[Preprint] Chapter 8

Organization of medical knowledge: documentation techniques applied to a macro-domain underpinned by socio-political issues

8.1. Introduction

The objective of this contribution is to evaluate the dynamics and systems of medical knowledge organization developed by information and documentation specialists and to explain the specific trends and developments in this field since the 1960s. Knowledge organization is a field of research that brings together researchers from disciplines such as information and documentation science, linguistics, philosophy, and computer science [GNO 20, ZAC 10]. After clarifying the key concepts and the methodology of the study, we will proceed with a literature review, combined with the analysis of a corpus of knowledge organization systems in medicine. An assessment, highlighting the current directions and explaining the positioning of the discipline, will conclude the reflection.

8.2. Documentation and Library and Information Sciences and the organization of knowledge

Documentation and Library and Information Sciences form an interdisciplinary field of research bringing together librarianship and information science, which lies between the humanities and social sciences (HSS) and computer science [HJØ 18]. Furthermore, the current trend is to use the terms Library and Information Science

1. Chapter written by Marcin TRZMIELEWSKI and Claudio GNOLI (P. 167-206).

and Information Science as synonyms [HJØ 18]. The reflections on the theoretical and practical notions developed by specialists in this field, i.e. teachers-researchers and professionals of information-documentation (librarians, documentalists, cataloguers, taxonomists, etc.) are concentrated around "access to knowledge and culture" and "recorded knowledge" [MET 06, p. 43]. One of the fundamental concepts and one of the principal missions of the sciences of information and documentation is to study and envisage *documentary mediation*. As Gérard Régimbeau points out, "documentary mediation is a mediation of knowledge" [RÉG 11, p. 108]. It manifests itself in the interactions between the information professional and the user of an information system and "requires the implementation of a communication system adapted to the user" [*Ibid*., p. 108-109]. The challenge of this process is to "allow the user to find the information he needs" so that he "builds his own knowledge in order to constitute himself a knowledge-base" [*Ibid*., p. 106-109]. The interactions between the producer of the information, the mediator and the user are implemented within the *documentary devices*, which are "instrumental components" within the information systems [MET 06, p. 54], responsible for the diffusion of the knowledge between these actors, with the aim of the appropriation of the information by the user as content allowing to act [COU 11]. The devices have three dimensions: technical, socio-organizational and socio-economic, which are inseparable and interdependent [MET 06]. To enable access, consultation and management of information in information systems, and to implement mediation within documentary devices, professionals, users and computer programs resort to *knowledge organization* [COU 11, GNO 20, HJØ 16, RÉG 11]. The two main aspects of this activity are: knowledge organization processes (cataloging, indexing, social tagging, shelf arrangement, ...) and knowledge organization systems (bibliographic description rules and formats, taxonomies, folksonomies, classifications, thesauri, semantic networks, ontologies, ...) [HJØ 16, MAZ 18]. Knowledge organization systems (KOS) are schemas that organize concepts (represented by terms that come from common word usage) and the relationships between these concepts to reflect all human knowledge or knowledge related to a knowledge domain [GNO 16, p. 403]. By *knowledge domain* we mean "a group with an ontological base that reveals an underlying teleology, a set of common hypotheses, epistemological consensus on methodological approaches, and social semantics" [SMI 12, p. 114]. Medical specialties, such as allergology or pediatrics, can be considered as such domains. The International Classification of Diseases (ICD) and the Medical Subject Headings (MeSH) are examples of medical knowledge organization systems (MKOS), which list and organize concepts within medical domains.

8.3. Methodology

The research for original, peer-reviewed articles and conference proceedings was conducted on March 25, 2020 and constitutes our corpus. We first manually searched the archive of the journal *Knowledge Organization* (1974-2019) and the conference proceedings *Advances in Knowledge Organization* (1990-2018), published by the International Society for Knowledge Organization (ISKO). Due to a modest number of relevant articles found in the archive (34 selected works), we extended the search by consulting the *Knowledge organization literature database*. The search engine in the database is available on the official ISKO website[2]. The database contains a bibliography related to knowledge organization from journals on information science, linguistics and computer science. To query the database, we used the terms "health" and "medicine". The queries provided 135 results. After removing duplicates and results not relevant to our approach, we retained 25 works. To complete and vary our sample, we went to LISTA (Library, Information Science & Technology Abstracts), a database of abstracts of publications in information science and technology, edited by EBSCO. The query terms used in the "title" field were composed of the adjectives "health" and "medical", combined with the names of different types of KOS [MAZ 18]: "(TI health OR TI medical) AND (TI vocabulary* OR TI gazetter+ OR TI dictionnar* OR TI glossar* OR TI terminolog* OR TI nomenclature* OR TI taxonom* OR TI classification+ OR TI subject headings OR TI thesaur* OR TI folksonom* OR TI conceptual scheme+ OR TI ontolog* OR TI semantic network+ OR TI knowledge graph+ OR TI knowledge organization)". We filtered the results by peer-reviewed scientific journal articles and we obtained 122 publications. After selecting the relevant works and eliminating the duplicates, we retained 10 articles. To complete our sample, we also integrated 2 articles obtained during our literature search in a generalist search engine. The final corpus amounts to 71 publications (see Appendix).

We analyzed, evaluated and synthesized the content of the documents in the corpus, using two reading grids, established as a result of the first exploratory readings: the first one is dedicated to theoretical approaches and evaluations, and the second one focuses on the design work of MKOSs. The progressive reading of the corpus according to a hermeneutic approach allowed us to organize the data, information and knowledge into categories and to connect them to each other in order to discover facts, regularities, relationships and phenomena. We identified the MKOSs discussed in the literature and collected information about them. The analysis of the MKOSs, with the help of the second grid, made it possible to

2. ISKO, "KO literature," available at: https://www.isko.org/lit.html, June 26, 2020.

illustrate certain statements with concrete examples. Consultation of some additional resources completed the report.

8.4. Presentation of the corpus of publications between 1960 and 2019

Among the 71 articles published in information and documentation sciences between 1968 and 2018, we observed 11 publications published between the years 1960 and 1999 and 60 between 2000 and 2019. The significant increase in publications from 2000 onwards can be explained by the development of the medical Internet and the large-scale computerization of the health sector, which took place at that time [CAM 14, GON 07, p. 14-55; THO 04] and attracted the attention of scholars in the discipline.

8.4.1. *Specialists working on the organization of knowledge in medicine*

Among the authors of our corpus, 70% are researchers while 30% come from the professional sector. First, we identified information and documentation specialists. As far as scientists are concerned, they are affiliated with schools, faculties, colleges, as well as centers, departments and programs, within universities specialized in Archivistics, Library & Information Science, Information Science, Librarianship and Documentation (*Biblioteconomía y Documentación*), Information and Documentation, Information Management, Communication & Arts, Communication Studies, Information and Media Studies and Information and Communication Sciences (*Sciences de l'Information et de la Communication*). On the professional side, they are often librarians, documentalists and catalogers. They work in national health libraries or in specialized libraries and resource centers, which are aimed at the general public, the academic community (higher health institutes, universities) or hospital professionals. We also found articles published by employees working in private companies providing documentation services. Secondly, we identified co-authors who participated in projects conducted by information and documentation specialists. These are researchers attached to schools, centers and departments of informatics within universities, or affiliated with faculties of medicine and research institutes in epidemiology and public health. We have also identified computer scientists and physicians who work in university hospitals and health care centers.

The majority of authors (58%) come from countries in the Americas: the United States leads, followed by Canada, Brazil, Mexico, and Puerto Rico. The minority (27%) come from European countries, in particular from Western Europe (France, Spain, United Kingdom, Italy, Germany, Switzerland) and Northern Europe (Sweden, Finland, Norway, Denmark). They are followed by specialists from Asian countries (India, Japan, Singapore, Israel, China, South Korea) (14%) and Australia (1%). No work from an African country has been identified.

8.4.2. *The socio-documentary fields studied*

The research first focuses on techniques and MKOSs for organizing resources in traditional documentary organizations: national and public libraries, general university libraries, health libraries, and documentation centers [Texts 11, 13, 16, 37, 46, 65].

Following the computerization of library catalogs and the constitution of medical bibliographies in the 1970s [NAT 19], and then the development of the Web from the second half of the 1990s [GON 07], specialists in the field have been interested in the evaluation and design of MKOSs and indexing methods in these environments [Texts 3, 4, 6, 10, 19, 20, 21, 22, 23, 25, 35, 36, 41, 42, 52, 53, 55, 62, 65, 66].

After the computerization of health systems in Western countries, at the turn of the 1990s and 2000s [CAM 14, GON 07, p. 14-55; THO 04], the attention of researchers has been focused on health care institutions. These are reflections on indexing practices and on the representation of documents recording activity (notably patient records) and information resources (scientific articles) as well as the design of ontologies for the development of knowledge bases, essential for the practices of health professionals [Texts 2, 5, 8, 15, 17, 31, 48, 49, 60].

The widespread availability of health information on the medical Internet at the turn of the 2000s and 2010s [ROM 08] has contributed to the extension of the field of investigation to the webosphere. Nowadays, scholars study the methods of organizing medical knowledge and the info-communicative activities of users on websites and social media [1, 7, 9, 24, 18, 24, 28, 29, 30, 32, 34, 35, 43, 44, 47, 51, 56, 61, 69, 70].

Recently, information and documentation sciences have been involved in public health and medical knowledge engineering research, trying to extract knowledge from massively accessible information on the Internet (big data). These are studies that apply the techniques of literature-based knowledge discovery, sentiment analysis and information visualization (dataviz) in the processing of data from social media, the online press or bibliographic databases [Texts 33, 39, 59, 61].

8.5. Medical knowledge organization systems

Medical knowledge organization systems (MKOS) are schemes consisting of concepts and relationships between concepts, representing knowledge about different domains of medicine and related fields. In MKOSs, concepts correspond to terms that are derived from specialized vocabulary (e.g., "Seasonal allergic rhinitis") and/or lay terminology (e.g., "Hay fever"). Furthermore, as evidenced by the analysis of the MKOSs in our corpus, diseases are often classified by reference to human body systems, e.g., cardiovascular, gastrointestinal, respiratory, or immune system. Information and documentation sciences are mainly involved in the organization of knowledge in Western medicine. However, as complementary and alternative medicine is gaining popularity among the general public, it is also coming to be considered. Examples are Ayurveda, Siddha medicine, traditional Chinese medicine, aromatherapy and herbal medicine [Texts 30, 31, 64, 67, 68].

8.5.1. *Typology and uses*

Taking into consideration the level of specialization of the topics covered by the MKOSs and the purpose of the devices for which they are implemented (general or specific audience), we can distinguish between general and specialized systems. General MKOSs aim to index all human knowledge and devote part of their schemas to concepts representing medical knowledge. They are used more in services and devices of a multidisciplinary nature, intended for a large, often non-specialized public. Specialized MKOSs emerged at a time when the rapid growth in the volume of medical knowledge, the constant evolution of medicine and the emergence of new specialties, at the turn of the 20th century, required the development of specialized tools, sufficiently detailed to satisfy the informational needs of users of scientific and technical information [Texts 46, 50, 54]. Specialized systems are dedicated mainly to phenomena in medical fields, but also include associated disciplines. They are mobilized in organizations, in systems and in documentation services specialized in medicine and health, aimed mainly at professionals of the sector, but also the general public. Their typology has not changed since the 1960s [Text 46] - they are either very general specialized systems that include all fields of medical sciences, such as the National Library of Medicine (NLM) Classification and the Medical Subject Headings (MeSH), or MKOSs dedicated to limited domains such as the Thesaurus of Psychological Index Terms and the Colon Cancer Treatment Ontology. Domain MKOSs often focus on medical specialties, for example: obstetrics and neonatology [Text 2], pharmacy [Text 37], neurosurgery [Text 49], nursing [Text 23], but also on specific pathologies: brain tumors [Text 17], colon cancer [Text 33, 45], infectious and parasitic diseases [Text

52], AIDS [Text 27]. The designers also focused on important public health issues, such as health insurance [Text 11, 60], health and aging [Text 55] or nutrition [Text 71].

The analysis of our corpus highlights the use of different types of MKOSs, including: general classifications, medical classifications, medical nomenclatures, subject headings, medical thesauri, semantic networks, medical ontologies, medical glossaries, dictionaries and terminology directories, categorization schemes, medical taxonomies, folksonomies, and consumer health vocabularies.

General classifications can be divided into enumerative classifications (Dewey Decimal Classification, Universal Decimal Classification, Library of Congress Classification) and faceted classifications (Bliss Bibliographic Classification, Colon Classification). They have been developed since the 19th century to classify medical and health collections in public libraries, in general university libraries and also, but more rarely, in university health libraries which are part of the larger university library system [Texts 11, 16, 37, 65].

As noted in Texts 13, 16, 37, and 65, medical bibliographic classifications are used in health libraries, located in medical schools or hospitals (NLM Classification), and in health sections created in public libraries (Plantree Classification), for the classification of openly accessible materials. It is interesting to note that between the 1950s and 1970s, there was a wide variety of medical classifications in health libraries (Cunningham Classification, Boston Classification, Barnard Classification, Army Medical Library Classification, ...) [Text 46] whereas nowadays, the NLM Classification and general classifications significantly dominate the sector [Text 65]. Other medical classifications (International Classification of Diseases – ICD, Diagnostic and Statistical Manual of Mental Disorders – DSM, Classification commune des actes médicaux[3]) and nomenclatures (SNOMED-CT, RxNorm) are mobilized to index the resources contained in electronic patient records [Texts 2, 15, 48]. For example, the ICD is used for coding morbidity to generate epidemiological statistics on a global scale, while the Classification commune des actes médicaux is used in France for medico-economic purposes, in particular for the coding of medical and technical procedures performed by health professionals. Furthermore, medical classifications and nomenclatures are considered terminological standards that ensure semantic interoperability between health data repositories. They therefore become components of the shared medical

[3] Common Classification of Medical Procedures

record, which allows patients to share their data with healthcare professionals[4] [ODE 16, Text 15].

Subject headings (Library of Congress Subject Headings, RAMEAU, Répertoire de vedettes-matière de l'Université de Laval), developed between the end of the 19th and the second half of the 20th century, are used by documentation professionals to describe and index the content of documents in the catalogs of public, general university and health libraries [Texts 10, 41, 65].

Medical thesauri (MeSH, Emtree, Thesaurus of Psychological Index Terms), semantic networks (UMLS), and more recently, ontologies (OntoDip), are developed and used by information professionals and computer programs to describe and index the content of documents in online library catalogs, bibliographic databases (e.g., MEDLINE/PubMed), and strategic information systems [Texts 3, 4, 6, 10, 20, 23, 25, 32, 37, 51, 52, 53, 65, 66]. Moreover, ontologies, which allow the "conceptual modeling of a domain and the definition of a shared vocabulary" as well as the "simulation of human reasoning" [WAL 18, p. 163], act as knowledge bases, and are used for semantic information retrieval and for knowledge extraction from electronic patient records and scientific literature [Texts 17, 31, 33, 39, 49]. As evidenced by work in computer science, ontologies are also being mobilized for medical imaging management and retrieval [MAR 11]. Information and documentation specialists also design glossaries, dictionaries (lexicons) and directories of medical terminologies [Texts 3, 44]. These are schemes, often organized alphabetically, that list specialized or lay vocabularies used in a medical field, which can be used as terminology resources in language processing systems based on a linguistic approach or for the creation of ontologies.

Finally, some MKOSs (categorization schemes, taxonomies, consumer health vocabularies, ontologies) are used for the organization and retrieval of specialized and general public information on the Web. A categorization scheme is used on the National Center for Complementary and Integrative Health website.[5] The faceted taxonomy Health Topics, which organizes topics related to common diseases and conditions, mediates content on MedlinePlus [Text 51]. Folksonomies are tags, keywords, and hashtags created by social media users through the process of social tagging [Texts 1, 18, 34, 35]. Consumer Health Vocabularies (CHVs) are schemas used to represent lay terminology, taking the structure of different MKOSs (from a terminology repository, classification, thesaurus, or ontology), and are used for

4. WHO, "Classifications," available at: https://www.who.int/classifications/icd/en/, 2020.

5. National Institutes of Health, "National Center for Complementary and Integrative Health," available at: https://www.nccih.nih.gov/, 2020.

example in search engines for consumer services [Texts 9, 44, 56]. As highlighted by work in computer science and biostatistics, CHVs are also used in text mining tools when automatically processing corpora of data from social media [NZA 15].

8.5.2. *The sources of the description*

MKOSs aim primarily to represent the content of documents by expressing their subject through a concept, represented by a term, sometimes accompanied by alphanumeric symbols (notations) or graphics (images). The subject may concern a discipline to which the document refers: *L9F:4* "Gynecology" (Colon Classification), or a phenomenon discussed in the document, for example a disease: *EA80* "Atopic Eczema" (ICD-11) or a treatment: *QW 900* "Desensitization, Immunologic" (NLM Classification). We can therefore consider them as *content models* of documents [ZAC 10, p. 148]. Moreover, with some specialized systems, it is possible to model *extra-documentary situations* [*Ibid*., p. 148]. In the MeSH, edited by the NLM, we find for example the descriptor "Publication Characteristics" *[V]* which means the form of documents can be described, in particular the "Publication Formats" (e.g., "Journal Article", "Conference Proceedings", "Academic Dissertation"), “Study Characteristics” (e.g., “Clinical Study”, “Meta-Analysis”, “Multicenter Study”) and "Publications Components" (e.g., "Comment", "Advertisement", "Published Eratum"). Classifying and sorting publications in medicine according to these criteria is important for the practice of evidence-based medicine, where the type of publication and study methodology conditions the level of evidence of the work [HAS 13, HJØ 16]. Furthermore, in Siddha Ontology, modeled by Hemalata Iyer and K. S. Raghavan, we find concepts related to institutions, domain experts, and types of collections and documents: reference books, journals, articles, and manuscripts in the domain [Text 31]. Moreover, in MKOS, users can be grouped into sociological categories according to the type of information or collection that may satisfy their info-communication needs and practices. For example, the categorization scheme that is used on the National Center for Complementary and Integrative Health's website contains the categories "Be an informed consumer" and "For Health Care Professionals" that address the specific types of users to whom the service is dedicated.

8.5.3. *The design of new MKOSs*

Our corpus includes 22 original articles on the design of MKOSs. The most frequently developed systems are ontologies (10 works) [Texts 2, 9, 17, 31, 33, 45, 49, 52, 60, 71] in the context of researchers' work, then thesauri (7 works) [6, 10, 23, 25, 27, 55, 67] and finally classifications (3 works) [11, 40, 50], generally developed and updated by documentation professionals. We also note the design of a conceptual framework of complementary and alternative medicine to establish bridges between the tradition of Western medicine and the tradition of Eastern medicine [Text 68]. In addition, one work proposes the development of a repertoire of lay medical terminology [Text 44].

8.5.3.1. The designers

As the texts in our corpus attest, researchers in information and documentation sciences most often develop conceptual models [Texts 2, 9, 17, 31, 33, 49, 50, 60, 67, 71], but also formalized systems [2, 17]. The development of organizational systems ready to be implemented in information systems (for example in an integrated library management system or in a shelf signposting system in library) is rather the prerogative of information professionals [Texts 6, 10, 13, 23, 25, 55].

Some MKOSs are developed outside the information and documentation community. The ICD, for example, is revised and maintained by the World Health Organization in collaboration with medical experts in various fields. SNOMED-CT is developed by a non-profit organization, SNOMED International, which brings together specialists in information and communication technologies, information architecture and medicine. Moreover, as shown by the programs of scientific events around artificial intelligence and knowledge engineering organized in France and internationally, notably the *Journées francophones d'Ingénierie des Connaissances*[6] (*Atelier IA et Santé*), the *Plateforme de l'Intelligence Artificielle*[7] (*Journée Santé & IA*) and the Congress on Medical and Health Informatics [OHN 19], laboratories, learned societies and consortia of informatics and artificial intelligence seem to be settling in the field of medical knowledge organization. By observing the different sources of funding of these events (governments, territorial communities, learned societies, universities, research organizations, scientific consortia, private companies and ICT giants), listed on the websites and mentioned in the works published in the proceedings, it seems that computer science and artificial intelligence have found a lucrative field of application, in which both private and public actors are interested, since the economic and societal stakes are very high. This funding allows them to conduct and present research on ontologies, terminologies and associated services. They rely on the exploitation of large corpora of texts and resort to automatic natural language processing (NLP) techniques, on the assumption that these corpora "provide the stable, consensual and shared elements of a domain" [AUS 12, p. 252].

6 . IC 2016, "Programme – 6 juin : IA et Santé 2016," available at: https://ic2016.sciencesconf.org/resource/page/id/27.html, 2016.

7 . PFIA 2020, "Journée Santé et IA," available at: http://pfia2020.fr/journeesthematiques/sante-et-ia/, 2020.

Probably, with the same issue of research funding, in the last decade we can note a significant growth of interest in medical ontologies in the field of information and documentation. This trend is interesting since ontologies, although already conceptualized in computer science by Gruber in 1993 [GRU 93], are not even mentioned in the *Dictionnaire encyclopédique de l'information et de la documentation*, published in France 1997 by Serge Cacaly [CAC 97]. As the publications in our corpus show, information and documentation specialists are now very much involved in the development and research of medical ontologies [Texts 2, 9, 17, 31, 33, 45, 49, 52, 60, 71]. In addition, Texts 2, 9, 52 and 60 confirm the funding of ontology projects led by information scientists, ministries of education, public health organizations, scientific development agencies and scientific associations.

8.5.3.2. Design methods

The elaboration of MKOSs consists in identifying different elements relevant to a domain: concepts, terms, situations, objectives and issues, through the analysis of different textual corpora. For this purpose, different types of documents are used: books, abstracts, scientific or general public articles, clinical documents, social media messages, websites of learned societies, query logs, descriptors of indexed documents, existing MKOSs and survey data [Texts 2, 9, 10, 13, 17, 23, 25, 27, 31, 33, 40, 44, 45, 49, 50, 55, 56, 60, 67, 68]. Recently, authors have also used the method of crowdsourcing including non-experts [Text 71]. Furthermore, as pointed out in Texts 49 and 56, there are ethical issues that need to be addressed when designing MKOSs, especially when extracting terms from the contents of computerized patient records and social media, which include personal data. After the collection of relevant elements for a given domain, the concepts and terms expressing them are then normalized and organized by professionals or by a machine into systems of semantic relations.

Information and documentation scholars' methods of designing MKOSs can be attributed to five different epistemological perspectives: pragmatism, historicism and hermeneutics, socioconstructivism, rationalism, and empiricism [GNO 20, p. 39-40; HJØ 03, p. 107; HUB 98, WEI 16].

8.5.3.2.1. The pragmatic method

The analysis of the objectives, values and applicative orientations of a community, which guide the production and use of genres of discourse in a field (hospital reports, scientific articles, messages on social media, etc.), is the first method, attached to pragmatism [GNO 20, p. 39]. It consists of the study of the uses of health information, seen as social, communicational and cultural practices [Text

58]. Most often, this involves using the categories of information searches, identified through studies of users' information behavior [Text 57]. For example, Hemalata Iyer conducts interviews with practitioners and educators of Siddha medicine to identify the principles, professional and informational practices, communication patterns and knowledge structures developed, and then transposes this information into a domain ontology model [Text 31].

8.5.3.2.2. The historicist and hermeneutic method

The second method is part of the historicist or hermeneutic perspective. It involves studying the context and development of knowledge and the social and scientific division of labor and categorizing concepts from a cultural point of view [GNO 20, p. 39; HJØ 03, p. 107]. The Universal Decimal Classification, the Bliss Bibliographic Classification, and the NLM Classification are thus conceived and revised by librarians and documentalists in Europe and America, who organize medical knowledge from the perspective of Western medicine. As a result, the fields of complementary and alternative medicine, which often belong to Eastern traditions, are poorly represented [Texts 30, 64]. It also seems that the MKOSs constructed in Eastern cultures are also influenced by Western medicine. The Colon Classification for example, which is revised in India, is not sufficiently developed to cover collections on Indian Ayurveda medicine [Text 30].

8.5.3.2.3. The socioconstructivist method

The third method, belonging to socioconstructivism, consists in the modeling of classification schemes that reflect knowledge influenced by social constructions, developed through mutual actions between individuals and their environment [HUB 98, WEI 16]. These constructs, which derive from individual experiences and social perspectives (formed for example by social ideologies or political interests), are said to stimulate the representation of a reality, which can sometimes be disconnected from scientific reasoning [HUB 98, p. 195-196]. In the field of HIV/AIDS, for example, diseases and associated phenomena coexist together in such a reality, because the categorization, marginalization and stigmatization of populations affected by HIV (gays, African-Americans, drug users, ...) or of their sexual behaviors (considered in some discourses as deviant or immoral) are influenced by social stimuli [*Ibid.*, p. 195-201]. According to a socioconstructivist approach, MKOSs must reflect the complexity of realities marked by the coexistence of social constructions alongside historical and cultural factors. To develop a vocabulary-mediator of dialogue in the HIV/AIDS community, as an attempt to accommodate such complexity, Jeffrey F. Huber and Mary L. Gillaspy look at the different models of communication and knowledge production (both traditional and non-traditional) as well as the different vernaculars developed by different actors (clinicians, researchers, patients, etc.). Given the multidisciplinary, interdisciplinary and transdisciplinary nature of the field, Huber and Gillaspy base their vocabulary on the different domains: "[...] Epidemiology and Transmission; Education and Prevention; [...] Treatments, Therapies, and Medical Management of HIV Disease; Psychosocial and Religious Issues, Case Management; Legal, Ethical, Economic, and Political Aspects; [...] Fine Arts; Belles Lettres and Non-Fiction" to which they attribute relevant concepts [Text 27, p. 297]. They also use the common facets: "Age Ranges, Sexual Orientation, Gender, Stages of Infection, Ethnic Groups, Geographic Names, At-Risk Populations, Religious Faiths, Signs and Symptoms, and Special Populations", endowed with a syntactic role that allows them to be associated with the main categories, and to complete them, if necessary [HUB 98, p. 203]. It is interesting to observe that, although the work is based on a socioconstructivist perspective, the designers finally resort to faceted analysis, which makes it possible to see that their method is also part of a rationalist approach, another method of classification which will be presented below.

8.5.3.2.4. The rationalist method

The fourth method is to create logical divisions that are considered universal [GNO 20, p. 39; HJØ 03, p. 107]. This method of organizing concepts is often based on the theory of facet analysis. It is considered by Birger Hjørland, to be an expression of rationalism [HJØ 14], even if other authors, such as Joseph T. Tennis [TEN 08], also see components of pragmatism in it, because the fundamental categories used to organize knowledge (explained later) prove useful for the classification process, and classifications that rely on these categories save time for the reader. Moreover, even if one can criticize the confusion between pragmatism and practicality of this method (practicalism), it seems to us that it is above all the facet analysis based on the contents exchanged and used in a domain (scientific articles, books, patient files...) for a concrete application, which allows us to see that it has pragmatist influences. The principles of this approach are based on a general theory of classification conceived by the Indian librarian Shiyali Ramamrita Ranganathan, and these principles were introduced in Europe in the 1950s by the Classification Research Group [VIC 60]. Based on a review of a sample of literature in a specialized field, concepts and terms are grouped into facets, which generally fulfill different semantic and syntactic roles. In faceted classifications, for example, concepts are assigned to facets of medicine. As Vanda Broughton points out, in class *H* "Physical anthropology, human biology, health sciences" in the second edition of the Bliss Bibliographic Classification, terms are assigned to the different categories:

– (Thing) Human beings;

– (Kind) Women, children, old people, etc.;

– (Part) Head, legs, muscles, bones, heart, brain, lungs, etc.;

– (Process) Respiration, digestion, reproduction, disease, etc.;

– (Operation) Surgery, drug therapy, physiotherapy, etc.;

– (Agent) Doctors, nurses, equipment, buildings, etc. [BRO 15, p. 308].

Thus, the terms in each category constitute a facet of a subject. In this way, in Bliss, all the terms of the category "Part" become, for example, the facet of the class *HDP* "Anatomy" or *HPT* "PARTS, ORGANS, SYSTEMS OF THE BODY", while the terms of the category "Operation" become the facet of the class *HNP* "Treatment, therapy" [*Ibid*]. In the same approach, K. S. Raghavan and C. Sajana propose facets of the domain, grouped in three major facets (which refer to Ranganathan's categories) to develop an ontology of neurosurgery dedicated to health professionals: "Personality (Patients, Body Organs, Health Care personnel, Institutions, Hospital Managers), Matter-Property (Diseases, Symptoms, After effects), Energy (Diagnosis, Treatment)" [Text 49, p. 210]. Since the ontology's mission is to ensure rapid access to clinical documents, Raghavan and Sajana develop these categories and associate concepts with them based on the patient records produced and used by professionals in their professional practices. The mobilization of information contents, used by the actors in their daily practice, to design an MKO, allows us to see that this approach does indeed have pragmatic aspirations.

8.5.3.2.5. The empirical method

The fifth method, which is empirical, is manifested by statistical generalizations, based on the "similarity" of informational objects that share a large number of properties in common [GNO 20, p. 39; HJØ 03, p. 107]. As evidenced in Texts 2, 9, 44, the empirical method often consists of analyzing very large text corpora via NLP techniques to establish semantic relationships between ontology terms, or via machine learning techniques to establish links between terms and terminology definitions. An exemplary study of this approach is the work of Yunseon Choi, which focuses on building an ontology dedicated to healthcare consumers. She identifies a non-expert vocabulary via a latent semantic analysis of social tags, assigned by users of Del.icio.us (a social bookmarking site) to index and share documents [Text 9]. It is interesting to observe that even if the neutrality of the statistical technique emanates from empiricism, the consideration of lay terminology in order for the ontology to best satisfy the needs of users, related to the search for relevant information resources, is in our view a pragmatist influence. On the other hand, the development of an ontology representing a non-expert view of the domain, based on a lay language built by an online community to index documents, also reflects socioconstructivist aspirations.

Authors rarely state the theoretical frameworks on which their work is based. One explanation lies in the recent nature of the epistemological foundation of MKOSs, developed with the formalization of the field of knowledge organization [GNO 20, HJØ 18].

8.5.3.3. Test, validation and evaluation methods

The knowledge organizations, proposed by information and documentation specialists, are tested, validated and evaluated in a qualitative and quantitative way. In the qualitative method, which is most often practiced, the aim is to evaluate the usefulness and efficiency of the MKOSs at representing the terms of the targeted domains or verifying their efficiency and their potential at integrating the information systems to which they are dedicated [Texts 2, 9, 17, 31, 49, 50]. The designers validate the designed MKOSs by conducting semi-structured interviews with individuals representing the categories of future or potential users: health care consumers [Text 9] or domain specialists [Text 2]. They are asked, for example, to indicate in a document the information they would like to have in a specific situation and the examiners verify to see if these elements are correctly represented in the system being evaluated. MKOSs are also validated through text analysis, performed by experts, information professionals or by machines [Texts 2, 50]. To validate the OntoNeo ontology, Mauricio Barcellos Almeida and Fernanda Farinelli use NLP techniques to automatically extract obstetrics and neonatology terminology from clinical records, which allows them to verify whether the most frequent terms, obtained from the extraction are present in the ontology [Text 2]. In other works, designers submit queries to test the efficiency and potential functionality of information systems, based on MKOSs [Texts 17, 31, 49]. For example, the authors of the Siddha medicine domain ontology perform semantic information retrieval in the knowledge base based on this ontology [Text 31]. The designers of the ontology of the neurosurgery domain, on which a decision support system based on the semantic indexing of patient records is relied on, ask this system specific queries, such as: "identify & retrieve records of patients: age => 40 with astrocytoma" [Text 49, p. 214]. Quantitative evaluation aims to measure the number of documents retrieved via a query to the information system. At the end of this operation, the recall and precision rates are calculated [Text 60]. In addition, to evaluate the accuracy of the statements in the nutrition ontology, the recruited subjects evaluate the accuracy rate of the relations established by the designers [Text 71].

8.5.3.4. New challenges for the design of MKOSs

General and specialized classifications, in which knowledge is organized by discipline, are now confronted with the challenge of interdisciplinary knowledge. However, some interdisciplinary concepts from the medical sciences may appear in several classes within these classifications, since they are studied by several disciplines. In the NLM Classification, for example, the concept of "tumor" is found in different disciplines: pathology, ophthalmology, gynecology, nursing, etc. Such a classification method leads to the dispersion of resources, which is illustrated in the location of documents (on interdisciplinary topics) in several spaces of a library's classification scheme. As a result, there is a risk of scattering materials on different shelves of a library, and in this way, users may lose some of the resources that may be of interest to them. The somewhat dated (1996), but very timely study by Lynn Silipigni Connoway and MaryEllen C. Sievert, masterfully illustrates this problem: because of the interdisciplinary nature of the concept of "health insurance", resources on this topic, catalogued in bibliographic databases, are dispersed in 13 different classes of the NLM Classification and the Dewey Decimal Classification as well as in 23 classes of the Library of Congress Classification [Text 11]. We will see later that such inconsistency in classifications can create constraints for knowledge representation in Semantic Web standards.

Now, knowledge organization specialists recommend moving KOSs to online applications in order to optimize indexing and information retrieval in this environment [BIN 20]. Such a goal leads to representing the traditional organization of concepts in the syntax of Semantic Web technologies. While medical ontologies are natively created following these standards, MKOSs, whose origins date back to the 19th century and the beginnings of digital transformation, must undergo the conversion to Networked Knowledge Organization Systems (NKOS). Following these recommendations, the Library of Congress and the NLM respectively published the Library of Congress Subject Headings and the MeSH in SKOS (Simple Knowledge Organization System) format, which is a standard and a set of specifications developed to support the use of MKOSs within the Semantic Web [Text 6, W3C 09]. However, in our opinion, basing general and specialized medical classifications on disciplines can become a considerable technical constraint for the conversion of these classifications to NKOS. Yet, for publishing classifications in SKOS format, the World Wide Web Consortium (W3C) recommends identifying MKOS concepts by URIs (Uniform Resource Identifiers), which allows concepts to be identified by a unique address for their description and linking, using Resource Description Framework (RDF) or RDF Schema (RDFS) languages, based on the "subject - predicate - object" triplet model [W3C 09]. This specification seems difficult to achieve with disciplinary classifications where some interdisciplinary concepts may appear several times in a schema, and each time from a different perspective. A group of researchers from different countries, working on the Integrative Levels Classification (ILC), a faceted interdisciplinary classification, proposes an alternative approach: instead of integrating interdisciplinary concepts into different disciplinary classes, they would represent them through phenomena, which are basic units of knowledge, independent of any discipline [GNO 16]. The latest work by this team, on the conversion of ILC into SKOS format, underlines that the phenomenon-based classification approach is quite suitable for the representation of classifications in Semantic Web standards [BIN 20].

Other texts present reflections on the design and evaluation of MKOSs and bibliographic data exchange formats to improve knowledge discovery techniques based on scientific literature [Texts 33, 39, 59]. They are a continuation of the work initiated by Don R. Swanson on the establishment of new relations between the knowledge contained in articles published in biomedical fields through treatments involving the use of semantic technologies. This idea can be related to the philosophy of the Web of data (linked data), which is a metadata infrastructure developed for the interoperability of repositories in order to "group the information in a useful way, as in a gigantic database where everything is written in a structured language" with the aim of developing different services of research, consultation, exchange, annotation and indexing of contents [WAL 18, p. 159]. In order to describe the knowledge about the documentary resources and the relations between these resources, it is necessary to use the languages of the Semantic Web that we have just mentioned (RDF, RDFS) and to build triplestores, which can be queried with the SPARQL language [*Ibid*., W3C 09].

Finally, the designers of MKOSs are currently led to organize information in a new type of medical devices, notably in "healthcare interface organizations" [Text 5]. As French examples of such devices, we can mention the Personal Health Records, the Territorial Support Platform or telemedicine tools. The aim of their development is to associate the public and private sectors, including patients and their families, so that they become spaces for cooperation around shared knowledge. As Christian Bourret points out in Text 5, such systems need new thinking on the organization and representation of knowledge, adapted to the informational needs and skills as well as to the cognitive capacities of communities of scholars, experts, professionals and laymen, in the spirit of building a collective intelligence based on the knowledge of all their members.

8.6. New challenges for indexing and information retrieval

Part of our corpus of works focuses on the new challenges for indexing and retrieving medical and health information in the context of the social Web, the medical Internet and bibliographic databases.

The first category of publications deals with social indexing practices [Texts 1, 9, 18, 28, 32, 34, 35], "allowing non-specialist users to index documentary resources" on Web 2.0 [WAL 18, p. 161]. In the netnographic approach, specialists collect and analyze data with qualitative (observation, interview, facet analysis, comparison, equivalence, NLT) and quantitative (descriptive statistics, infometric and similarity measures) techniques. The results of these works highlight the subjective nature of social indexing, performed by different categories of users on online services. The study by Hemalata Iyer and Lucy Bungo shows, for example, that less than 1% of the tags concerning complementary and alternative medicine, posted by users of a social cataloging web application, correspond to terms of the UMLS semantic network [Text 28]. The data collected by Margaret E. I. Kipp on CiteULike, a web-based bibliographic cataloging application, compared with those collected on PubMed, highlight that there are significant differences in the criteria for indexing biomedical literature between biomedical researchers and professional catalogers [Text 34]. Marit Kristine Ådland and Marianne Lykke emphasize that users and editors of a cancer website disagree on both the purpose of tags and what characterizes a good tag [Text 1].

Many MKOSs have been designed for information professionals in order to simplify access to information. However, the above-mentioned work points out that the medical terminology used by users and their indexing criteria may differ from the terminologies and criteria used by professionals. For example, Pertti Vakkari evaluates the extent to which the vocabulary used by users of digital question-and-answer services on the Web, concerning health, nutrition and social services, is covered by general and specialized systems developed by information professionals. The results vary between 15% and 65% of terminological convergence, which shows a semantic divide between professional MKOSs and the vocabulary used by non-specialized users on the Web [Text 63]. These results make us think about the knowledge organization tools developed in a top-down approach, which can be incompatible with the users' behaviors and practices, which can have negative consequences on the user's information search process and distance them from the information they need. Solutions to these terminology and indexing discrepancies are most often sought in the construction of terminology resources and consumer health vocabularies [Texts 9, 44, 56] and in taking into account users' preferences for document indexing and information relevance criteria [1, 14, 29, 34, 35]. This kind of user knowledge can be acquired, for example, through domain analysis, which is a paradigm inspired by a sociological approach to knowledge organization, according to which indexing must be considered with a socio-cultural perspective, i.e., linked to the social practices of individuals in a discourse community [HJØ 16]. Domain analysis thus brings together both hermeneutic and pragmatist approaches [GNO 20].

The second category of work is based on a cognitive approach to knowledge organization [GNO 20] which seeks to take into account the cognitive abilities of the user (located in a culture or community) when searching for information [Texts 24, 29, 47, 51, 56]. In this approach, Dagobert Soergel, Tony Tse and Laura Slaughter are inspired by the work on human cognition carried out in biomedical informatics, which emphasizes that the understanding of pathologies by patients and physicians can be summarized in two distinct models: *illness model*, manifested in patients, and *disease model*, characterizing the perception of physicians [Text 56]. Soergel's team bases their work on this model and develops an interpretive layer, which aims at mediating health information between the perspective of specialists and the perspective of non-experts. The model focuses on the design of a set of tools: an educational ontology (with non-expert definitions and terminologies), a validated biomedical knowledge base, a false-belief explanation base, and a visual display and classification navigation interface. All these tools form an "interpretative layer" allowing the non-expert user to find the document related to his information need and to understand its content. In addition, to improve access to information, some designers seek to represent knowledge in a design appropriate to the cognitive abilities associated with the information culture of particular groups. For example, the work of Lisa M. Given *et al*. and Hemalata Iyer and Mary Guadrón attempts to identify strategies for organizing and visualizing knowledge on health websites for older adults [Texts 24, 29]. Kyong Eun Oh, Soohyung Joo, and Eun-Ja Jeong collect facets that are preferred, easy to use, and useful in order for the general public to access online health information [Text 47].

The third category of studies deals with the phenomenon of crowdsourcing [Text 66]. The study by James W. Woods *et al*. provides instructive feedback on this practice, using the example of the indexing of images of skin lesions from the NLM collection by dermatologists [Text 66]. 9 experts spent an average of 30 minutes describing the images via a form made available to them on the Web. Comparison of the vocabulary used for indexing, with the UMLS terms shows that 300 terms from this MKOS out of the 346 unique terms submitted by the practitioners have an exact equivalence [Text 66]. This example highlights the great potential of participatory production, which could be used for indexing and annotating large corpora of clinical activity documents or health information resources (e.g., heritage collections). Crowdsourcing could also be an interesting alternative to automatic indexing and annotation techniques.

The fourth category of work shows that vocabulary control and rigid structuring of terminology in MKOSs built in a top-down approach, e.g., medical thesauri, are still useful for scientific information retrieval. Ying-Hsang Liu and Nina Wacholder point out that MeSH terms are indispensable for measuring the accuracy rate for domain experts, even for graduate students in biomedical fields who have not undergone specific training in information retrieval [Text 36]. In addition, Xiangming Mu, Kun Lu, and Hohyon Ryu, who conducted a study of undergraduate and graduate students with no experience in information retrieval, show that a system that allows searching by MeSH term and navigating its schema is more effective in information retrieval than a system that provides a simple search interface [Text 43]. Finally, as evidenced by numerous medical theses and articles, MeSH is currently widely used by both researcher-practitioners and medical students to query PubMed for systematic literature reviews.

8.7. Social, cultural, political and economic issues

In addition to the problems related to indexing and information retrieval, the organization of medical knowledge also raises social, cultural, political and economic issues.

As Texts 12 and 26 in our corpus attest, adding and removing concepts in an MKOS is based on a socio-political evolution of knowledge, and raises sensitive questions and even political tensions, prompted by normative issues. In 1968, the American Psychiatric Association added homosexuality to the Diagnostic and Statistical Manual of Mental Disorders (a classification of mental illness). This appearance provoked protests from homosexual activists. After a long debate, in 1973, the term was removed from the classification [Texts 12, 26]. Moreover, in the ninth version of the International Classification of Diseases (ICD-9), used until the end of the 1980s, the concept of homosexuality (*302.0* "Homosexuality") appeared in the scheme, as the first subdivision of class *302* "Sexual deviations and disorders", and belonged to chapter *300-316* "NEUROTIC DISORDERS, PERSONALITY DISORDERS, AND OTHER NONPSYCHOTIC MENTAL DISORDERS". The concept was accompanied by a usage note for health professionals: "Code homosexuality here, whether or not it is considered a mental disorder". Even if the classification never explicitly stated that homosexuality should be considered a disease, the analysis of generic concepts, allowing the context in the classifications to be revealed [ZAC 10], led to interpretations of the media discourse as discriminatory and erratic [DRI 94]. In the tenth version of the classification, published in 1990 and replacing ICD-9, the term no longer appears as a reason for sexual contact [DRI 94]. The above examples clearly illustrate the normative stakes of MKOSs, which reflect the power of certain actors to categorize what is normal and what is pathological [WAL 18, p. 158]. The categorization of individuals has a direct link with their representation in a society. So much so that it is understandable that it becomes a tool of revolt for communities that do not identify with certain categorizations proposed by normative bodies.

Moreover, the cultural warrant principle, which calls for the design of MKOSs that are appropriate and useful to the individuals of a culture, may lead to the interests, values, rights and beliefs of others being overlooked, depriving them of the right to access information [BEG 02]. As we have already pointed out in the section on MKOS design methods, the fields of complementary and alternative medicine are poorly represented in the classifications reviewed by Western information professionals [Texts 30, 64]. Information resources on Eastern medicine topics may therefore be less visible in the collections of a library located in Europe. As a result, followers of Siddha medicine who visit this library, for example, are less likely to find the information they need.

Finally, as emphasized by work in the information and communication sciences and in medicine, the design of reference medical classifications also raises economic issues, linked to political decisions taken by governmental bodies and intergovernmental organizations responsible for their revision [TAN 16, WAL 18, p. 158]. The inclusion or exclusion of certain diseases in classifications such as the ICD or the Classification commune des actes médicaux has, for example, repercussions on the marketing of new drugs by the pharmaceutical industry and on the reimbursement of medical acts by national health insurance funds, mutual health insurance companies and insurance companies. As an illustration of such power, we can mention a case reported by specialists in allergology, a recent specialty that is sometimes incorrectly represented in medical classifications. The absence of a specific class for anaphylaxis in ICD-10, due to the confusion of this disease with anaphylactic shock in class *T78.2* "Anaphylactic shock, unspecified" (the terms "anaphylaxis" and "anaphylactic shock" do not represent the same concept), and the downgrading of the concept of anaphylaxis to class *T78* "Adverse reactions, not elsewhere classified," has led to the underreporting of anaphylaxis mortality by health professionals in Brazil when coding death certificates. The lack of epidemiological data in the Brazilian national database has significantly affected decision-making by the government and pharmaceutical companies, and as a consequence the non-marketing of self-injectable epinephrine for the treatment of anaphylaxis [TAN 16].

The above examples make it clear that MKOSs represent and impose a certain worldview at a given moment and in a particular context [DUB 20, p. 12]. They can also direct knowledge, give visibility to a pathology, become instruments of power, revolt and access to information, as well as enable or prevent the circulation of goods in the health economy.

8.8. Discussion

Our analysis leads us to the observation that the theories and techniques for organizing medical knowledge, developed by information and documentation specialists, have been profoundly affected by the digital transformations of the health information field. On the technical side, the constant growth of the volume of knowledge in this field has created, for example, the need for specialized MKOSs. The paradigm of evidence-based medicine has influenced the criteria for indexing medical literature. The development of Web 2.0 has contributed to the emergence of the practice of social indexing and has created the need to adapt knowledge organization tools to this environment. In addition, the Semantic Web and the idea of the Linked Data have guided the representation of MKOS in new computer standards and languages. Finally, massive data have attracted the attention of researchers who try to extract knowledge from them. In parallel to these technical aspects, we observe the development of theoretical reflections. Epistemological and methodological contributions as well as ethnographic and netnographic studies are the manifestation of this new orientation, which seeks to put the user at the heart of the reflection. It seems that this surge is a consequence of the participative and social character of Web 2.0, which has facilitated the obtaining of behavioral data, the analysis of which has led to an awareness of users' needs. First, the importance is given to the non-specialized user. Traditional medical terminologies and indexing techniques are being challenged. They are confronted with the vocabulary, the indexing and navigation preferences as well as the cognitive abilities of the users. Then, other works focus on the specialized user situated in his work context. This is illustrated by MKOS design methods, which take into account different vernacular vocabularies built within medical domains, as well as the needs, behaviors and info-communication practices of health professionals. Finally, specialists are interested in the different issues of knowledge organization, a concern that is specific to the HSS.

Despite the constitution of a corpus from only three data sources, the technical and theoretical trends are in line with the global changes affecting the field of knowledge organization [SOS 19, p. 31-43; WAL 18, p. 155-164]. The large-scale design of medical ontologies for online applications and for knowledge organization, management and retrieval processes is a leading example. Designers are evolving traditional systems to conform to Semantic Web standards. Participatory production is also spreading, little by little, for the construction of MKOSs and for the indexing of documentary resources on medical topics. Moreover, TALN, clustering and information visualization techniques are more and more practiced, which may reflect a rapprochement of the fields of knowledge of engineering and artificial intelligence, given the interdisciplinary nature of information sciences that oscillate between HSS and computer science, but also, quite simply, a step towards the adaptation of knowledge organization techniques to new technological trends and requirements.

Moreover, statistical classification techniques, such as machine learning (ML), are already used to develop predictive models (classification algorithms), for example for cancer diagnosis, without recourse to classical knowledge organization tools [SID 19]. As a consequence, the relevance of MKOS description, classification and document indexing seems to be questioned with respect to ML techniques such as deep learning, artificial neural networks, etc. [SID 19]. On the other hand, Andrew MacFarlane, Sondess Missaoui and Sylwia Frankowska-Takhari point out that knowledge organization tools should not be neglected in this task [MAC 20]. Using the example of multimedia documents, the authors highlight that the implementation of projects involving supervised learning techniques first requires knowledge about the informational needs and practices in the domains of investigation (which can be mediated by KOSs) in order to identify the elements relevant to the parts of the document contents to be "learned" by the machines. Second, the algorithms used in this kind of work require training documents with metadata describing their "general" and "contextual" features (e.g., objects, styles, genres, emotions, locations), which are difficult for the algorithms to detect [MAC 20]. According to the model developed by MacFarlane et *al*. training corpora for machine learning can consist of documents and associated subject metadata (controlled by KOSs), e.g., from image banks. They can then be merged with image corpora, whose features can be extracted using ML techniques, to constitute the indexes needed for automatic classification. The relevance of this model for the classification of information in the medical domain remains to be evaluated.

The positioning of information and documentation sciences with regard to the organization of medical knowledge can be explained by taking into consideration general and specialized MKOs and by analyzing different facets of medical fields. This approach allows for a holistic view of the objects of study. As we have just seen, the dimensions of knowledge that are often investigated are: reality, ontology, epistemology, documents, collections, information needs (connected to informational behaviors and info-communicational practices) and cognitive capacities of individuals. These "steps between the world and classification", which can be identified in the contents of MKOSs, are highlighted by Claudio Gnoli from an initial scheme elaborated by Brian Vickery [GNO 20]. They can be applied in medical domains as follows:

– α reality (the undifferentiated totality upstream of human understanding),

– β phenomenon, e.g., allergic hypersensitivity,

– γ perspective, e.g., an integrated approach,

– δ document, e.g., an article in a scientific journal that discusses it,

– ε collection, e.g., a digital library that contains the item,

– ζ information needs, e.g., a search by medical specialty thesis,

– η people, e.g., an intern in a teaching hospital,

– θ cognition, e.g., his natural abilities to navigate on lists.

The works inspired by a pragmatic approach, analyzed in this study, also underline that some MKOS designers now feel the need to free themselves from a technocentric approach, which gives pride of place to the tools implemented in the health sector [GRO 07], and to build the digital devices and services, in connection with the users' practices. The study of medical domains in a holistic approach, specific to information and documentation sciences, thus seems very favorable. This approach can lead to the proposal of MKOS models for the design of mediation devices, which are then translated into concrete realizations by engineers. We, as researcher in information and communication sciences and professional in information-documentation, encourage specialists in the discipline to set up multidisciplinary projects in digital humanities, in partnership with the health sector, and in cooperation with specialists in computer science.

8.9. Conclusion

The work in information and documentation sciences on the organization of medical knowledge is divided into two axes. The first one invites us to conceive and evaluate the MKOS. It is characterized by analyses of textual corpora, the use of documentary techniques, semantic technologies and by studies of users, their info-communication activities and their cognitive capacities. The second axis includes reflections specific to a science of mentefacts [8], notably on the theory and epistemology of knowledge organization and on the issues related to classification.

8. By the concept of "mentefacts" we mean the intellectual products of human creativity (culture): theories, MKOSs, books, critical thinking, etc. [GNO 19].

In the first axis, the aim is to develop MKOSs for the design of systems allowing users to manage, access and consult information. In the second axis, the medical discourse occupies a predominant place. Specialists analyze the discourse carried by information resources and MKOSs, and emphasize their role as mediators of political, scientific, social, cultural and economic phenomena.

This study highlights that knowledge organization opens up a broad spectrum of applications in the field of medicine and health. It also helps explain why MKOSs, despite their artificial and often controlled nature, are able to draw society's attention to the sensitivity of population health and are powerful political instruments.

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