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Concept theory and semiotics in knowledge organization

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Abstract

Purpose – The purpose of this paper is to explore the basics of semiotic analysis and concept theory that represent two dominant approaches to knowledge representation, and explore how these approaches are fruitful for knowledge organization.

Design/methodology/approach – In particular the semiotic theory formulated by the American philosopher C.S. Peirce and the concept theory formulated by Ingetraut Dahlberg are investigated. The paper compares the differences and similarities between these two theories of knowledge representation.

Findings – The semiotic model is a general and unrestricted model of signs and Dahlberg's model is thought from the perspective and demand of better knowledge organization system (KOS) development. It is found that Dahlberg's concept model provides a detailed method for analyzing and representing concepts in a KOS, where semiotics provides the philosophical context for representation.

Originality/value – This paper is the first to combine theories of knowledge representation, semiotic and concept theory, within the context of knowledge organization.

Keywords Knowledge representation, Knowledge organizations, Concepts, Knowledge management, Management information systems, Information science

Paper type Conceptual paper

Introduction

Ever since parametric tools for organizing knowledge were developed, much attention in the field of knowledge organization has focused on theoretical methodologies and frameworks (Smiraglia, 2002a, b, 2005; Mai, 2002, 2005; Szostak, 2004; Hjørland, 2008, 2007a, b, 2005). Two major theoretical problems still remain, however: the lack of a unified terminology and the lack of structural and theoretical understanding with regard to the term "knowledge representation". The lack of a unified terminology can be traced back to ancient times, when different philosophical disciplines lacked common definitions for the terms "knowledge", "sign", and "concept". Instead, philosophers referred to these notions as forms of representation related to the existence of "things" by taking different approaches to describe them: metaphysics, epistemology, and ontology (Montague, 1925).

In modern times, computer scientists have focused on developing numerous frameworks and methodologies for representing what is known in the world as knowledge in ways that machines can understand, store, and represent (Hermann, 2005; Sowa, 2000; Markman, 1999). Many competing definitions can be identified throughout the knowledge organization literature (Buckland, 1991; Dahlberg, 1987; Hjørland, 2007b, and many more). As a result, numerous researchers in the field of

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knowledge organization have examined the term knowledge representation with regard to such concepts as "knowledge", "sign", and "concept" and conceptualized them differently, which has resulted in dissimilar theories and methods of representation in knowledge organization (Poli, 1996; Mai, 2000; Mai, 2001; Thellefsen, 2002; Priss, 2004; Smiraglia, 2002b; Smiraglia, 2002a; Smith, 2006). None of these authors have addressed the theoretical framework behind the term knowledge representation.

According to Peirce, representation refers to "anything that can stand for something else" (Griffin, 1997). Chandler (2004) explained, "There are the assumptions about realism of the term [i.e. representation] embedded [in it]." Thus many researchers avoid using the term representation because of its deceptive realism. The representation of knowledge, according to Hall (1997), refers to the production and conversion of meaning through language. Hall (1997, p. 45) argued that the connection "between concepts and language enables us to refer to either the real world or imaginary worlds". Davis *et al.* (1993) defined knowledge representation as the consequences of thinking rather than acting; in other words, it occurs by reasoning about the world rather than by taking action in it. Hjørland (2007a, b) examined knowledge representation from an epistemological perspective and determined that as an act, the representation of knowledge is always predetermined by epistemology and knowledge theory.

Scholars have examined the development of knowledge organization theory through the eyes of traditional schools of thought: rationalism, epistemology, and empiricism (Hjørland, 2002). A different approach, however, would be to examine the language structure. According to Martinich (1996), the philosophy of language focuses on language structure in the following areas: syntax, semantics, and pragmatics. The study of syntax is usually associated with the study of grammatical sentences in pure terms. Semantics involves the study of the meaning of words and sentences. Pragmatics is the study of what speakers do with languages. In this study, we adopt Martinich's approach by examining the term knowledge representation, using the syntax, semantics, and pragmatic approaches as they are associated with Peirce's and Dahlberg's theories.

The objective of this paper is to compare the consequences of a semiotic understanding of signs and concept theory in knowledge organization with regard to knowledge representation with reference to the philosophy of language paradigm. We will demonstrate how these theories (Peirce and Dahlberg) provide different understandings of knowledge representation with regard to concepts and entities in organized knowledge. Finally, we will examine how Peirce's semiotic theory and Dahlberg's concept theory produce a better understanding of knowledge representation in the context of knowledge organization. The value of this paper is that it is the first to combine knowledge representation, semiotic theory, and concept theory within the context of knowledge organization.

1. Knowledge organization

Knowledge organization (KO) is understood as a sub-area within the Library and Information Science (LIS) community that focuses on bibliographic representation. Hjørland (2007a, b) defines KO as being concerned with constructing and evaluating semantic tools for information retrieval (IR). More specifically, KO is concerned with such activities as indexing, abstracting, and classifying bibliographical items within

libraries, databases, archives, etc. KO thus investigate the nature and quality of knowledge organization processes (KOP) as performed by information specialists and computer algorithms, and the structure and function of knowledge organization systems (KOS). The role of (KOS) is to organize documents, representations of documents, and concepts (Hjørland, 2008). According to Hodge (2000), KOS encompass all types of systems designed to provide access to information sources. KO thus include a wide array of research interests, including the theoretical basis of KOS, the history of KOS, terminological issues, domain studies, genre studies, and the social organization of the sciences. As such, KO may be considered from at least two perspectives: a narrow perspective and a wide perspective. A narrow perspective focuses on different parts of information systems (e.g. "metadata", and the "bibliographic record", as well as its structure, function, and interrelated parts). At a more general level there is a focus on subject classes and concepts. In the narrow sense, KOS is related to the design of information architecture and its application. Also, KOS may be universalistic as Dewey Decimal Classification (DDC) and Universal Decimal Classification (UDC) or as specialized as the organization of knowledge of a particular discipline. A wider perspective on KO includes such disciplines as sociology of knowledge and culture studies (see Hjørland, 1997), literature genres and rhetoric (cf. Andersen, 2004), semiotics (see Mai, 2000; Thellefsen *et al.*, 2003), and bibliometrics (see Schneider, 2006).

1.1 Knowledge organization systems

Library systems traditionally have been designed from the perspective of providing physical access to documents and have their roots in the historical developments of libraries and information sources. The basic functions and purpose of KOS can be listed as:

- facilitating information retrieval (IR-function);
- providing information about documents (document information function); and
- providing shelf arrangements (ordering function) (Broughton *et al.*, 2005).

KOS are intended to encompass all types of schemes for organizing information and promoting knowledge management. KOS include classification and categorization schemes that organize materials at a general level, subject headings that provide more detailed access, and authority files that control variant versions of key information, such as geographic names and personal names. They also include highly structured vocabularies, such as thesauri, and less traditional schemes, such as semantic networks and ontologies. Because KOS are mechanisms for organizing information, they are at the heart of every library, museum, and archive (Hodge, 2000).

Hodge provided a useful, non-exhaustive overview of the general types of KOS and ordered them in three main categories:

(1) Term lists:
   - authority files;
   - glossaries;
   - dictionaries; and
   - gazetteers.

(2) Classification and categories:
   - subject headings; and
   - classification schemes, taxonomies and categorization schemes.

(3) Relationship list:
   - thesauri;
   - semantic network; and
   - ontologies.

However, the approach to KOS from the perspective of "concept" and "sign" and their representation are never followed through in knowledge organization (KO) literature.

1.2 Theories of knowledge organization

The process of knowledge discovery in science has traditionally followed the path of systematic exploration, observation, analysis, and testing. Olson (1998) reminded us that research is always conducted within a particular political and cultural reality. The term "theory" ordinarily implies something that needs testing or proofing that has been derived through research and shares its principles with members of the scholarly community. Smiraglia (2005) argued that no single theory in KO can organize intellectual and physical-knowledge entities, but he did not review the role of language that a theory in the field needs to entail. A review of the literature reveals that research that investigates the role of language in KO and information retrieval essentially uncovers two major families of theories:

(1) an interpretive approach, which includes the socio-cognitive approach, semiotics, pragmatics and historicist approaches, and domain analysis; and

(2) a descriptive/objectivist approach, which includes cognitive science, computer linguistics, and concept theory, also described as "the information processing paradigm" (Brier, 1996).

1.2.1 Current problems in theories of knowledge organization. Many scholars have addressed theoretical problems in KO. Mai (2000) reported that the fundamental problem is the connection between language and its meaning with regard to knowledge representation. Mai addressed this problem from a semiotic perspective in order to offer a better comprehension of the indexing process than that provided by traditional procedures. Szostak (2010) argued that the problem with theories in KO is the lack of "translation of language" theories to guide both users and scholars. In summary, although we outline two current problems in KO, we need to further examine KO theories in the context of defining theoretical problems in the field by applying it to the syntax, semantics, and pragmatics of language.

2. Knowledge representation

The act of representation has often been associated with the production of meaning in the body and mind with multiple dimensions, including text, electronic text, picture, movie, sound, etc. Often the term raises philosophical, conceptual, and empirical arguments and questions, according to Goodman (1987) and Jorna and Van Heusden (2003). Markman (1999) offers four definitions of representation as part of his

investigation. The first definition entails representing knowledge in the world, where the location of representation is its focal point of distinction. The second definition is the act that takes place at a focal point. The third definition outlines the rules we need to follow in order to understand the act of representation. The last definition refers to "process". Process is a combination of the first three components, all of which enable us to understand the act and demonstration of representation.

Although Markman's (1999) definition is not concerned with the philosophical and conceptual questions that the term may raise, the philosophy literature offers four established approaches to the term (Bartels, 2006). The first approach represents the act of representation in the sense of a description or a formal scheme (i.e. a symbol set or a group of entities). The second approach constitutes a relationship. The representation is the mirroring or depiction, which constitutes a relationship. The third interpretation, which originated in the field of psychology, considers representation as a procedure or a process that describes the human function act. The fourth approach is based on the idea that a concept is rooted in a binary distinction with a dialectical method. According to this approach, the representation involves a system of reasoning that arrives at the truth by an exchange of logical arguments. Although all four approaches can be classified under cognitive science, they can also be easily integrated with Peirce's and Dahlberg's theories. The fourth approach, however, is the only one that directly discusses representation as part of systems in the form of language.

The fourth approach is better known as the Palmer (1978) school of thought in cognitive science. Palmer declared two types of representation in the language systems: the represented world and the representing world. According to Palmer, the represented world (W1) shows a world about which we want to make statements and assertions. The representation of the world (W2) stands for the world in which we make those statements, assertions, and inferences. Palmer added that the two components correspond to forms of intrinsic and extrinsic representations. A representing world that necessarily maintains a property of the represented world represents the intrinsic; otherwise, it represents the extrinsic. As a result, according to Palmer, language is extrinsic representation.

In KO, the discussion of epistemological frameworks provided a new direction for investigation (Svenonius, 2004; Hjørland, 1997 and others). In the study of language within cognitive science, Clark (1977) reported the need to explore different methodologies to understand the role of the language within this epistemological framework. Many discussions found in the KO literature that focus on the subject of representation, however, are lacking in how they address the theoretical background of the term. We recommend that future studies examine the term representation and its relevance in KO.

Meanwhile, the concept of knowledge representation originates from computer science, where the debate on the term started when researchers attempted to convert the machine to a true transformer of knowledge. According to Brewster and O'Hara (2007, p. 564), these pioneers were often criticized for their lack of ability to transfer the representations of the machine into "the true experience with the real world knowledge". Many researchers currently define knowledge representation as managing collections of facts about the world (Smith, 2006). According to Sowa (2000, pp. 54-5), knowledge representation is related to formal representation, and it is often discussed as a verb-phrase calculus been utilized by both human and the

machine. According to Davis *et al.* (1993), knowledge representation can also be defined as consequences of thinking rather than acting, in other words, by reasoning about the world rather than by taking action in it.

Discussions on the nature of knowledge representation can also be found in fields other than computer science, including: philosophy of language and logic, contemporary computational linguistics, cartography and geographic information systems (GIS), media studies, psychology, and education. In these fields, researchers share major themes in their investigation of the term, which include language and notation, ontology language, and knowledge/information retrieval. In KO, many researchers have analyzed knowledge representation with regard to their respective studies. Svenonius (2004) examined the term and its effectiveness for the purpose of information retrieval. In her examination Svenonius embraced the logical epistemological approach to the term. She reported that the term is too "expressive", which makes it harder to apply to information retrieval. She recommended additional studies to determine whether a particular case study will provide a more useful understanding of the term.

Hjørland (1997, 2007, b) argued that knowledge representation needs to be studied from an epistemological point of view. He reviewed different fields to report how these fields employed epistemological and activity frameworks to discover new knowledge. In his review, however, Hjørland did not discuss the role of the language as an essential part of representation. Mai (2001) reported that the fundamental problem in the field of KO is the connection between language and its meaning. He stated that the process of indexing involves the interpretation and representation of documents; this activity is highly dependent upon social and cultural contexts. To address the problem, Mai discussed Peirce's semiotics and how the meanings of various words and expressions are produced in individual settings. He argued that Peirce's definition of signs enables a more comprehensive analysis of the stages in the process of indexing and classification that indexers must go through in order to achieve their objectives.

While representation has often been discussed in the fields of philosophy and psychology, we reviewed four philosophical approaches and highlighted the Palmer approach, which is founded on the idea that the concept is based on a binary distinction with a dialectical method. Palmer (1978) studied "representation" in language systems. He distinguished between two types of representation: the represented world and the representing world. In cognitive science, it is important to distinguish between the two worlds so that it will be easy to identify the true world. In KO many researchers have examined the cognitivist framework, but we did not find any discussion of representation. In addition, researchers focused on knowledge representation in their investigations. Svenonius (2001) advocated the examination of the term in particular cases. Hjørland recommended further examination of knowledge representation based on theories of knowledge (epistemology), and Mai (2002) advocated reexamining the term based in semiotics.

3. Foundation of semiotic theories

Throughout history, the term "sign" has taken many forms, including: words, images, object, although signs have no intrinsic meaning unless we provide it (Chandler, 2004). The first known reference to the term sign can be found in ancient Greek, where it

appears to be connected to the word *Semeion,* which stands for "mark" or "sign". Chandler (2004) provided references from Aristotle's writing, where Plato's Cratylus Hermogenes urged Socrates to pay close attention to the signifier and signified of the sign. In the nineteenth century, deliberation on the meaning of the term continued in two schools of thought that provided different interpretations: Saussure and Peirce. In this paper we focus on Peirce's sign theory.

3.1 C.S. Peirce's sign theory

C.S. Peirce's theory addresses the function of interpretation as an integral part of the signification process. Peirce formulated the triadic constituents of the sign as "the representamen", "the object", and "the interpretant", where the representamen stands for something else, namely its object, and the meaning of this relation is conceived as the interpretant. The interpretant has the mediative function that unites the representamen and the object, and the triadic sign relation is considered irreducible (CP 2.228)[1]. According to Shapiro (1983), the function of the interpretant is to fit observed precepts into recognized paradigms, thereby deriving meaning from the perceptual realm. The meaning of a sign is thus related to its object by means of the interpretant; the reaction of an interpreting mind, however, is determined by what it already knows about the sign's properties. Consequently, the meaning of a sign is incomplete and provisionary, and its communication is dependent on a common ground (CP 3.621).

A more fundamental account of sign types belongs to the first trichotomy and relates to the representamen; it expresses the formal condition of signs being signs. It consists of "qualisign", "sinsign", and "legisign":

> A qualisign is a quality which is a sign. It cannot actually act as a sign until it is embodied; but the embodiment has nothing to do with its character as a sign (EP 2:291)[2].

The qualisign is thus defined as being a quality of a sign. A quality is a monad, however, it must be carried by another sign in order to act as a sign. A quality thus can describe an object only by means of resemblance or shared features. In other words, a qualisign must be an icon.

A sinsign is an individual object or event. A qualisign must be instantiated in a sinsign, and a sinsign always involves a qualisign. The legisign is a sign of law, or regularity. The legisign establishes the connection between qualisign and sinsign. A legisign thus involves both a qualisign and a sinsign.

The most developed class of signs is the third trichotomy, which has the function of mediation and relates to the interpretant. It consists of a "rheme", a "dicent sign", and an "argument". A rheme is a sign that is neither true nor false, nor a proper noun, nor a single word except for "yes" or "no" (CP 8.337). The dicent sign is accordingly a more developed sign that includes a rhem and is characterized as a proposition (CP 2.309; 2.251; 8.337). A dicent sign is either true or false. The argument is a sign of law that leads from premises to conclusion. Although the dicent sign only affirms the existence of an object, the argument proves or tests its truth.

The first trichotomy is thus concerned with the necessary fundamentals of the sign, or:

> [. . .] the general conditions of signs being signs (CP 1.444).

The second trichotomy is concerned with the necessary conditions by which signs can say something truthful about the object they represent (CP 2.229). The third trichotomy should be understood as:

> [. . .] the necessary conditions of the transmissions of meaning by signs from mind to mind (CP 1.444) (see Table I).

At the horizontal line, the sign types are grouped in the categories of firstness, secondness, and thirdness. The three trichotomies thus include a first, a second, and a third. A qualisign is a first of firsts, an icon is a first of seconds, and a rhem is a first of thirds:

> Firstness is the mode of being of that which is such as it is, positively and without reference to anything else. Secondness is the mode of being of that which is such as it is, with respect to a second but regardless of any third. Thirdness is the mode of being of that which is such as it is, in bringing a second and third into relation to each other (CP 8.328).

Peirce's philosophy may be acknowledged as pragmatic pluralism (Rosentahl, 1994). In this view, Peirce's philosophy distinguishes between metaphysical possibility and epistemological actuality. The metaphysical possibility may be labeled "reality" and the epistemological actuality may be labeled "world". The world stands in relation to reality, and reality forms the possibility for existing worlds. More precisely, the metaphysical possibility is defined as the consistently thinkable and independently real, within which the facts of experience must be located; and the epistemological actuality is defined as the world based on perceptual knowledge, which can be characterized as a system of ideas that grasps or fixates the independently real through interaction:

> The real world is ontologically one with independent reality as an infinitely rich continuum of qualitative events. It is, metaphysically, that independently real. Yet a world is dependent upon the meaning system that grasps in a way in which reality as independent is not, for a world is that perspective of the infinitely rich reality that has been "fixed" or "carved out" by a system of ideas. Knowledge is abstractive and selective. A world, though concrete, is nonetheless selective in the sense that a world, as the concrete content denoted by a system of meanings, is a way in which the concreteness of reality can be delineated, or "fixed". A system, once chosen, limits the alternatives possible within it, but alternative systems may be possible (Rosentahl, 1994, pp. 7-8).

What is important in the above quotation is that we can distinguish between an independent reality, which contains infinite ongoing processes, and events that can be understood or explained only by a system of meanings. Reality thus may be perceived and explained through a system of ideas, and this gives rise to Peirce's phenomenological categories, which are distinguished in a trichotomy: firstness, secondness, and thirdness.

	First trichotomy of the representamen	Second trichotomy in relation to the object	Third trichotomy in relation to the interpretant
Category of firstness	Qualisign	Icon	Rhem
Category of secondness	Sinsign	Index	Proposition/dicent sign
Category of thirdness	Legisign	Symbol	Argument

Table I.
The three trichotomies of signs (CP 2.243-52)

Firstness is considered a potential of being. Secondness is an actualization of firstness, and thirdness mediates between the potential of being and the actualization. Thirdness then forms generality and habit. Reformulating the statement above, firstness, secondness, and thirdness stand in a complementary relation: firstness is what is possible and thus consistently thinkable (the world being perceptible and conceivable); secondness is actualization of what is potentially possible; and thirdness being actually or logically possible. This trichotomy thus both constitutes what is metaphysically independently real and what is knowledgeable. Thus, the trichotomy both expresses the metaphysical categories of reality and simultaneously forms Peirce's phenomenological categories that express what is knowable. Peirce metaphysics and phenomenology thus supplement each other in a self-corrective manner.

Consequently, concepts are, in the Peircean sense, fallible understandings of independent reality, and by fallible is meant that future investigations can continuously correct the meaning of concepts. In the Peircean pragmatic sense, concepts constitute the intelligible world; however, in order for concepts to be intelligible, reality must be intelligible as well. Accordingly, knowledge as cumulative and knowledge as changing are not opposed to each other for Peirce:

> [...] rather knowledge as changing is also knowledge as cumulative, for any novel world emerges from a cumulative process or history, which yields enrichment of intelligibility both of the old and of the new (Rosentahl, 1994, p. 19).

The most important issue concerning the development of concepts is the tendency of signs to create stable interpretative habits, based on experimental facts. The central issue is stated in the following quote, where according to Peirce:

> Three elements go to make up an idea. The first is its intrinsic quality as a feeling. The second is the energy with which it affects other ideas, an energy which is infinite in the here-and-nowness of immediate sensation, finite and relative in the recency of the past. The third element is the tendency of an idea to bring along other ideas with it (CP 6.135).

An idea develops from first through a second and to a third. The idea is motivated by something exterior to mind, it affects and is affected by other ideas and it has the ability to motivate or inspire to new ideas. This is in short the continuous process of investigation.

The three elements that make up an idea thus follow the phenomenological categories of firstness, secondness and thirdness. A first may accordingly be understood as "potentiality", a second as "existence", and a third as an "intellectual concept" (CP 5.475) or a logical interpretant (see Table II). The next section will consider knowledge representation as an ongoing dynamic process of signification and interpretation. Figure 1 summarizes Peirce's sign theory.

Table II.
Peirce's classification of firstness, secondness and thirdness

	Firstness	Secondness	Thirdness
Signification	Immediate interpretant	Dynamical interpretant	Final interpretant
Cognition	Emotional interpretant	Energetic interpretant	Logical interpretant
Communication	Intentional interpretant	Effectual interpretant	Cominterpretant

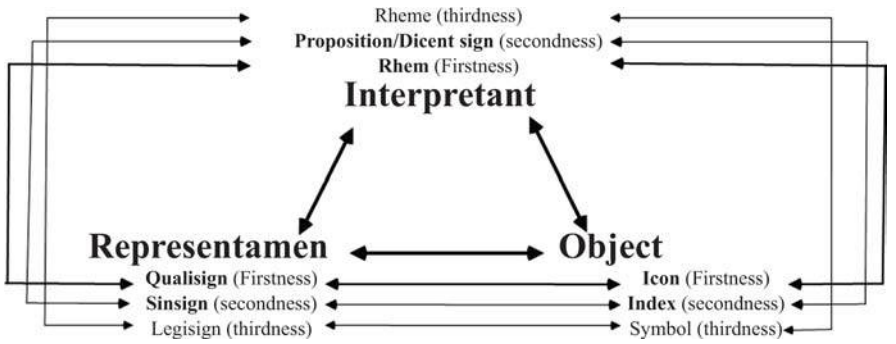

Figure 1.
Peirce's theory

3.2 Knowledge representation and Peirce's theory

A sign can be thought of as something that stands for something else, a word, an utterance, a footprint, etc. (CP 2.531). The object is that which is represented by the sign. For instance, the word "cow" may represent a particular cow, which is the object. The sign stands for its object; however, according to Peirce, representation is not a simple dyadic relation, but is conditioned by a third component, the intepretant. The interpretant connects a sign and its object, and may be thought of as the meaning of the sign. Peirce's account of the interpretant is distinctive and central to his semiotics.

Peirce's work on semiotics progressed through different periods of his life, and his definitions of sign (representamen, sign vehicle, or ground), object, and interpretant gradually became more sophisticated and complex. Consequently, Peirce's theory of semiotics can be divided into three main stages: an early phase that established the basic constituents of the sign structure[3]; an interim stage, where Peirce worked on a classification of sign types; and the final stage, in which he divided the object into the "immediate object" and the "dynamical object". Also the interpretant is here divided into several trichotomies that address different conceptual levels in the signification process.

Peirce's early account of semiotics suggests the concept of infinite semiosis: that a sign process is always a consequence of a previous sign process and that the interpretant will always establish itself as a sign in a successive sign chain. In Peirce's early writing, the sign is considered nominalistic and is associated with cognition:

> An interesting feature of Peirce's early account is that he is keen to associate signs with cognition [...] We can see this from Peirce's early idea that every interpretant is itself a further sign of the signified object. Since interpretants are the interpreting thoughts we have of signifying relations, and these interpreting thoughts are themselves signs, it seems to be a straight-forward consequence that all thoughts are signs, or as Peirce calls them "thought-signs" (Atkin, 2006).

The conception of infinite semiosis is known within the LIS community. In particular Blair (1990) has discussed its role in information retrieval. Thus the conception of "thought-signs", as formulated in the early account of semiotics, relates representation or concepts, and interpretation or the meaning of signs, to human agents" mental space.

Peirce later (during the interim stage) developed the three types into ten classes of signs, based on the three sign trichotomies[4] shown in Table I. In this development, semiotics gradually became more sophisticated, and the representamen, object, and interpretant are considered as trichotomies that serve different purposes:

> In consequence of every representamen being thus connected with three things, the ground, the object, and the interpretant, the science of semiotic has three branches. The first is called by Duns Scotus grammatica speculativa. We may term it pure grammar. It has for its task to ascertain what must be true of the representamen used by every scientific intelligence in order that they may embody any meaning. The second is logic proper. It is the science of what is quasi-necessarily true of the representamina of any scientific intelligence in order that they may hold good of any object, that is, may be true. Or say, logic proper is the formal science of the conditions of the truth of representations. The third, in imitation of Kant's fashion of preserving old associations of words in finding nomenclature for new conceptions, I call pure rhetoric. Its task is to ascertain the laws by which in every scientific intelligence one sign gives birth to another, and especially one thought brings forth another (CP2.229).

As such, semiotic (or semeiotic in Peirce's terminology) is considered a suborder of philosophy that is concerned with the question of truth, though:

> [...] not so much with what is true (which is the job of the empirical sciences) but in establishing the conditions for what is to count as true (Liszka, 1996, p. 5).

The meaning of a sign relation thus relates to the interpretant, which mediates between a sign (a representamen) and an object. A further elaboration on the function of the interpretant, however, suggests that it functions at different conceptual levels:

- signification;
- cognition; and
- communication.

3.3 Peirce's theory and its relationship to KOS

The building blocks of KOS, or the elements that are represented in KOS, are classification schemes, thesauri etc. that could be formulated as terms/words, concepts, classes, or signs. From the perspective of semiotics, the first level KOS organize concepts into a structure that studies the relation of concepts to concepts or signs to signs (the general conditions of signs being signs (grammar) (CP 1.444):

> Something becomes a sign not because of any inherent feature it has but because it acquires the formal characteristics that any sign must have, namely, that it correlate with an object and that it produce an interpretant in a process in which the three are irreducibly connected (Liszka, 1996, p. 19).

The second level studies the formal conditions of the truth of representation (critical logic). Critical logic is thus concerned with valid inferences. According to Peirce, the logics of induction, deduction, and abduction are principal to reasoning. Induction relates to experience or observation of facts (probability), deduction to the necessary consequences that follow from premises (necessity), and abduction to the forming of hypothesis (possibility).

The third level studies the formal conditions of inquiry, and thus depends on critical logic; however, it is also the formal study of communication and is related to the function of the interpretant.

In Peirce's late semiotic, the object is divided into the "immediate object" and "the dynamical object". The immediate object is the object as it appears at any point in semiosis, and the real object (i.e. the dynamical object) is the object as it really is. This

distinction is important, because the immediate object is provisionary and may involve erroneous interpretations of the dynamical object.

The interpretant determines the meaning or understanding we reach of a sign/object relation, however:

> [. . .] the sign signifies its object only in virtue of some of its features. Additionally, the sign determines an interpretant by focusing our understanding on certain features of the signifying relation between sign and object (Atkin, 2006).

Peirce elaborated on the function of the interpretant, and three trichotomies are of particular interest: first, the interpretant is divided into the "immediate interpretant", the "dynamical interpretant", and the "final interpretant". In "Prolegomena to an Apology for Pragmaticism" (1906), Peirce described the interpretants as follows:

> In regard to the Interpretant we have [. . .] to distinguish, in the first place, the Immediate Interpretant, which is the interpretant as it is revealed in the right understanding of the Sign itself, and is ordinarily called the meaning of the sign; while in the second place, we have to take note of the Dynamical Interpretant which is the actual effect which the Sign, as a Sign, really determines. Finally there is what I provisionally term the Final Interpretant, which refers to the manner in which the Sign tends to represent itself to be related to its Object (CP 4.536).

The second trichotomy, which functions at the level of cognition, divides the interpretant into the "emotional interpretant", the "energetic interpretant", and the "logical interpretant". This trichotomy may be considered a specification of the dynamical interpretant[5]. Liszka (1996) disputed this interpretation, however, and argued that the divisions of the interpretant are relatively synonymous or analogous. The advantage of Liszka's argument is that it is true to the systemacy of firstness, secondness, and thirdness. And as a consequence, we can consider the three elaborations of the intepretant as different analogous levels of abstraction.

A third trichotomy divides the interpretant into the "intentional interpretant", "the effectual interpretant", and the "communicative interpretant" (or cominterpretant). The third trichotomy relates the interpretant to the process of communication. Table II summaries Peirce's trichotomy classification.

This elaboration of the sign structure provides for some interesting aspects, which are relevant for KOS. First, the relation between the immediate object and the dynamical object suggest that the immediate object expresses a partial understanding of the dynamical object. Second, where the immediate interpretant is the syntax or general feature of a sign, the dynamical interpretant is our understanding of the sign at some instant in the sign process. The dynamical interpretant is therefore an actual understanding of the dynamical object at some interim stage of inquiry; it provides an incomplete understanding of the dynamical object:

> Immediate objects, then, are accumulative and inferential, and are connected to each other by more than sharing a dynamic object; they represent different stages of understanding in the same information gathering process (Atkin, 2008, p. 74).

The final interpretant is the one that will remain unchanged during any further investigation and interpretation. The final interpretant is thus the final understanding of the dynamical object at the end of enquiry. Consequently, the determination of the dynamical object implies a series of dynamical interpretants and immediate objects.

In relation to KOS, the immediate level of the interpretant expresses the system's formal structure. We may, for instance, distinguish term lists from classification systems and thesauri. The dynamical interpretant as stated by a subject indicator is the actual but incomplete determination of the dynamic object at some interim stage in the semiotic chain/process, and consequently, dynamical interpretants constitute immediate objects. The final interpretant occurs when the immediate and dynamical objects become one. The final interpretant thus stands for the dynamical object; at the end of enquiry, it would be the concept's final meaning. Within science, the final interpretant would be the true relation between sign and object. One may argue that the final interpretant is beyond reach, because scientific theories are continuously modified. Therefore, the final interpretant is instead the telos of the signification process. According to Peirce, science develops according to an ideal, which is the final interpretant, and thus from this perspective, Peirce considers science progressive. From the perspective of KOS, the final interpretant would be considered the true relation between subject representations and the subject itself, as determined by the scientific community. However, also here the final interpretant is beyond reach, but only approximate. Some concepts may be relatively stable within a community, other concepts, however, constantly develops new meanings, simply because of the dynamical nature of the community.

The division of the interpretant into the trichotomy of immediate, dynamical, and final interperetant provides a formal and general explanation of the different stages in the signification process. The final stage, which is the final interpretant, expresses the telos towards which end the signification process may turn at the end of inquiry:

> My Final Interpretant is [. . .] the effect the sign would produce upon any mind upon which the circumstances should permit it to work out its full effect.
>
> [. . .]
>
> The Final Interpretant is the one Interpretive result to which every Interpreter is destined to come if the Sign is sufficiently considered. [. . .] The Final Interpretant is that towards which the actual tends (SS 110-111).

The second trichotomy, which divides the interpretant into the emotional, the energetic, and the logical interpretant, is considered from the perspective of an interpreting mind, thus relating the signification process to thought. Consequently, the logical interpretant is the meaning of an intellectual concept (CP 5.476; 5.480-6). The meaning of an intellectual concept emerges through the stages of the emotional interpretant and the energetic interpretant; within science, it could be an idea, or a hunch, which is motivated by an object (a phenomenon) and then develops and becomes manifest; eventually it becomes fixated in a concept, which is the logical interpretant. Accordingly, the logical interpretant follows the trajectory of the final interpretant, which is the ultimate end of discovery. Subject representations are logical interpretants; however, subject representations may be motivated by interests other than the final interpretant of a particular scientific concept. Therefore the meaning of subject representations may deviate from the scientific meaning that is defined and grounded in the scientific community.

The third division of the interpretant, the trichotomy of intentional, effectual, and cominterpretant, is considered from the perspective of communication. In relation to

communication and particularly in relation to KOS, this trichotomy is of interest, because it addresses the communicative relation between an utterer and an interpreter. The utterer, (here understood as a sender of a message), in the case of a KOS, represents an intended meaning by means of a subject representation. The meaning of a subject representation consequently depends on what Peirce called the "commens", or communicative interpretant (or just cominterpretant). The cominterpretant is based in collateral experience, meaning, for instance, that if an utterer communicates a particular concept to an interpreter, the communication process will depend on the interpreter's experience. For the communication is to be successful, the utterer and interpreter must share the same symbolic system of representation (e.g. scientific language) and collateral experiences.

Subject representations of a KOS could be considered logical interpretants that reflect a particular structure and meaning of the dynamical object. Considering the success of a KOS by its ability to establish a cominterpretant (or in LIS terms, to provide for relevant documents), meaningful subject representations depend on a match between different sign systems. A KOS thus states that particular documents fall within a particular subject category, or may be represented by a particular subject indicator. The effectual interpretant relates to how a perceiving mind understands the meaning of a subject indicator.

The communicative interpretant is the ultimate effect of signification, where the intentional meaning and the effect produced by a perceiving mind are identical. The communicative interpretant consequently represents the stage in a communicative process where an utterer and a perceiver share a common understanding of an object communicated by means of a shared terminology. This summarizes the major challenge of KOS.

Understanding a KOS as semiotic structure has the advantage of including both the relation between a representation and an object and the relation between the interpretant and the object. This provides us with a theoretical framework that is sensitive not only to objective semantic structures as defined by concept theory, but also to the process of interpretation and meaning.

Semiotics acknowledges that concepts are motivated by premises based in theoretical assumptions about reality; whether these assumptions are true or false is to be determined by future investigations. Thus, concepts cannot be objective, independent, or neutral, but should rather be investigated as semantic units purposefully designed by a scientific community, in order to communicate a particular intended meaning about relevant research phenomena.

3.4 The classification of language and Peirce's semiotics

From the discussion above follows, that concepts, in the Peircean sense, are intellectual, based in reasoning (concepts are logical interpretants) and perception (concepts are motivated by something exterior to a perceiving mind). Also, knowledge about a concept relates to previously acquired knowledge, and therefore concepts must be defined within a continuum, departing from one knowledge state to a more and continuously developing knowledge state. The logical interpretant represents these provisionary stages that in the end (idealistically) may lead to a final interpretant, which is considered the ultimate end or truth.

What remains to be addressed as an important ingredient in relation to concepts is the function of language and communication.

The meaning of a sign is produced by the interpretant. The interpretant mediates between a sign (a representamen) and an object. However, a further elaboration on the function of the interpretant in relation to language suggests that the interpretant functions at different conceptual levels:

- the level of signification (grammar);
- the level of cognition (critical logic); and
- the level of communication (universal rhetoric).

Grammar studies the relation of concepts to concepts, or signs to signs (the general conditions of signs being signs (grammar) (CP 1.444):

> Something becomes a sign not because of any inherent feature it has but because it acquires the formal characteristics that any sign must have, namely, that it correlate with an object and that it produce an interpretant in a process in which the three are irreducibly connected (Liszka, 1996, p. 19).

The second level studies the formal conditions of the truth of representation (critical logic). Critical logic is concerned with valid inferences. According to Peirce, the logic of induction, deduction and abduction are principal to reasoning. Induction relates to experience or observation of facts (probability), deduction to the necessary consequences that follows from premises (necessecity), and abduction to the forming of hypothesis (possibility).

The third level studies the formal conditions of inquiry, and is considered the formal study of rhetoric or communication. Defining concepts as signs thus implicate grammar, logic and rhetoric, and the formal features of signification, cognition/inference and communication (see Table III).

The first level (syntax) determines the nature of representations, i.e. how signs are signs of something. E.g. how a substantive is considered a term/a lexeme that stands for an object/concept. The level of cognition determines the meaning of a sign being a concept. It implicates a reasoning capacity that connects the level of signification with a determinate meaning. The third level determines how the sign acts as a communicator of meaning in a community.

3.4.1 Syntax, semantics, and pragmatics related to KOS. Semantics is considered the study of meaning in language. However, according to Martinich (1996), philosophers distinguish between three areas of the study of language: syntax, semantics and pragmatics. Syntax may be considered synonymous with "grammar", and studies the rules that describe well-formed sentences in purely formal terms (Martinich, 1996, p. III). Semantics studies the meaning of linguistic expressions in relation to:

The level of signification	The level of cognition	The level of communication
Syntax	Logic	Pragmatics
Grammar	Denotation	Connotation
Form	Substance	Use
Word	Concept	Context

Table III.
Three conceptual levels of the interpretant

- its reference (extension);
- its truth value;
- its intension; and
- its relation to what a competent user of an expression must know (e.g. being able to recognize the structure and building blocks of a sentence).

Pragmatics studies the context dependent features of language, and presupposes knowledge that goes beyond the semantic structures.

Syntax thus study the characteristics of words and sentences (form and syntax), semantics study the meaning of concepts. Semantics is concerned with the determination of concepts (intension), how they relate to objects (reference), and the particular items that fall under a concept (extension).

Pragmatics is concerned with how concepts are determined by use, how meaning depends, not only on syntax and semantics, but involves the context of how concepts are used in communication, i.e. the intention of the communicator and the motivation of the receiver. However, this aspect is implicit in most kinds of KOS. The thesaurus may, however, provide for context information by explicating scope notes.

In a KOS context the meaning of concepts is determined by semantic relations. The traditional kinds of KOS (authority files, classification systems and thesauri) normally include at least equivalence (synonymic), generic (hierarchical) and associative relationships. The contemporary kinds of KOS (ontologies and semantic networks) may include several more specific semantic relations. The general kinds of semantic relations relevant for KOS are listed below:

- *Synonymy.* The word A expresses the same as word B (equivalence).
- *Polysemy.* A word is polysemious if it has multiple related meanings.
- *Antonymy.* A word with the opposite meaning, e.g. rich/poor, or fat/thin.
- *Hypernymy.* A word that includes a subset of subordinate terms, e.g. Martial Arts is hypernym to Ju Jitsu or Karate (is also determined a "Is-a relation").
- *Hyponymy.* A is a hyponym of B if the meaning of B is part of the meaning of A and A is a subordinate of B (is also determined a "has part relation").
- *Holonymy.* Names a whole where meronymes names its parts.
- *Meronymy.* Means part of a whole (is also determined a "part of relation").
- *Acronymes.* Abbreviations, e.g. LIS is acronym for Library and Information Science.
- *Locative.* The location of an object, e.g. A being placed in B.

Other kinds of semantic relations that, however, may be considered pragmatic (see Hjørland, 2007, b) are:

- scholarly, paradigmatic or discourse specific;
- specific to specific empirical languages (e.g. national languages, or language for special purposes (LSP); and
- user oriented, e.g. a company, a work group (corporate language, jargon).

Different kinds of KOS meet different demands and serve various knowledge interests. Furthermore, they are approached with different expectations. KOS are thus useful for different purposes and are determined by contexts; a dictionary may be useful if information about a word or a concept is sought, a thesaurus is useful in relation to searching information by means of a controlled vocabulary in a database. Semantic networks (or conceptual graphs) are useful tools for modeling or mapping generic structures of concepts.

The pragmatic relations, as suggested by Hjørland, are important, because they implicate much more context information, and as such, necessitate a more extensive context analysis of concepts as they are specified within a universe of discourse. Accordingly, paradigms, epistemological views, socio-cultural practices within communities, and language, are considered of outmost importance, when the meaning of concepts is to be determined.

4. Foundation of concept theory

A concept is often referred as a cognitive unit of meaning that holds an abstract idea in the language, according to Margolis and Laurence (2005). According to them, the term "concept" has become one of art among philosophers because of the diversity of concerns with which it is associated. Adding to the confusion is the fact that the term causes dispute among philosophers, often reflecting deeply opposing positions: the analytic and postmodern schools of thought. Friedrich Ludwig Gottlob Frege was the first to make a distinction between concept and object by establishing a concept theory. He defined a concept (Frege, 1892) as a function that has a truth-value. According to Frege, the concept being human is understood as a function that has True as value for any argument that is human, and False as the value for everything else. His contribution is considered to be one of the frameworks of the analytics school. Modern researchers added to our understanding of the term by considering concepts as the psychological entities found in natural language signifying mental representations (Peacocke, 1992; Fodor, 1998; Laurence and Margolis, 2002).

4.1 Dahlberg's concept theory

Dahlberg offered a triadic foundation of the term "concept". According to this model, a "concept" is a generated whole that does not yet exist. Dahlberg proposes a concept system that consists of a triangular representation made up of reference, characteristic, and verbal form. The central point in Dahlberg's concept triangulation is the reference function. The reference function addresses the person's judgment about the referent of the concept/knowledge unit. The creation of reference occurs through three activities: predication, denotation, and designation. The term "denotation" is synonymous with the reference step, while the term "predication" represents the postulation of the reference. The term "designation" is the actual transformation of the reference and the characteristics of the concept to a verbal form.

Dahlberg's main objectives are to provide a better scheme to organize new knowledge classified as knowledge units or concept(s). Figure 2 summarizes Dahlberg's trichotomy.

The "Referent" is the main component of Dahlberg's triangulation. According to *Webster's Dictionary* (1976, p. 176), the term stands for an act, direction, and use of resources for the purpose of information. According to Hartmann and Stork (1972),

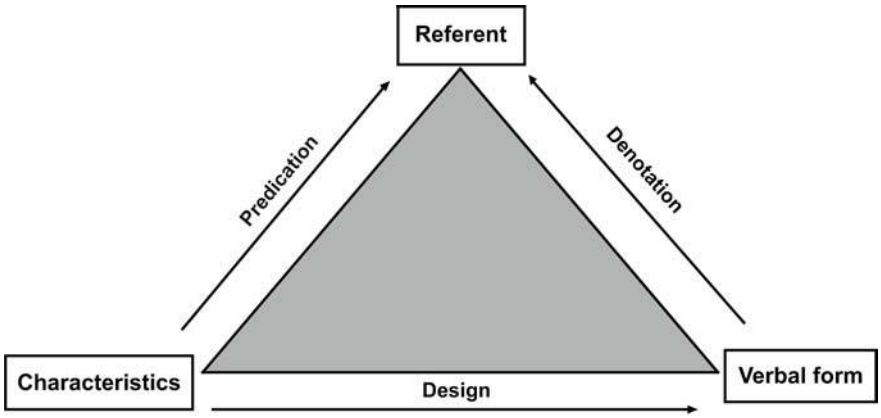

Figure 2.
Dahlberg's concept theory

reference in the context of language and linguistics points out the symbolic relationship that a linguistic expression has with the concrete object or abstraction it represents. In Dahlberg's concept theory, the concept of reference holds three constitutive parts: the actual referent act, the judgment of the referent act, and the verbal form that is used to represent the concept. Dahlberg reports that a reference also can be classified into different schemes to provide the necessary foundation for systematic efforts to analyze the concepts of any subject field (Dahlberg, 1978, p. 144). To ensure the reference analysis, Dahlberg explained that each reference needs to be examined according to the degree of abstraction, ranging from individual to general ideas about reality.

The characteristics of concept creation are derived from a statement about its reference. The characteristics as a function can also be defined as a concept/unit of knowledge. Dahlberg found that the characteristics of a concept should be evaluated by their contents rather than by their form. She noted that each concept carries different characteristics. To address the different concept characteristics, she divided the characteristic's functions into three factors: essential, accidental, and individual characteristics. Essential characteristics stand for all references of a given kind, while the characteristics that apply to only some references of a given kind are called accidental.

Characteristics that apply to a single referent are called individual. Dahlberg made further distinctions by outlining additional subcategories that include: form-categorical characteristics, ontological characteristics, concept-constituting characteristics, and consecutive characteristics. Each of these functions improves the capacity to explore the relationships between a single case, general case, and implied case. The following is an explanation of the verbal-form function.

The verbal-form function stands for the component that conveniently summarizes or synthesizes and represents the purpose of designating a concept in communication. The verbal-form functions as a representation of a concept creation. Dahlberg outlined five principles that are involved in this function, including: compliance with reference, component, reflection of characteristics, minimum length of term, verbal derivability, and internationality.

These principles outline the actual process of analyzing the concept reference and its characteristics. Dahlberg asserted that there is more than one way to represent a concept. She applied both logic and syntax rules showing the difficulty of addressing the functions of a representation, only by means of the verbal form function. According to Dahlberg, part of the problem can be explaind by reference to a lack of definitions of properties of concepts and their characteristics.

To assess the concept of triangulation, Dahlberg appraised its properties. She outlined three directions to assess the concept diagnosis. The first step is in the construction of the concept(s), and the second step is differentiation among the concepts. She distinguishes between three cases. The first case, which merged all references of a given topic or area, is called genus. The second case, species, addresses some references of a given kind. The third direction is called an individual group, where a single concept is referred to after having been evaluated. Table IV summarizes the three-step procedure of constructing and differentiating concepts.

Dahlberg also discussed the relationships between concepts. She identified more than 12 types of concept relationships, including: two types based on the research methods paradigms (quantitative and qualitative), the mathematical-statistical approach, the mathematical-conceptual approach, and the concept-theoretical approach, as well as hierarchical, partition, opposition, functional formal, form-categorical, and material relationships. Each of these relationship groups can be further sub-categorized. This review focuses on the concept-theoretical approach because of its relevance to our inquiry.

In KO, not many researchers have examined "concept theory." Hjørland (2007, b), who reviewed Dahlberg's theory on his website, conducted a review of the major philosophical movements: rationalism, empiricism, historicism and hermeneutics, pragmatism and activity theory, and Kuhn's theory in the context of concept theory. He argued that examinations of concept from the perspective of epistemology and activity theory can be useful to KO, but he did not enquire into the semiotic nature of concepts and the role of language. More research is needed to better understand the nature of concepts in organizing and representing knowledge.

4.2 The term knowledge representation in Dahlberg's concept theory

Dahlberg did not directly address the term "representation" or "knowledge". A closer look at her theory, however, reveals two direct references to these terms. The first notation relates to the term "reference," where she refers to it as human judgment about

Step in construction	Steps in differentiation	All references of a given kind	Some references of a given kind	A single reference
A.	Referential	Genus	Species	Individual
B.	Predicational	Essential characteristics	Essential characteristics	Essential accidental individualizing
C.	Representational	General terms (ordinary terms)	Special terms/ technical terms	Names/proper names

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Table IV.
Dahlberg's classification of types of concepts and their differentiation

knowledge units/concept. The second reference of the term relates to the connection between the characteristic of concepts and its verbal function entailed in the process of representation. Dahlberg distinguished between the representation of knowledge and the representation of "concept". An individual engages in the representation of knowledge, which is a learned activity that is influenced by the closest human community. The representation uses words as expressions of insights, facts, and objects of cognition. According to Dahlberg, however, each word is unreliable because it has multiple meanings. Dahlberg emphasized that applying concept or knowledge as units of analysis, instead of analyzing words, ensures better control over the validity and reliability of our classifications.

To address the knowledge-representation problem, Dahlberg identified two components:

(1) the relationship between the concepts; and

(2) the classification of the concept.

Dahlberg divided the relationship between concepts into three parts: formal, form-categorical, and material. She then divides the formal relationship into four categories: identity, inclusion, intersection, and exclusion. In contrast, material concept relationships are composed of four parts: a generic or abstraction relationship, a partition relationship, an oppositional or complementary relationship, and a functional relationship. Dahlberg did not provide more details on those examination relationships, and future studies need to address how those relationships can be organized to support concept retrieval.

Dahlberg extended the search for representation by providing three different approaches that help display the concepts and their relationships with regard to their representation. The first is a mathematical-statistical approach, which is based on a cluster analysis of concepts and their relationships. The second is a mathematical-conceptual approach that is based on concept analysis derived from the Darmstadt School. The third is based on the concept-theoretical approach, in which the concept's characteristics are analyzed as refined systems.

Regarding the last approach, the search of a document can be done by controlled language expressions listed in a thesaurus or a descriptor list, mostly with their own hierarchical relationships. Dahlberg addressed the danger and limitations of conceptual analysis representation by stating that "it is essential to remember that the methods and activity area of knowledge organization is tightly connected to its object area. Scientific statements related to the subject field of knowledge organization therefore must be reducible concepts of both areas" (Dahlberg, 2006, p. 14). Overall, although Dahlberg did not address the terms "representation" and "knowledge representation" directly, the notation of the terms can be found throughout her theory, in particular, with regard to the term "reference" and the connection between "characteristics" and "verbal form" in the classification of concept systems.

4.3 Dahlberg's theory and knowledge organization systems (KOS)

Dahlberg (2006) discussed the definition of the term "knowledge" and its characteristic from a linguistic stand point. Her theoretical structure is completed by assigning value to inherent knowledge elements, according to the contents of referents of all kinds. She then distinguished between the four elements of "knowledge": knowledge elements,

knowledge units, larger knowledge units, and knowledge systems. Knowledge elements are defined as the characteristics of concepts, whereas knowledge units refer to the way I delimit the measurement of knowledge. The third category, larger knowledge units, is defined as a concept-combination between text and definitions. Knowledge systems, Dahlberg's last category, exist when knowledge units are planned and arranged in a cohesive structure.

4.4 The classification of language under Dahlberg's theory

The study of philosophy of language has a long history, where the subject of what is the meaning of a word/concept and even a personal understanding of those concepts, and their ontological status was addressed by different paradigms. The most outspoken paradigm to address this question was the analytical paradigm. Early advocates of the analytic paradigm saw direct relationship between the term concept and its close relationship to the term idea. Dahlberg's theory follows the analystic paradigm by supporting the idea of searching for the "truth" that depends on relations of concepts.

Dahlberg incorporated the study of concepts under knowledge organization schemes to provide a better understanding of organizing knowledge. Dahlberg outlines ten categories:

(1) general-form concepts;
(2) theories and principles;
(3) object classification systems and thesauri;
(4) activity processes;
(5) property attributes;
(6) persons;
(7) institutions;
(8) technology and production;
(9) application and determination; and
(10) distribution and synthesis.

The first group classifies certain kinds of documents, including bibliographic works and conference proceedings. The second category refers to theories and principles that deal with indexing and classification. The next group, "object", addresses classification systems and thesauri that deal with the classification of the object. "Activity processes", which is the fourth category, involve methods of classifying and indexing. The fifth category deals with the property attributes of indexing and classification. The sixth category, "person", deals with subject-related systems, mainly taxonomy. The seventh group deals with related systems and is titled "institutions". The eighth class involves concepts from fields (mainly technological) that are related to KO; the title of this class is "technology and production". The ninth classification, "application and determination", covers the methods of the field that are applied to document forms and subject contents. It also covers intellectual products in the field. "Distribution and synthesis", the last group, addresses the environment of the field and its social organization, as well as issues of education, law, economics, and service. Dahlberg

concluded that the first category and the last three categories are useful for arranging the KO research-entities framework (Dahlberg, 2006, p. 14).

Next, we will take a closer look at Dahlberg theory from the perspective of syntax, semantics and pragmatics.

4.4.1 Dahlberg's syntax, semantics and pragmatics and KOS. Dahlberg did not directly address syntax, semantics, and pragmatics in relation to KOS. Instead, Dahlberg (2006, 1994, 1995) described different types of relationship among concepts where some of these relationships can be examined with reference to syntax, semantics and pragmatics and knowledge systems as defined by her. Under the triangulation of the concept in her theory as discussed in Section 4.1, the verbal form of the concept stands for the verbal forms of concepts. Dahlberg (1978) outlined five types of principles that the verbal form entails. The first is compliance with the/a referent that stand as a comply condition to the referent. The second principle entails the reflection of the nature of a concept in the natural setting. The third principle offers the minimum length of the term in terms of the discourse of its creation. The fourth principle offers the verbal derivability the concept. This process of derivability entails the discourse of knowledge elements and their and truth value, the concepts functionality, its relationships of and use. This principle stands for the internationality that contains Latin or Greek elements that holds different meaning to different languages. From these five principles, Spangler (1985, pp. 334-5) reported on their contributions to better understand the structure of language. Futhermore, we found reference to the pragmatic aspect of concepts in Dahlberg's theory when a concept is generated by pulling together a single knowledge element to any item of reference. When we generate a new concept, according to Dahlberg, it is possible to use its representation in terms of its discourse in a more conscious way and can be verified according to validity and truth (2006, 1994, 1993). As a result, Dahlberg did not address the three components of Martinich classification nor examine Hodge's definition. However, a closer look at her discussion enables us to find connections between syntax, semantics and pragmatics and the term concept. More studies are needed to examine, if syntax, semantics and pragmatic notions can be applied to Hodge's definition of KOS.

5. Similarities of and differences between the two theories with respect to knowledge representation

An examination of the similarities of and differences between Peirce's and Dahlberg's theories with respect to knowledge representation and KOS highlight issues that warrant future investigation.

The two theories share the following: being classified within the philosophy of language, using triangulation as form of representation, having supporting casts and sub-classifications to the triangulation's main characteristics, and focusing on the role of knowledge representation.

The strongest similarity between the two theories is the use of triangulation as the center of the main categories representing signs and concepts. In both triangulations, the transactions between the key components and schemes are identical. In Peirce's theory, this interaction occurs between the interpretant, the representamen, and the object and usually this interaction occurs concurrently. In Dahlberg's theory, the interactions between the reference, characteristics, and verbal form also occur simultaneously.

The supporting casts to the main division of the two triangulations (signs and concept) share similarities with regard to their schemes and classifications. In his sign theory, Peirce breaks the three main categories into:

(1) Firstness – "the mode of being of that which is such as it is, positively and without reference to anything in itself" (Peirce 1931-58, 2.411);

(2) Secondness – "the mode of being of that which is such as it is, with respect to a second but regardless of any third" (2.432), which can be identified as the representation or *Vorstellung*, a representation that is made by the perceiving subject of the object-in-itself; and

(3) Thirdness – "the mode of being of that which is such as it is, in bringing a second and third in relation to each other" (2.446).

This classification casting helps to examine and overcome the terms and actions that are not easily consorted to Peirce's triangulation, according to Mounce (1997, pp. 34-39).

Dahlberg's concept triangulation includes 11 sub-components, but none of them match Peirce's classification, which incorporates the self as a major component. According to Colapietro (2003), Peirce's theory is inherent in the life of signs, as this life is itself manifest in communicative and perceptual processes. Dahlberg's classification is more concerned with adapting to the user and supporting her casting components based on user demands. More studies are needed, however, to examine whether Peirce's subcategories can be integrated into Dahlberg's theory.

Although both theories address the term knowledge representation indirectly, one can find similarities in how the two theories refer to the foundation of the term. In Peirce's theory, the meanings of signs are produced by the interpretant in its relation to an object, and objects may be known only by means of a perception of signs. Peirce's theory thus includes elements of perception and interpretation as a fundamental aspect of knowledge representation, and if considered in relation to KOS, subject representations are signs that are organized systematically in order to provide a particular intended interpretive act that users of the system will recognize.

In Dahlberg's theory, knowledge representation can be detected in the referent component, where the term refers to human judgment. It is a human who makes a judgment about its references; thus Dahlberg also denotes the interpretive activity by a user of knowledge representations. This interpretation is dominated by three human activities: predication, denotation, and designation. This raises the question: can knowledge representation be examined according to the degree of abstraction based on these three conditions? More research needs to address how knowledge representation fits human perception according to the degrees of abstraction.

Differences between the two theories can be found at many levels, including the meaning behind the sign and concept, the classification of terms, and the ideology behind the theory. Dahlberg did not discuss the meaning of the term "concept". She reported that the meanings of terms were discussed by many and that her contribution would consist of addressing the reference as a major part of the classification. More studies need to examine whether this assumption is true.

The term KOS is often intended to encompass all types of schemes for organizing information and promoting the organization of knowledge. From the perspective of Peirce's theory, we reviewed different definitions of Peirce's interpretant(s) and reported that the final interpretant by Peirce can be considered to have a true

relationship between the subject representation and the subject itself. Dahlberg's concept theory provides us with three approaches to displaying the relationship of the term concept that can be applied to the definition of KOS. From Dahlberg's point of view, a concept-theoretical approach can be used to construct concept systems that can be controlled. We recommend that researchers engage in future studies on the terms knowledge representation and organization of knowledge systems within digital libraries, archives, and even social media to explore their contributions and their frameworks. Figure 3 summarizes the differences between Peirce and Dahlberg theories with regard to KOS.

The philosophy of language is the reasoned inquiry into the nature, origins, and usage of language. According to Martinich, the examination of language in philosophy was usually associated with three area of investigation: syntax, semantics, and pragmatics. The study of syntax is usually associated with the study of grammatical sentence in pure terms. The study of semantics is involved in the study of the meaning of words and sentences. Pragmatics is the study of what speakers do with languages. Both Peirce and Dahlberg provided insight into the syntax, semantics, and pragmatics of language.

Finally, one can accept that humans are inherently creatures of organization, but in any form of organization systems, language plays an essential role. In the KO literature, numerous scholars have examined language theories that review Peirce's semiotic sign and Dahlberg's concept theories. Meanwhile, examinations of the terms representation and knowledge representation are associated with the production of meaning in language.

Reviewing the KO literature on the discussion of the two terms reveals that scholars often discuss them within an epistemological framework. The aim of this study was to examine Peirce's and Dahlberg's theories with regard to the terms representation and knowledge representation. To address these terms in the domain of KO, we used the term brought about by Hodge (2000), who defined the KOS field. Employing this definition enables us to examine whether the two theories address the terms knowledge and knowledge representation from the perspective of the language system tools in a way that will allow us to organize knowledge structures. In Peirce's sign theory, the interpretant is the connecting bond between a representation and an object. The meaning of a concept lies in the interpretant. Accordingly, a representation is a sign only if it is open for interpretation, or, put differently, in order to function as a sign, a representation must be recognizable as a sign. Thus interpretation is a prerequisite in semiotics. It is important at this stage to stress that Peirce's theory is not thought as an instrument for KO. Peirce's semiotic is considered in three perspectives:

(1) the formal conditions of signs being signs;

(2) the formal conditions of truth; and

(3) the formal conditions of inquiry.

These perspectives may be seen as different levels of interdependent abstraction. The third and most developed level thus depends on the second, and the second on the first. Semiotics is thus not only a theory of representation, but also a full-fledged theory of inquiry. One may argue, however, that what semiotics has in theoretical depth it lacks in application. Peirce's semiotics is developed from the perspective of philosophy and thus inquires into the nature of representation.

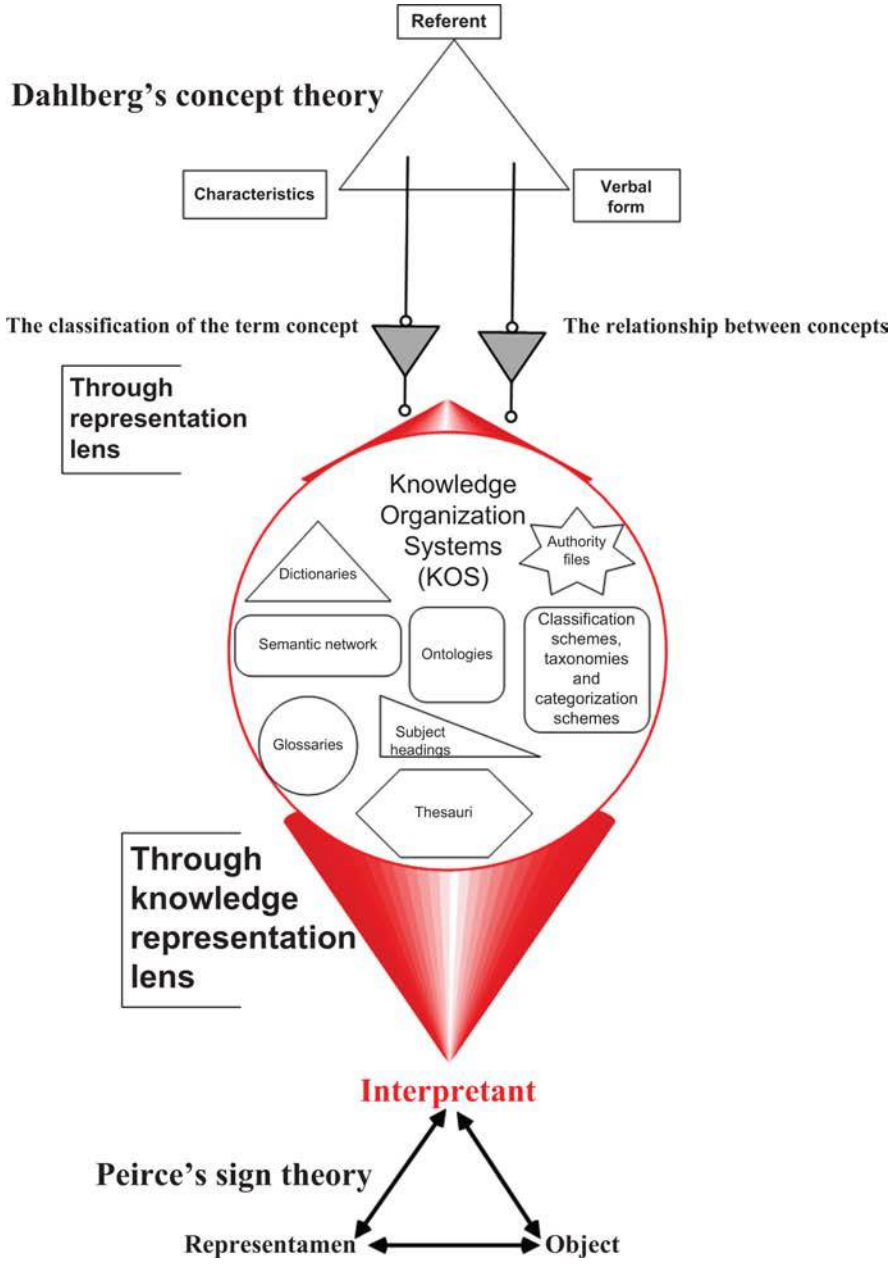

Figure 3.
Peirce and Dahlberg theories with regard to KOS

Dahlberg's theory does not directly discuss the representation of the meaning behind the term concept or Hodge's definition. Instead, she outlined an examination of the concept representation using two components: the relationship of the concept and the classification of the concept. A closer look at her concept triangulation that holds the terms "reference", "characteristics" and "verbal form", indicates that their relationships and classification required more in-depth discussion on the terms representation and knowledge presentation. Dahlberg did not incorporate Hodge's definition into her theory. In her discussion, she focused on only one type of system, mainly the concepts and their relationships. We recommend that future studies examine Dahlberg's theory with regard to Hodge's definition of KOS in order to address today's multiple layers of rich electronic documents.

To sum up, both theories hold different frameworks and applications in regard the structure and role of the terms "concept" and "sign". By comparing the two theories with regard to the term knowledge representation reveals that Peirce's theory provides us with a more detailed analysis of KOS structures and tools. In comparison, Dahlberg theory does not address the key terms of knowledge representation and KOS. Our analysis revealed that these terms can be disclosed based on Dahlberg's concept theory in order to discover new knowledge. However, future studies need to address the perspectives of sign/concept and knowledge representation in today's social media multi environments.

6. Conclusion

Both Peirce's semiotic theory and Dahlberg's concept theory are concerned with knowledge representation, but they differ on several points. First, the semiotic approach is developed from a philosophical and logical point of view and is concerned with how signs can evoke meaning in a perceiving mind. Peirce's semiotics is not concerned with particular kinds of knowledge representation systems, but semiotic theory gives us tools for addressing the process of interpretation. Semiotics provides an elaborate framework for defining the formal conditions for signs being signs, for signs being accurate representations, and for signs being communicative and related to enquiry. Dahlberg's theory does not address the term knowledge representation directly but recommends examining concepts and its representation by considering two components:

(1) the relationship of the concept; and

(2) classification of the concept.

Furthermore, the semiotic theory provides a clear understanding of the function of a representation of an object and the object in itself, by marking a clear difference between the immediate object and the dynamical object. Dahlberg's theory offers a closer look at an advanced classification structure and extends the search for representation of the term "concept" by providing us three different approaches. And finally Peirce's theory offers a comprehensive and elaborate investigation of the function of the interpretant in the sign process (see Table II), while more examination needs to address Dahlberg's theory.

Both theories include mental judgment, imply an interpretive activity, and may be rooted in logic; however, where Dahlberg's concept theory is developed from the perspective of KO, and thus is concerned with application, Peirce's semiotic is first and

foremost a theory of reasoning. The semiotic model is a general and unrestricted model of signs, and Dahlberg's concept model is evolved from the instrumental perspective of making better KOS. Consequently, Dahlberg provides a detailed method for analyzing representation and concepts within a KOS environment, whereas semiotics offers a detailed philosophical context for concept of representation.

Notes

1. The notation "CP" stands for "Collected Papers of C.S. Peirce", Peirce, C.S. (1958-1966), *Collected Papers*, Belknap Press of Harvard University Press, Cambridge, MA, followed by volume and paragraph.
2. The notation "EP" stands for "The Essential Peirce: Selected Philosophical Writings", Peirce, C.S. (1992), *The Essential Peirce: Selected Philosophical Writings*, Indiana University Press, Bloomington, followed by volume and page number.
3. Peirce's earliest attempt at defining a theory of semiotics is promoted in his 1867 paper "On a new list of categories" (CP 1.545-6).
4. Peirce's account of ten sign classes is extensively described in his 1903 syllabus (EP 2.289-99, CP 2.254-64). In Peirce's later account of semiotics, he proposed an account of 28 and 66 sign classes; however, they never received the same kind of treatment as the ten sign classes. The transition from the account of ten to 28 and 66 sign classes is suggested by Farias and Queiros (2003), "On diagrams for Peirce's 10, 28 and 66 classes of signs", *Semiotica*, Vol. 147, pp. 165-84. Farias, and Queiros (2006), "Images, diagrams, and metaphors: hypoicons in the context of Peirce's sixty-six-fold classification of signs", *Semiotica*, Vol. 162, pp. 287-307.
5. Within the Peirce community, the relation between the different interpretant trichotomies has been discussed. According to Fitzgerald (1966), *Peirce's Theory of Signs as Foundation for Pragmatism*, Mouton, The Hague, the emotional, the energetic and the logical interpretant, may be seen as a further specification of the dynamical interpretant, because they are actual effects on the interpreter. This view is supported by Short, (1981), "Peirce's concept of final causation", *Transactions of the Charles S. Peirce Society*, pp. 17-33, who argues that each immediate, dynamical, and final interpretant can be subdivided into emotional, energetic, and logical interpretants.

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