and relies on the category of extended and transformed knowledge base. This category suggests that an information literate person is able to influence and transform other people, on the basis of critical reflection on the enhanced information base combined with critical reflection on values, attitudes and beliefs in which a particular way of using information is grounded.

(7') *Critical thinking in ethics* relates to Bruce's wisdom conception of information literacy. Some aspects of critical thinking in that domain are investigations of different types of values and ethical problems relevant for understanding the social use and impact of information. That aspect of critical thinking investigates ethical issues in information science ([Himma & Tavani 2008](#); [Haider & Bawden 2007](#)).

(7'') Another aspect of critical thinking views the wise use of information as comprising all the other conceptions of information literacy, adding to them the critical reflections of the corresponding ways of defining and using information. In that way, the wise use of information corresponds to the advanced abilities of critical thinking analysed in philosophical praxis and literature (for instance, [Johnson & Blair 1994](#); [Bowel & Kemp 2005](#); [Walton 2008](#); [Sobocan, *et al.* 2009](#)). That dimension of critical thinking may possibly analyse the ways in which the varying sub-domains might focus on developing the abilities of using information wisely. It transforms philosophy of information into the unifying theory of information science, and may be labeled *critical information thinking*.

Philosophy of information as the unifying theory of information science

We have tried to show that, implemented in the varying sub-domains of information science, the philosophical discipline of critical thinking is a necessary condition for enhancement of the corresponding abilities of information literacy. We have also tried to show that the ability of using information wisely (understood as the most extensive conception of information literacy) corresponds to the critical information thinking in, and reflecting on, the various sub-domains. Philosophical meta-analyses on the principles, goals and achievements of the diverse sub-domains (with regard to the development of critical thinking and wise use of information) are promising as the unifying theory of information science. The philosophy of information may unify the diversity of information science into a complex, dynamic, meaningful and wise activity oriented towards further sensible, intelligent, healthy, creative, ethical, safe and free development of human consciousness and world - in, but even beyond, the epoch of information age.

Concluding remarks

We have analysed the philosophy of information as underlying and unifying theory of information science. *As the underlying theory*, the philosophy of information implements the relevant philosophical questions into each of the corresponding sub-domains of information science).

- In the sub-domain of information retrieval, the philosophy of information studies the epistemological and ontological principles of pertinent information-retrieval theories and systems.
- The sub-domain of knowledge organization implements the issues of philosophy of language: information systems of knowledge organization could be analysed as languages, and their syntax, semantics and pragmatics may possibly be analysed with regard to the enhancement of effective information retrieval.
- In the sub-domain of information or knowledge management, many results of diverse epistemological theories are fruitfully applied in the endeavour of explaining organizational knowledge and collective intelligence.
- The logical analyses resulting from argumentation and persuasion theory successfully apply to studies on the problem-solving situations of information behaviour. The results of the argumentation and persuasion theory supply valuable analyses of corresponding cognitive/motivational states and processes, the principles of initiating attitude change, the principles of (un) conscious choices of specific attitude revisions, analyses of strategies in information-seeking dialogues.
- Philosophical analyses of bibliometrics might possibly investigate concrete rules of bibliometric models with regard to their influence on constructing different conceptions of knowledge; they also study the conception of scientific publication-praxis as an indicator of the quality of scientific practice.
- Concerning the sub-domain of information literacy, the seven conceptions of information literacy have been related to corresponding philosophical and logical conceptions of critical thinking.

The conception of information literacy as wise use of information turns the philosophy of information into *the unifying theory of information science*. The wise use of information presupposes advanced abilities of critical thinking in each of the specific sub-domains. It thus works on implementing the critical meta-analyses of each of the sub-domains, with respect to the role that information technology and the corresponding variety of knowledge structures, codes, languages, systems and programs might have for a possible wise development of mind and world.

There are certainly other ways of explaining what philosophy of information is and how (if at all) it might be related to information science.

The approach suggested in the present article is one of the several possible ways of thinking about the connection between the two theoretical fields. The present article is not aiming at suggesting a complete philosophical explanation of information science. It would rather like to initiate further research and constructive debate on the mutual connections between the knowledge sub-domains of information science and philosophy. The ways of implementing philosophy of information as the underlying and the unifying theory of information science without doubt require exhaustive works on the particular dimensions of the phenomenon of information, based on knowledge and experiences both from information science and philosophy. It also requires extensive, open-minded, ethical and creative cooperation between experts from the varying sub-domains of both fields.

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