

Knowledge Map of Information Science

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This article is part of a group of four articles that resulted from a Critical Delphi study conducted in 2003–2005. The study, “Knowledge Map of Information Science,” was aimed at exploring the foundations of information science. The international panel was composed of 57 leading scholars from 16 countries who represent nearly all the major subfields and important aspects of the field. This article presents a systematic and comprehensive knowledge map of the field, and is grounded on the panel discussions. The map has 10 basic categories: (1) Foundations, (2) Resources, (3) Knowledge Workers, (4) Contents, (5) Applications, (6) Operations and Processes, (7) Technologies, (8) Environments, (9) Organizations, and (10) Users. The model establishes the groundwork for formulating theories of information science, as well as developing and evaluating information science academic programs and bibliographic resources.

Introduction

Context

The field of Information Science (IS) is constantly changing. Therefore, information scientists are required to regularly review, and if necessary, redefine its fundamental building blocks. This article is part of a group of four articles that resulted from a Critical Delphi study conducted in 2003–2005. The study explores the theoretical foundations of information science. It maps the conceptual approaches for defining *data*, *information*, and *knowledge* (Zins, 2007b); maps the major conceptions of information science (Zins, 2007a); portrays the profile of contemporary information science by documenting 28 classification schemes compiled by leading scholars during the study (Zins, in press); and culminates—in this article—in the development of a systematic and scientifically based knowledge map of the field, one grounded on a solid theoretical basis. This article presents a skeleton of a systematic and comprehensive knowledge map of the field. The map is grounded in the panel discussions.

Formulating a knowledge map means to establish the boundaries of the field and define its main parts.

Knowledge Mapping

Knowledge mapping plays an important role in the construction, learning, and dissemination of knowledge. In a previous study, Zins (2004) substantiated the importance of two preexperiential elements. These are the preexperiential constitutive concept and the preexperiential cognitive structure. Note that the term *preexperiential* stresses that these two intellectual elements do not depend on the present experience. The term *a priori*, usually refers to intellectual elements that are not dependent on any (previous) sensory experience, while the term *preexperiential* refers here to intellectual elements that are not based on the present experience, but are based on previous experiences.

The preexperiential constitutive concept sets the boundaries of the knowledge domain. In our case, the constitutive concept *information science* sets the content of the field. To be specific, *information science* implies six alternative contents pending on the implemented conception (see Zins, 2007a). These are the mediating aspects of D-I-K-M phenomena as they are implemented in the high-tech domain (i.e., the high-tech model) versus the mediating aspects of D-I-K-M phenomena as they are implemented in all types of technologies (i.e., the technology model) versus the mediating aspects of D-I-K-M phenomena as they are implemented in the social domain (i.e., the culture model) versus all the aspects of D-I-K-M phenomena as they are implemented in the human realm (i.e., the human world model) versus all the aspects of D-I-K-M phenomena as they are implemented in the living world, human and nonhuman (i.e., the living world model) versus all the aspects of D-I-K-M phenomena as they are implemented in all types of biological organisms, human and nonhuman, and all types of physical objects (i.e., the living and physical worlds model).

The *preexperiential structure* represents logical, linguistic, explanatory or probabilistic relationships among relevant related concepts and their subconcepts. To demonstrate the key role of preexperiential structures in facilitating knowledge construction, let us zoom in on the concept of *information science*. While reflecting on the concept, it becomes

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Human Knowledge			
Information Science		Epistemology	philosophy of science
Knowledge Organization	Information Retrieval		sociology of knowledge

FIG. 1. A map of concepts.

evident that it gains its meaning only by relating to other concepts, such as *information*, *data*, *documentation*, *library studies*, *archival studies*, *information systems*, and the like. Evidently, we need a preexperiential cognitive structure (or map) that represents the thematic relations among the various concepts in order to understand the meaning of the concept *information Science*.

Each word in our language is related to various other words. The cognitive map represents the thematic relations among the various words. This notion is not new. It was suggested by linguists and anthropologists (e.g., structuralists), and by philosophers (e.g., Wittgenstein, 1918/1994). The related concepts might belong to the same hierarchical order. For example, epistemology, philosophy of science, sociology of knowledge, and information science all explore the metaknowledge aspects of human knowledge. The concepts might belong to a higher order (i.e., broader terms), as in the case of human knowledge and information science, since information science is part of human knowledge. Concepts might also belong to a lower order (i.e., narrower terms), as in the case of information science, knowledge organization, and information retrieval. Knowledge organization and information retrieval are subclasses of information science. These relations are presented in Figure 1.

In most cases the preexperiential structure of related concepts might be partial, inconsistent, and biased. Nevertheless, it is necessary for perceiving the thematic context. Usually, the cognitive concept map is used intuitively. Occasionally it is the product of reflective thinking.¹ Each one of us has a cognitive map regarding the field of IS. I assume that you, the reader, also have a cognitive map of IS, although it might be incomplete or inconsistent, and you may not be aware of it at this moment. I invite you to join me to a four-step intellectual experiment.

- Step 1. Imagine that you were invited to introduce the field of information science. Please write down the main topics.
- Step 2. Review the list of topics. Is it exhaustive (i.e., does it include all the relevant main topics)? If not, please add the missing topics.
- Step 3. Recheck the list for duplications. If you find duplications, please erase them.
- Step 4. Finally, arrange the topics in a logical order.

If you performed the four steps as described above, you have just succeeded in formulating the skeleton of your cognitive map of IS, a skeleton that seems to you at this very

moment systematic and comprehensive. If, in the course of the experiment, you used a paper (or a computer) to write down the map, then you created an external map (i.e., a universal map) that documents your internal cognitive map.

A comprehensive and systematic cognitive concept map enables the individual to grasp the knowledge domain in its entirety, and gain insight into its logical structure and into the known and the hidden thematic relations among its various constituents. The importance of universal maps depends on the fact that they affect our cognitive maps and thus affect the way we understand the world and act in it.

Still, the structuring has to be systematic. Formulating a systematic knowledge map of the field should be based on a systematic conception of *information science*. This systematic conception of information science should be grounded on systematic conceptions of the constitutive concepts *data*, *information*, and *knowledge* (see Zins, 2007b). In this article I present a systematic map that is coherent with my previous conceptions of *data*, *information*, *knowledge*, and *information science*, and is grounded on the panel discussions.

Methodology

The scientific methodology was Critical Delphi. Critical Delphi is a qualitative research methodology aimed at facilitating critical and moderated discussions among experts (the panel). The international and intercultural panel was composed of 57 participants from 16 countries. It was unique and exceptional, comprising leading scholars who represent nearly all the major subfields and important aspects of information science (see Appendix A). The indirect discussions were anonymous and were conducted in three successive rounds of structured questionnaires. The first questionnaire contained 24 detailed and open-ended questions covering 16 pages. The second questionnaire contained 18 questions in 16 pages. The third questionnaire contained 13 questions in 28 pages (see relevant excerpts from the three questionnaires in Appendix B). The return rates were relatively high: 57 scholars (100%) returned the first round questionnaire, 39 (68.4%) returned the second round, and 39 (68.4%) returned the third round. Forty-three panelists (75.4%) participated in two rounds (i.e., R1 and (R2 or R3)), and 35 panelists (61.4%) participated in all three rounds. In addition, each participant received his/her responses that I initially intended to cite in future publications. The responses were sent to each panel member with relevant critical reflections. Forty-seven (82.4%) participants responded and approved their responses. Twenty-three of these, representing 48.9% of the 47 and 40.3% of the entire panel of 57, revised their original responses. Therefore, one can say that the critical process (the study) was actually composed of four rounds.

¹In recent volumes of *Knowledge Organization* there was an interesting debate between Beghtol (2003, 2004) and Hjörland and Nicolaisen (2004a, 2004b) on "naïve" classification vs. "professional" classifications.

Formulating the Knowledge Map

The process of formulating the knowledge map was exhaustive (see Appendix B). It consisted of three independent, though related, phases. First, I formulated systematic conceptions of *data*, *information*, *knowledge*, and *information science*. The map is grounded on, and consistent with, these conceptions. Second, the map is grounded on the panel's diverse reflections regarding the structure of the map and its rationale; after the map and its rationale were presented to the panel, the panel was asked to critically reflect on it (see Appendix B). Third, the map is grounded on the panel's responses throughout the study, especially the 28 classification schemes that were formulated by the panel members. The map can represent the various categories and subcategories that are included in at least 26 schemes; these schemes reflect the *culture model* (i.e., information science is the study of the mediating aspects of human knowledge in the social realm).

The Model

Overview

The three-phase research methodology produced a 10-facet hierarchical model. The 10 facets are (1) Foundations, (2) Resources, (3) Knowledge² Workers, (4) Contents, (5) Applications, (6) Operations and Processes, (7) Technologies, (8) Environments, (9) Organizations, and (10) Users (see Figure 2). Most facets are composed of a three-level hierarchical structure, as for example, Foundation (first level), Theory (second level), Conceptions (third level). In many cases the third level is not fully developed, and is left for further development in future studies by the IS academic and professional community; for example, Operations and Processes (first level), Types (second level), Production, Documentation, Representation, Dissemination, Storage, Retrieval, Use (third level). In some cases, the classification is refined by adding one or more levels of topical subdivision, as in the following case: Organizations (first level), Types (second level), Functional Type (third level), Memory Organizations (fourth level), and Libraries, Archives, Museums (fifth level).

The 10 main categories are divided into two groups. The first group, which has one category, Foundations, is composed of the metaknowledge of the field. The second group, which has nine categories (2 through 10) is composed of the essential body of knowledge on the explored phenomena, which are the mediating perspectives and conditions of human knowledge in the universal domain.

Metaknowledge

The Foundation section is unique. It includes the metaknowledge of the field of information science. Its rationale

²I use the term *knowledge* rather than *information* since I define *information* as empirical knowledge (see Zins, 2007b).

rests on philosophical grounds rather than on the phenomenological analysis of information science, as is the case with sections 2 through 10. The necessity of a specific metaknowledge section is derived, as a philosophical implication, from Kurt Gödel's Incompleteness Theorem (Gödel, 1931/1986). From Gödel's theorem one can conclude that it is logically impossible to form an axiomatic system without assuming additional postulates. By accepting this implication, we realize that it is theoretically impossible to formulate a self-sufficient explanation based exclusively on the phenomenological analysis of information science. Consequently, an additional metaknowledge section, which in the model is called Foundation, is a necessary basis in the knowledge construction of the field. Metaknowledge is knowledge of knowledge. It includes epistemological, methodological, conceptual, theoretical, historical, and practical postulates, principles, and guidelines regarding the relevant body of knowledge (Zins & Guttman, 2003).

Nine Basics of Information Science

As noted, sections 2 through 10 are based on the phenomenological analysis of information science. Information science in its essence may be viewed as a social science. It is the study of the mediating conditions and perspectives of human knowledge in the universal domain (i.e., as it is embodied in physical objects). Based on a phenomenological analysis of the phenomena of mediating universal knowledge one can identify nine basics of information science. These are Resources, Knowledge Workers, Contents, Applications, Operations and Processes, Technologies Environments, Organizations, and Users. The nine elements are based on the following rationale. Information science explores the various conditions relevant for connecting resources (section 2) with users (section 10). This involves seven constituents (sections 3 through 9): the knowledge worker (e.g., information professionals, librarians, archivists; section 3), the content (e.g., biomedical informatics, educational information, etc.; section 4), the application (e.g., searching, shopping, socializing; section 5), the operation and process (e.g., documentation, representation, organization, processing, manipulation, storing, dissemination, and retrieval of knowledge; section 6), the technology/medium (e.g., paper, HTML, XML, etc.; section 7), the environment (e.g., American, European, Internet, etc.; section 8), and the organization (e.g., libraries, archives, information services, etc.; section 9).

Sections 3 through 9 represent seven building blocks of the mediating process. To simplify the explanation of their order let us group them into two parallel sets of characteristics. The first set follows the "who, what, why, how, where, and when" order. The second set follows the equivalent "6 Ms" order, which is "mediator, matter, motive, method, means, and milieu." The mediating process is characterized by answering the following questions: *Who* mediates? (the *mediator*: the knowledge workers; section 3); *What* is

Domain	Foci	Main Categories (1 st division)	Sub-Categories (2 nd division)	Sub-Categories*/Examples & Explanations** (3 rd division)	Exemplary Fields
Meta-Knowledge	Knowledge on the field of IS itself	1. Foundations	Theory	A. Conceptions B. Disciplines (e.g., <u>Anthropology</u> (e.g., "culture"), <u>Arts</u> (e.g., "design"), <u>Communication</u> (e.g., "communication", "media", "message"), <u>Computer science</u> (e.g., "computer language"), <u>Economics</u> (e.g., "information economics"), <u>Education</u> (e.g., "learning"), <u>Engineering</u> (e.g., "information technology"), <u>History</u> (e.g., "primary source", "secondary sources", "tertiary source"), <u>Law</u> (e.g., "intellectual property", "copyright"), <u>Linguistics</u> (e.g., "language"), <u>Philosophy</u> (<u>Epistemology</u> (e.g., "knowledge"), <u>Ethics</u> (e.g., "information ethics", "professional ethics"), <u>Political Science</u> (e.g., "democracy"), <u>Psychology</u> (e.g., "cognition"), <u>Research Methodology</u> (e.g., "evaluation", "research", "research methodology"), <u>Semiotics</u> (e.g., "sign"), <u>Sociology</u> ("e.g., "society") C. Theories	Theory of IS
			Research	A. Theoretical B. Empirical 1. Quantitative 2. Qualitative	Research Methodology
			Education	academic education and to professional training: theoretical knowledge and practical knowledge.	LIS Education
			History	Historical accounts of the field.	History of IS
			Issues	quality information (resources), information (resources) quality	Information Quality
Subject-based knowledge	Knowledge on the explored phenomena (i.e., the mediating aspects & conditions of human knowledge)	2. Resources	Types	Primary resources (i.e., the human originators), secondary resources, tertiary resources	Information Systems
			Issues	A. Personality traits B. Theoretical knowledge C. Applied knowledge and practice	Information Ethics LIS Education
		Who? mediators	3. Knowledge Workers	Types	Taxonomies of professional workers by fields of expertise (e.g., medical informatics), and organizational sector (e.g., librarians, archivists)
				Issues	Content related issues (e.g., What is a subject?)
		What? milieus	4. Contents	Types	Taxonomies of structures (e.g., knowledge maps, subject classifications schemes, thesauri), classification systems (e.g., LCC, DDC, UDC, CC, BC), subjects (i.e., Archeology, biology, Computer Science) and the like.
				Issues	Issues related to the development of application oriented systems.
		Why? Motives	5. Applications	Types	Taxonomy of applications (e.g., (information) searching, shopping, socialization and socializing).
				Issues	Issues related to the various operations and processes involved in mediating human knowledge.
		How? methods	6. Operations & Processes	Types	Taxonomy of operations and processes: documentation, representation, organization, processing, dissemination, publication, storage, manipulation, evaluation, measurement, searching, and retrieving knowledge.
				Issues	Technological related issues (e.g., user-interface design).
		means (media)	7. Technologies	Types	Taxonomy of knowledge technologies and media: electronic-based technologies (e.g., computer-based information systems, Internet), paper-based and printing-based technologies (e.g., books), communication-based technologies and media (e.g., cellular phones, MP3).
				Issues	Social issues (e.g., Information policy, information accessibility), including ethnic and cultural issues, professional issues related to the settings, as well as legal issues (e.g., Intellectual property, privacy), and ethical issues (e.g., privacy vs. public interests).
		Where and when?	8. Environments	Types	A. Ethnic & Cultural environments B. Settings (e.g., Education, Health)
				Issues	Issues related to the organizational settings (e.g., managing knowledge in business organizations)
		milieus	9. Organizations	Types	A. Organizational Type: 1. Governmental Sector 2. Public sector 3. Private sector B. Functional type 1. Memory organizations 2. Information services
				Issues	User related issues (e.g., user information needs, user behavior, user search strategies)
		10. Users		Types	A. Individuals B. Groups and Communities 1. Gender-based 2. Age-based 3. Culture & ethnicity-based 4. Need & interest based (e.g., division by profession)

* The words in **bold** are categories. ** The other terms are exemplary terms (entries).

FIG. 2. Knowledge map of information science.

being mediated? (the *matter*: the contents; section 4); *Why* it is mediated? (because of the *motive*: the application; section 5); *How* it is mediated? (by the *method*, and the *means*: The *method* is the relevant operation or process;

section 6; and the *means* is the relevant technology; section 7). *Where* and *when* does the mediating process happen? (the *milieu*: the environment; section 8; and the organization; section 9).

Theory and Embodiment

The 10-facet map has a dual pattern of a theory–praxis structure, or rather a theory–embodiment structure. The theory–embodiment structure is implemented in the 10-facet map, as a whole, as well as in each of its ten sections. In the 10-facet map the *theory* constituent is implemented in the Foundation section, while the *embodiment* constituent is implemented in sections 2 through 10. Now let us zoom in on the 10 sections. The Foundation section, which is the theory constituent of the map, is itself divided into a theory constituent (i.e., the theory category) and an embodiment constituent (i.e., the research, education, and history categories). Each one of the nine sections (2 through 10), which are the embodiment constituents of the map, is too divided into a theory constituent (i.e., the issues category) and an embodiment constituent (i.e., the *types* category).

Foundation

The *foundation* section is composed of theory, research, education, and history of information science. The theory subsection is divided into three categories: conceptions, disciplines, and theories. *Conceptions* includes the conceptions of information science. *Disciplines* is composed of (at least) sixteen bodies of knowledge that establish the theoretical basis of information science; these are anthropology (e.g., culture), arts (e.g., design), communication (e.g., communication, media, message), computer science (e.g., computer language), economics (e.g., information economics), education (e.g., learning), engineering (e.g., information technology), history (e.g., primary source, secondary source, tertiary source), law (e.g., intellectual property, copyright), linguistics (e.g., language), philosophy (epistemology (e.g. knowledge), ethics (e.g., information ethics, professional ethics), political science (e.g., democracy), psychology (e.g., cognition), research methodology (e.g., evaluation, research, research methodology), semiotics (e.g., sign), sociology (e.g., society). *Theories* consists of the theories that are unique to information science per se. These are theories that provide the theoretical explanation of the process of mediating knowledge.

The *research* category includes concepts and resources relate to information science research and to evaluation and assessment of policies, techniques, and systems. Research on information science theory and practice is composed of two types, theoretical and empirical. Empirical research is divided into quantitative and qualitative. Note that scientific research and program evaluation are two different activities. Nevertheless, they are interrelated and utilize similar methodologies. Furthermore, the category includes various types of research activities (e.g., information measurement, system evaluation) that are not part of the mediating process, while research activities that are part of the mediating process are included in sections 2 through 10.

The *education* category refers to academic education in information science and to professional training of information/knowledge workers. Information science education embodies

theoretical knowledge and practical knowledge. The *history* category includes historical accounts of the field.

Knowledge Worker

The *knowledge worker* section addresses three aspects related to the knowledge worker, namely the knowledge worker's personality traits and value orientation, his or her theoretical knowledge, and his or her applied knowledge and work experience. Generally, it is expected that the knowledge worker be open-minded and sensitive to ethical issues (e.g., privacy issues). Note that this section relates to the personal worker. It differs from the foundation–education section, which refers to (L)IS education, namely academic and professional programs.

Theoretical knowledge should consist of general humanist knowledge, general information science knowledge, and professional knowledge in the field of expertise (e.g., educational informatics, medical informatics). In addition, the knowledge worker is expected to have relevant applied knowledge and work experience.

Resources

The *resources* section addresses various issues and types related to knowledge resources. Resource-related issues are mainly focused on quality issues. Knowledge resources are divided into primary, secondary, and tertiary resources. Primary resources of universal knowledge are the human originators of the knowledge. In other words, a primary resource is the individual knower whose (subjective) knowledge is being mediated through the mediating process (for more on the interrelations between subjective knowledge and universal knowledge see Zins, 2006, 2007b). Secondary and tertiary resources are either humans (e.g., teachers) who report on what they know from primary resources, or information systems and resources that present or include (i.e., store) documented (i.e., universal) knowledge.

Contents

The *contents* section addresses issues and types related to the content of the mediated knowledge. These are issues related to various types of structures (e.g., knowledge maps, subject classifications schemes, thesauri), classification systems (e.g., LCC, DDC, UDC, CC, BC), and subjects (i.e., archeology, biology, computer science).

Applications

The *applications* section addresses issues and types related to the development of resources designed for meeting human needs and interests that can be promoted by acquiring knowledge; among them is social well-being (i.e., health, happiness, prosperity, meaningful life). The *types* subcategory includes taxonomies of applications (e.g., information searching, shopping, socialization and socializing).

Operations and Processes

The *operations and processes* section includes issues related to the various operations and processes involved in mediating human knowledge, among them documentation, representation, organization, processing, dissemination, publication, storage, manipulation, evaluation, measurement, searching, and retrieving knowledge.

Technologies

The *technologies* section comprises issues and types related to information and knowledge technologies. These are technologies that are aimed at facilitating the mediating of knowledge, through documentation, representation, organization, processing, dissemination, publication, storage, manipulation, evaluation, measurement, searching, and retrieving knowledge, among them electronic-based technologies (e.g., computer-based information systems, Internet), paper-based and printing-based technologies (e.g., books), as well as communication-based technologies and media (e.g., cellular phones, MP3). Information science differs from technological-based fields, such as computer science, by focusing on the contribution of these technologies to a better dissemination of knowledge. This includes issues related to human interface design.

Environments

The *environment* section refers to social issues (e.g., information policy, information accessibility), including ethnic and cultural issues, professional issues related to the settings, as well as legal issues (e.g., intellectual property, privacy), and ethical issues (e.g., privacy vs. public interests). The *types* category includes two subcategories: (1) ethnic and cultural environments, which is composed of taxonomies of environments (e.g., American, European, Internet, etc.), and (2) settings, which is composed of a taxonomy of settings (e.g., education, health).

Organizations

The *organization* section relates to the organizational aspects of the information provision. The organizational perspectives are divided into two subcategories: organizational type and functional type. The organizational type classification is divided into three subcategories: governmental sector, public sector, and private sector, namely, organizations that mediate knowledge can be affiliated with governmental, public and private sectors. The functional type classification is divided into two subcategories: memory organizations, which includes libraries, archives, museums, and the like, and information services.

Users

The *user* section refers to the prospective end users of the linked resources. Different criteria serve to classify the users. A quantitative criterion may classify users into three

major categories: individuals, groups, and communities, each of which entails different foci. A descriptive criterion may characterize the nature of the users. Users can be characterized by their need and interest, gender, age, and cultural and ethnical identity. As one can see, there are different ways to map the user section. This section is divided here into two major categories: (1) individuals and (2) groups and communities. The groups and communities category is divided into four subcategories; two are biological-based, namely, gender-based and age-based groups and communities, and two are social-based, namely, culture and ethnicity-based and need- and interest-based groups and communities (e.g., division by profession).

Discussion and Conclusion

A Systematic, Comprehensive, and Scientifically Based Map

The knowledge map presented here enables us to understand the structure of the information science knowledge domain and the conceptual relations among its major parts. This is because the structuring was essentially grounded on a phenomenological analysis of the diverse characteristics of information science's manifold phenomena, as well as on the empirical data that were gathered throughout the panel discussions. The phenomenological analysis provided the theoretical basis of the model. The scientific Critical Delphi structuring methodology grounded the model on empirical data, and established its scientific basis. Evidently, the combination of rationalistic and empirical research approaches emerges as a powerful tool for developing a systematic, comprehensive, and scientifically based knowledge map. The model that has been developed in this study should be relatively systematic, comprehensive, and scientifically based.

Facet Classification

The 10-facet knowledge map is a facet classification. The term *facet classification* refers here to any classification whose structure is composed of categories that represent distinctive aspects of the subject. Usually, these categories are jointly exhaustive and mutually exclusive. The reader should not confuse it with the notion of facet classification that is connected with the facet-analytic approach (e.g. Mills, 1957; Mills & Broughton, 1977; Vickery, 1960), and is implemented in Ranganathan's Colon Classification (CC) and Bliss' Bibliographic Classification (BC). The model is also an analytico-synthetic classification. The term *analytico-synthetic classification*, which is closely related to CC and BC, is implemented here differently. Generally, a systematic classification construction is an analytico-synthetic process. The analysis is a means to the synthesis, which culminates in the structured scheme. The domain analysis of a subject—in our case, information science—enables us to define the key elements of the subject, but we still need the synthesis in order to capture logical and thematic relations among them, as well as the boundaries of the subject domain.

Structuring IS Subfields

The ten basics of information science can be utilized for structuring IS various subfields, *mutatis mutandis*. Accordingly, for example, the knowledge map of medical informatics includes ten basics. These are (1) Foundations of medical informatics (e.g., disciplines: information science, medical sciences, sociology), (2) Resources of medical informatics (e.g., Medline), (3) Knowledge Workers (i.e., professionals specializing in medical informatics), (4) Contents (i.e., biomedical information), (5) Applications (e.g., forums for patients' support groups), (6) Operations and Processes (e.g., searching medical information), (7) Technologies (e.g., databases), (8) Environments (e.g., American milieu), (9) Organizations (e.g., Good Samaritan Hospital), and (10) Users (e.g., physicians, patients).

Academic Integrity

The model used here is not the one, ultimate model. In the IS literature one can find various models, which are based on different methodological approaches; for example, citation mapping (e.g., Ellis, Allen, & Wilson, 1999; Small, 1999, 2003). It is clear that the model reflects personal interpretations of the concept of information science and its related concepts. The phenomenological analysis is based by its very nature on my philosophical, professional, and ideological tenets. The subjective interpretations inherent in the phenomenological analysis, as well as in the grounded-theory qualitative research methodology, do not mean that the model is arbitrary and irrational. Yet the real question is what constitutes the logical consistency and the scientific validity of the model. Obviously, logical consistency and scientific validity are based on established criteria that were followed during the study. However, one cannot avoid the fact that, at the end of the day, the ultimate criterion is the researcher's—i.e., mine, in this case—impartial academic integrity.

Categories Versus Concepts

It is essential to differentiate between the various categories that form the hierarchical structure and the various concepts that are represented by (or classified into) these categories. The difference between the map's categories and the related concepts is similar to the difference between bookshelves in a bookcase and the books that are placed on it. The map's categories are like bookshelves. They can carry different books (e.g., concepts, titles of bibliographic resources, titles of academic courses, etc). Categories of systematic maps are mutually exclusive (i.e., do not overlap) and jointly exhaustive (i.e., adequately cover the subject matter). This is the case with the map presented here.

Overlaps

One might, however, find overlapping among some of the categories. The overlaps arise from different interpretations

and emphases. The nuances are unavoidable, especially in light of the various approaches for defining key concepts of the field (see Zins, 2006, 2007b). Nevertheless, they do not negate the validity of the model, but rather exemplify the diverse perspectives of the information science phenomena and its diverse foci.

Representing Knowledge

The concepts, on the other hand, can be placed on several categories of the map. The adequacy of the map is being tested by its ability to represent any relevant concept by at least one category. The map was tested by its ability to represent the various categories that appear in the 28 schemes that were formulated by the panel in the course of the study (see Zins, *in press*). The map can represent the categories that are included in all 26 schemes, which reflect the culture model, though some adjustments are needed. Note, however, that some of these categories can be placed in several sections of the map. Similarly, the exemplary IS fields (see Zins, *in press*, Table 2 [Shifra Baruchson-Arbib]) can be placed in more than one category. Furthermore, the reader might disagree on the place where a specific field is assigned. This does not refute the validity of the model, but only reflects disagreement on the proper place of the specific field. However, if the reader cannot place one of the fields in any of the given categories, the inference is crucial: it means that the model has to be revised. Since information science is constantly changing, I expect this development to be inevitable.

Academic and Professional Education

Knowledge maps and subject classifications are powerful tools for professional education. Subject classification is aimed at assisting the reader to follow the thematic links among the various concepts that are included in the knowledge domain. Since this specific knowledge map is based on a phenomenological analysis of complex information science phenomena, it is assumed that it reflects fundamental conceptual relations among its various components. As Hjörland (1998, 2000, 2002) puts it, classifications always reflect (consciously or unconsciously) the theoretical and philosophical approach of the field being classified. In our case, we launched the structuring of the map with the conception that information science explores the mediating aspects of universal human knowledge. This can help information scientists to acquire a clearer conception of the information science profession, and as Bowker and Star (1999) made clear, "classifications are a key part of standardization processes that are themselves the cornerstones of working infrastructures." Furthermore, information science educators can utilize the knowledge map for developing introductory courses and compiling reading lists and bibliographic collections based on the conception of the field (see Haythornthwaite, Bowker, Jenkins, & Rayward, 1999 as an example of implementing knowledge mapping in LIS education).

Bibliographic Resources

The knowledge map can also be an efficient tool for organizing bibliographic resources and facilitating intelligible representation of accumulated knowledge in information science based on thematic relations. Obviously, the model can be a powerful tool for evaluating the knowledge coverage of academic and professional journals of information science, as well as an efficient tool for developing structured thesauri.

A Concluding Remark

This study maps the field of information science. This might help the reader to a better understanding of the issues and the considerations involved in establishing a solid, systematic and comprehensive conception and knowledge map of the field; but by no means does it replace the personal quest to ground one's positions on solid theoretical foundations.

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Appendix A

The Panel

Dr. Hanne Albrechtsen, Institute of Knowledge Sharing, Denmark; **Prof. Elsa Barber**, University of Buenos Aires, Argentina; **Prof. Aldo de Albuquerque Barreto**, Brazilian Institute for Information in Science and Technology, Brazil; **Prof. Shifra Baruchson-Arbib**, Bar-Ilan University, Israel; **Prof. Clare Beghtol**, University of Toronto, Canada; **Prof. Maria Teresa Biagetti**, University of Rome 1, Italy; **Prof. Michael Buckland**, University of California, Berkeley; **Mr. Manfred Bundschuh**, University of Applied Sciences, Cologne, Germany; **Dr. Quentin L. Burrell**, Isle of Man International Business School, Isle of Man; **Dr. Paola Capitani**, Working Group Semantic Web, Italy; **Prof. Rafael Capurro**, University of Applied Sciences, Stuttgart, Germany; **Prof. Thomas A. Childers**, Drexel University, Philadelphia; **Prof. Charles H. Davis**, Indiana University; **Prof. Anthony Debons**, University of Pittsburgh; **Prof. Gordana Dodig-Crnkovic**, Mälardalen University, Sweden; **Prof. Henri Dou**, University of Aix-Marseille III, France; **Prof. Nicolae Dragulanescu**, Polytechnics University of Bucharest, Romania; **Prof. Carl Drott**, Drexel University, Philadelphia; **Prof. Luciana Duranti**, University of British Columbia, Canada; **Prof. Hamid Ekbia**, University of Redlands, CA; **Prof. Charles Ess**, Drury University,

Springfield, MO; **Prof. Raya Fidel**, University of Washington, Seattle; **Prof. Thomas J. Froehlich**, Kent State University; **Mr. Alan Gilchrist**, Cura Consortium and TFPL, UK; **Dr. H.M. Gladney**, HMG Consulting, USA; **Prof. Glynn Harmon**, University of Texas at Austin; **Dr. Donald Hawkins**, Information Today; **Prof. Caroline Haythornthwaite**, University of Illinois at Urbana Champaign; **Mr. Ken Herold**, Hamilton College, Clinton, NY; **Prof. William Hersh**, Oregon Health & Science University, Portland, OR; **Prof. Birger Hjørland**, Royal School of Library and Information Science, Denmark; **Ms. Sarah Holmes***, the Publishing Project, USA. **Prof. Ian Johnson***, the Robert Gordon University, UK; **Prof. Wallace Koehler**, Valdosta State University, GA; **Prof. Donald Kraft**, Louisiana State University; **Prof. Yves François Le Coadic**, National Technical University, France; **Dr. Jo Link-Pezet**, Urfist and University of Social Sciences, France; **Mr. Michal Lorenz**, Masaryk University in Brno, Czech Republic; **Prof. Ia McIlwaine**, University College London, UK; **Prof. Michel J. Menou**, Knowledge and ICT management consultant, France; **Prof. Haidar Moukdad**, Dalhousie University, Canada; **Mr. Dennis Nicholson**, Strathclyde University, UK; **Prof. Charles Oppenheim**, Loughborough University, UK; **Prof. Lena Vania Pinheiro**, Brazilian Institute for Information in Science and Technology, Brazil; **Prof. Maria Pinto**, University of Granada, Spain; **Prof. Roberto Poli**, University of Trento, Italy; **Prof. Ronald Rousseau**, KHBO and University of Antwerp, Belgium; **Dr. Silvia Schenkolewski-Kroll**, Bar-Ilan University, Israel; **Mr. Scott Seaman***, University of Colorado, Boulder; **Prof. Richard Smiraglia**, Long Island University, NY; **Prof. Paul Sturges**, Loughborough University, UK; **Prof. Carol Tenopir**, University of Tennessee; **Dr. Joanne Twining**, Intertwining.org, a virtual information consultancy; **Prof. Anna da Soledade Vieira**, Federal University of Minas Gerais, Brazil; **Dr. Julian Warner**, Queen's University of Belfast, UK; **Prof. Irene Wormell**, Swedish School of Library and Information Science in Borås, Sweden; **Prof. Yishan Wu**, Institute of Scientific and Technical Information of China (ISTIC), China.

*An observer (i.e., those panel members who did not strictly meet the criteria for the panel selection and terms of participation).

Appendix B: Excerpts From the Questionnaires on the Knowledge Map

Knowledge Map of Information Science: Issues, Principles, Implications (First Round) December 15, 2003

Major categories. This section is focused on the foundations of information science.

Overview. Generally, the map has eight basic categories: (1) Foundations, (2) Resources, (3) Environments/Cultures, (4) Organizations, (5) Contents, (6) Technologies, (7) Operations and Processes, and (8) Users. The eight categories are formed into two groups. The first group

TABLE B1. Knowledge map of information science.

Domain	Focus	1st level category
Metaknowledge	Knowledge of the field of information science	Foundations
Fundamental knowledge	Knowledge of the explored phenomena (i.e., the mediating and technological aspects of human knowledge).	Resources Environments/ Cultures Organizations Contents Technologies Operations & Processes Users

is composed of the metaknowledge of the field of information science. This is knowledge on the knowledge domain. It includes one category, Foundations. The second group is composed of the fundamental body of knowledge on the phenomena explored by IS, namely the mediating and technological aspects of human knowledge. It consists of seven categories, (2) through (8), based on phenomenological analysis of the various phenomena of objective knowledge. See Table B1.

The Foundation category is composed of four subcategories: Theory, Research and Evaluation, Education, and History. Theory is composed of Definition and Disciplines; these are the disciplines that establish the theoretical foundations of IS (e.g., anthropology, communication, computer science, economics, linguistics, mathematics, philosophy (i.e., epistemology, ethics, logic, and philosophy of science), psychology, and sociology). Research and Evaluation deals with research and evaluation topics, including research methodologies. Education deals with IS education. History deals with the history of the field. See Table B2.

Categories (2) through (8) are deduced from the conception of information science as the study of the mediating and the technological aspects of human knowledge (in the objective domain). Based on a phenomenological analysis of the phenomena of objective knowledge one can identify at least seven basics. Resources includes human and nonhuman (e.g., artificial intelligence, robotics) resources. Environments/Cultures

TABLE B2. Metaknowledge of information science.

Category	Subcategories
<i>Theory</i>	Definition Disciplines (e.g., anthropology, communication, computer science, economics, linguistics, mathematics, philosophy (i.e., epistemology, ethics, logic, and philosophy of science), psychology, and sociology)
1. Foundations	<i>Research &</i> <i>Evaluation</i> <i>Education</i> <i>History</i>

TABLE B3. Knowledge map of information science.

Major categories	Sub-categories/Examples	Panel's comments ^a
1. Foundations	<i>Theory</i> <i>Research & Evaluation</i> <i>Education</i> <i>History</i>	
2. Resources	Human and nonhuman (e.g., artificial intelligence, robotics)	
3. Environments/ Cultures	Societal, cultural, legal, and ethical issues	
4. Organizations	(e.g., libraries, archives, information services)	
5. Contents	(e.g., classification schemes)	
6. Technologies		
7. Operations & Processes	(e.g., documentation, representation, organization, processing, manipulation, storing, dissemination, and retrieval of knowledge)	
8. Users		

^aIf you have any comment regarding a specific category, please write it in the right column.

deals with environmental and societal issues (e.g., ethics, policies). Organizations deals with the various organizations involved in dissemination of knowledge (e.g., libraries, archives, information services, etc.). Contents relates to the various issues, Technologies, Operations and Processes (e.g., documentation, representation, organization, processing, manipulation, storing, dissemination, and retrieval of knowledge), and Users. See Table B3.

Question 5.1

If you have comments, observations, or critical reflections regarding the rationale, the number, title, and order of the eight major categories, please share them with the panel. Thanks.

Question 5.2

If you have an alternative map please explain its theoretical rationale, construct its structure, and the panel will discuss it in the second round.

Information science: Subcategories

Subcategories. The field of information science has diversified subfields (or subcategories). Furthermore, many subfields have more than one title, and many titles stand for more than one subfield. The time has come to use the same language.

Question 6.1

Arrange all the subcategories (or subfields) of information science in systematic order. You can use the 8-category map presented in section 5, the map you developed in question 5.2 (above), or any other order. Thanks.

TABLE B4. Knowledge map of information science (second round).

Major categories	Subcategories	Panel's comments and IS relevant subfields ^a
	<i>Theory</i> <i>Conceptions</i> <i>Disciplines</i>	
1. Foundations	<i>Research & Evaluation</i> <i>Education</i> <i>History</i>	
2. Resources		
3. Environments/ Cultures		
4. Organizations		
5. Contents		
6. Technologies		
7. Operations & Processes		
8. Users		

^aPlease fill in the right-hand column (see question 5.1).

Answer 6.1

(A systematic list of information science subcategories)

Knowledge Map of Information Science: Issues, Principles, Implications (Second Round) April 15, 2004

Knowledge map of information science

Generic knowledge map. In the first round, I presented a knowledge map of Information Science. I believe that this eight-category map (or model) is a generic map. It can adequately map any one of the systematic conceptions of information science, with necessary adaptations, and it can adequately map the “mainstream” of the field. See Table B4.

Question 6.1

Please (1) explain why the map above can or cannot adequately represent your revised conception of IS, and (2) fill in the right-hand column. (Note, that you can use your answers in round 1, if they are relevant to your revised conception.) Thanks.

Question 6.2

*If you have an alternative generic map that can adequately map all the revised conceptions of IS, with necessary adaptations, please present it here. Thanks.

*Or if you have an alternative map that can adequately map only your revised conception of IS, please present it here. Thanks.

Knowledge Map of Information Science: Issues, Principles, Implications (Third Round) October 8, 2004

Knowledge map of information science

Question 6.1

If you have additional reflections on the map, please let me know. Thanks.