Representing and organizing everyday medical terminology and conceptualization in a general faceted classification: towards a reconciliation between epistemological and ontological approaches

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Abstract. Representation of terminology and conceptualization of healthcare professionals in KOSs is necessary to support information processing and searching by final users. In the present article, we assess the possibility to represent and organize everyday terminology and conceptualization of allergology professionals in a general faceted classification. We show that expression of such terminology and conceptualization is possible in the third version of Integrative Levels Classification, through its special and common facets. That leads us to say that the reconciliation between epistemological and ontological approaches to organization of knowledge can be reached. Therefore, we argue that such combination should be taken in consideration in the design of medical knowledge organization systems.

1. Introduction

In information science, we may distinguish two approaches to the organization of knowledge. The first one, the ontological approach, "concerns the nature of the known things, especially in terms of the general categories to which they may belong" (Gnoli 2008, 139). Such approach leads designers of knowledge organization systems (KOS) to focus on "issues like the subdivision of a class into kinds and parts, or the acknowledgment that a given concept consists of a process or a static entity" (Ibid.). Facet analysis (Raghavan and Sajana 2010) and automatic terminology processing (Muresan and Klavans; Choi 2016) fit into this approach and are often used to organize medical knowledge (Trzmielewski 2023). The second one – the epistemological approach, "is about how humans know the world through their sense organs, and how they process knowledge according to categories both innate and culturally biased" (Gnoli 2008, loc. cit.). Methods such as analysis of context (Huber and Gillaspy 1998), analysis of practices (Iyer and Raghavan 2018) and domain analysis (Hjørland 1998), are connected to such approach and are mobilized as well to organize knowledge in medicine (Trzmielewski 2023). As "knowledge is both epistemological and ontological, as it passes through human perception by its very nature, but also refers to real objects of the world having some intrinsic structure" (Gnoli 2008, loc. cit.), some reconciliation between the ontological and the epistemological approaches should be sought. In the present article, we search for such reconciliation, by assessing the possibility to represent and organize everyday terminology and conceptualization of allergology professionals in a general KOS. We reuse contextualized and bottom-up terminological data, and we apply it in the third version of Integrative Levels Classification (ILC), which is a general classification with main classes and facet categories developed in a top-down way.

We will begin with a presentation of the ALLERGIDOC and ILC projects. Then, we will indicate our theoretical framework and methodology. Finally, we will present and discuss our results, and we will provide some perspectives for future development of our study project as well.

2. ALLERGIDOC and Integrative Levels Classification projects

Allergy is a major health issue in our society in terms of care and prevention. In France, allergy or allergology, the domain that studies and treats allergies, was only recognized as a specialty in its own right in 2017 (Demoly 2017), and there is no KOS that might be used by professionals in this domain for their activities of processing and search for information (Trzmielewski 2019). This situation led Trzmielewski to cooperate with the Allergy Unit of the University Hospital of Montpellier to develop

the ALLERGIDOC[1] project, aiming to create an ontology to represent and organize allergy knowledge and support clinical, research and education activities of allergy professionals, based on information indexing, searching, and classification tasks.

In numerous cases, medical KOSs have been designed through techno-centric approaches, which have led designers to pay less attention to the human and social aspects. To distinguish ALLERGIDOC work from other works on design of medical KOSs, Trzmielewski constructed a first version of this ontology through a contextualist approach, relying on the study of information practices of allergology professionals, and on the analysis of documents used by these employees in their daily activities. For further information on this project, consult Trzmielewski (2022, 2023).

The Integrative Levels Classification (ILC) is a general faceted classification being developed progressively since 2004 by an international team of knowledge organization specialists led by Gnoli. The ILC research project takes its theoretical and technical foundations from the work developed in the 1960s by the Classification Research Group in London, particularly in the persons of D. J. Foskett and D. Austin, under a NATO[2] grant. At the time this did not produce any finished system for contingent reasons, but it did leave a precious heritage of advanced techniques (freely faceted classification) that are now being implemented in ILC (Gnoli 2016, 2017, 2020). A second stable edition (ILC2) is available online (ISKO Italia 2023), also in SKOS[3] format (Binding et al. 2020). This includes 10,845 classes and facets covering the whole spectrum of knowledge broadly, plus deeper specificity in certain domains that have already been worked out in detail. A third edition (ILC3) with improvements in the consistency of facet syntax and in various classes is currently under development.

Although drawing from the heritage of bibliographic classifications such as Dewey Decimal Classification or Universal Decimal Classification, ILC is different from them in allowing to represent any combination of concepts without the ties of traditional disciplines (e.g. “Medicine”). Rather, phenomena of the world are listed in the ILC schedule according to a sequence of increasing organization, based on the theory of integrative levels introduced by Needham (1937) and formalized by Feibleman (1954). According to this theory, when elements of a lower level (e.g.: molecules, genes) are combined, they can give rise to a new integration (e.g.: organisms), with different properties and nature:

a forms
b quantum fields
c spacetime

1 ALLERGologie : Information, Données et Organisation des Connaissances
2 North Atlantic Treaty Organization
3 Simple Knowlege Organization System

d particles
e atoms
f molecules
g continuum bodies
h celestial bodies
i rocks
j land
k genes
l cells
m organisms
n populations
o agency
p consciousness
r production
s services
t communities
u polities
w customs
x creative arts
y scholarship.

Levels thus allow to establish the sequence of phenomena through dependence relationships based on phylogenetic criteria. These are completed by inclusion relationships arranging the phenomena according to the increase in morphological specificity (e.g. *m* organisms are divided into *mn* fungi, *mp* plants, *mq* animals and so on).

In ILC, ordinary classes (concepts) are represented by lowercases and by terms expressed in English. Although terms are important to final users (to know with which class they are dealing), notation is even more important because it represents the actual conceptualization framework of the classification and is independent of specificities of any alphabetically expressed language. In ILC, we can represent combinations of concepts relating to any scientific domain, through the possibility of expressing relationships between any pair of classes. Relationships are expressed by digits corresponding to ten fundamental categories (Gnoli 2016, 2017):

0 as for aspect
1 at time
2 in place
3 by agent
4 affected by disorder
5 with transformation
6 having property
7 with part

8 in quantity
9 of quality.

In ILC, to express subject such as “Caring adult patient suffering from cancer”, class *sh* “healthcare” provides facets *sh96* “for patient” and *sh94* “healing condition”. Their combination results in *sh96p94nr* “healthcare, for adult, healing cancer”.

The ILC scheme has been tested by applying it to the organization of collections of knowledge items including bibliographic databases dedicated to folk culture and bioacoustics (Figure 1), as well as the Basic Register of Thesauri, Ontologies and Classifications (BARTOC).

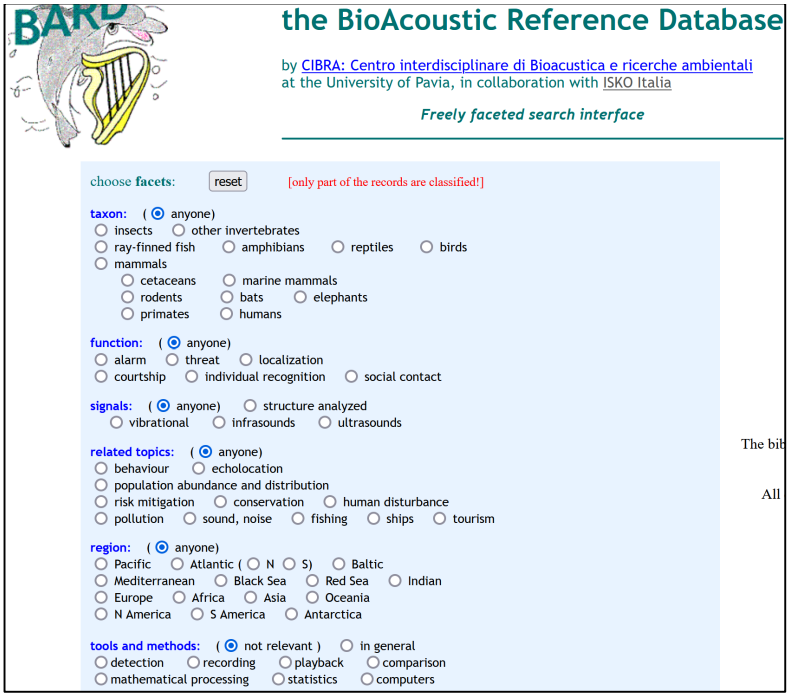

FIG. 1 – Example of use of ILC in a bibliographic database on bioacoustics

As we may observe, ALLERGIDOC and ILC present two different approaches to knowledge organization, respectively epistemological and ontological. In our work, in order to take the best of both approaches, we assessed whether it is possible to integrate everyday terminology and conceptualization of allergology professionals in a general KOS such as ILC. That brought us to address a broader question, i.e. whether epistemological and ontological approaches to knowledge organization can be reconciled in the design of medical KOSs.

3. Theoretical framework and methodology

To collect and organize allergology terminology, we developed a mixed approach. In the first place, we mobilized an epistemological approach, by adopting a socioconstructivist perspective. Such perspective consisted in the analysis of cognitive processes that take place through mutual interactions between allergology professionals and their informational and socio-organizational environments (Clavier and Paganelli 2015; Weiss et al. 2018). The allergology domain was considered as "a group of people [social actors] who share common goals" (Mai 2005, 605). Thus, our concern was shifted from the "correct" representation and organization of the allergological reality to the "useful" representation of the problems encountered by these actors (Tennis 2012), the usefulness depending on the context of the action and interaction with the KOS. Thus, we used a bottom-up approach, oriented by information and work practices of professionals.

In the second place, we mobilized an ontological approach, by adopting a more rationalist perspective. That led us to classify allergology terminology through faculty of human reason, by using logical divisions and top-down categories of knowledge that are considered to be of general use (Gnoli 2020).

Therefore, we relied our study on one hand, on the analysis of context of use of specialized knowledge (Clavier and Paganelli 2015), by the study of the information practices (Chaudiron and Ihadjadene 2010) of allergology professionals who seek, produce, and mobilize knowledge in the domain; and on the other hand, on the facet analysis (Vickery 1966; Ranganathan 1967) of terms used by these professionals in their daily activities. Although some researchers consider facet analysis as an only rationalist technique (Hjørland 2014), some specialists claim that such analysis is also connected to empirical and pragmatic aims, as it is used to organize and represent terminology that expresses the practices of health professionals (Dousa and Ibekwe-Sanjuan 2014; Trzmielewski and Gnoli 2022). Indeed, the Classification Research Group adopted facet analysis for designing special KOSs "for particular groups of users and adapted to their needs" (Vickery 1966, 10).

We started with a study of information practices, carried out by Trzmielewski in 2020-2021 in the Allergy Unit of the University Hospital of Montpellier. He elaborated 16 participants' observations of 8 journal club meetings, devoted to the presentation and critical analysis of scientific articles and conference presentations, and 8 clinical meetings focused on the presentation and analysis of patient records. He also conducted 20 interviews with professionals investigating their information and work practices.

Then, Trzmielewski manually extracted terms from the corpus of data on practices, based on the reports of the observations (in total: 19,470 words) and on the transcripts of the interviews (121,203 words). Instead of extracting terms according to their frequency in the corpus, he assessed their relevance to the domain based on his

knowledge in allergology, acquired during a year spent in the Allergy Unit. To organize collected terms, he performed a content analysis (Hudon 2009), which allowed to classify allergology terminology into thematic and user-oriented facets (Albrechstsen 1992). The content of the reports and transcripts was useful to this task because it provided contextual information that led us to know if some terms should be classified in one category or another. For example, a phrase coming from an interview: "*Il y a le côté clinique, donc toute l'histoire clinique des patients, et il y a tout le côté des tests d'investigation, donc des tests cutanés, des tests de provocation*", enumerating two types of allergy tests, allowed to establish a category assembling "Diagnostic method[s]" including "Tests cutanés" ("Skin tests") and "Tests de provocation" ("Challenge tests"). These facets were further validated by allergy professionals, by checking whether they are useful for document indexing and characterization of allergic cases. Therefore, these facets expressed general categories of thought of professionals from the Allergy Unit.

Finally, we represented and organized the collected terminology through a facet analysis (Gnoli 2017), which led us to integrate the terms into existing facets of ILC3. Terms reorganized in such a way were input in ILC3 MySQL database.

4. Results

In total we collected 497[4] terms from everyday use by allergology professionals. Terms were converted to singular form, except for those terms who only make sense in plural, such as "Acariens" ("Dust mites"). Terms also were alphabetically ordered and replaced by masculine genres.

Allergology terminology is highly specialized and conveys scientific and clinical knowledge (see Table 1). We identified numerous equivalent variations, at morphological level: abbreviations ("ITO" = "Introduction de tolérance orale") and shortened forms ("Allergo" = "Allergologie"). Variations at lexical level ("Intervention curative" = "Traitement", "Prick test" = "Test cutané", "Test de souffle" = "Spirométrie") were found as well. Such synonyms were not represented in ILC3, because the classification is only available in English. However, ILC3 does allow to express equivalent terms: in the ILC3 database, *mq4ipl* "allergy" has its synonymic form "allergic disease" (see Figure 2).

As a consequence of ILC international target, we had to work in English. Allergology terms and facets were translated with the use of medical and general dictionaries available online.

4 209 terms came from the reports of the observations, 244 from the transcripts of the interviews, and 44 from reports of the facet validations.

Allergène
Acariens
AINS
Aliment
Allergène alimentaire
Amoxicilline
Ana o3
Anisakis
Antibiotique
Anti-inflammatoire
Arachide
Aspirine
Augmentin
Bétadine
Bêtalactamine
Bevacizumab
Blattes
Blé
Bouleau
Bradykinine
Cacahuète
Ceftriaxone
Céfuroxime
Céleri
Céphalosporines deuxième génération
Chat
Chien
Chimiothérapeutiques
Chimiothérapie
Couscous
Crustacé
Cuit
Cyprès
En extrait
EXACYL
Farine de blé
Fruit à coque
Gluten
Hostie
Hyménoptères
Lait
Lait de brebis
Lait de chèvre
Lait de vache

TAB. 1 – A fragment of terminological database generated in ALLERGIDOC project

FIG. 2 – A fragment of an entry representing synonyms in ILC3 database

The thematic analysis of terminological data initially brought up 17 facets. The validation of these facets led to the identification of several facets of phenomena used by allergology professionals to search for information: “Allergen”, “Comorbidity”, “Diagnostic method”, “Disease”, “Healthcare circuit”, “Mechanism”, “Person”, “Prevention”, “Quality of life”, “Risk factor”, “Symptom”, “Treatment”. These ALLERGIDOC facets have then been translated into special facets of ILC3 class *sh* “healthcare”:

sh “healthcare”
- *sh5* “*healing stage*”
- *sh7* “by *drug*”
- *sh94* “healing *condition*”
  - *sh942* “with *concurrent condition*”
  - *sh943* “caused by *organic pathogen*”
  - *sh946* “showing *symptom*”
  - *sh947* “complicated by *complication*”
- *sh96* “for *patient*”
- *sh97* “of *treated part*”
- *sh98* “*severity*”

In ILC3, special facets can only be applied to a specific class, for example those for diseases including “allergy” can be applied only to *m* organisms, as technical phenomena such as automobiles and markets are not affected by diseases. In consequence, allergology terms are mainly part of two classes of ILC3: *m* “organisms” (that includes ***mq*** “animals”), where ***mq****4ipl* “allergy” is considered as a natural phenomenon; and ***sh*** “healthcare”, a subclass of *s* “services”, where ***sh****94ipl* “allergy” is a part of the medical domain. This differentiates special facets from common facets of ILC3, such as *-27d* “in France”, that can be attached to any class. Therefore, the special facets of *sh* “healthcare” allow to express the medical context. As the Table 2 shows, the “Healthcare circuit” facet was translated into the class *sh* “healthcare”, encompassing the entire health care domain. On the other hand, facets such as “Diagnostic method”, “Prevention” and “Treatment” (which are generic facets in ALLERGIDOC project) became special facets classified under *sh5* “healing stage” in ILC3.

ALLERGIDOC facets	Special facets of ILC3
“Allergen”	*sh494* “caused by *organic pathogen*”
“Comorbidity”	*sh942* “with *concurrent condition*”
“Diagnostic method”	*sh5* “healing *stage*”
“Disease”	*sh94* “healing *condition*”

"Healthcare circuit"	*sh* "healthcare"
"Person"	*sh96* "for *patient*"
"Prevention"	*sh5* "healing *stage*"
"Quality of life"	*sh94b* "wellness; well-being; quality of life"
"Risk factor"	*sh942* "with *concurrent condition*"
"Symptom"	*sh946* "showing *symptom*"
"Treatment"	*sh5* "healing *stage*"

TAB. 2 – Representing ALLERGIDOC user-oriented facets (on the left) through universal facets of ILC3 (on the right)

Some terms representing allergology knowledge are specifically context dependent, that causes semantic variability of terminology. As suggested by professionals, terms such as "Asthma" or "Eczema" are considered at the same time as a "Disease", a "Risk factor" and a "Symptom". Instead of representing these terms by poly-hierarchies, we decided to express them with parallel facets of ILC3 (see http://www.isko.org/ilc/how.pdf), taken from *sh* "healthcare" facets. By doing so, "Asthma" considered as a healed disease was represented as *sh**94**lhs* "healthcare, of asthma", "Asthma" as a risk factor by *sh**942**lhs* "healthcare, with concurrent condition : asthma", and "Asthma" as a symptom through *sh**946**mq(4lsh)* "healthcare, showing symptom : asthma".

Furthermore, in allergology, food or drugs are considered as types of "Allergen" and not for example as products fabricated by specific firms. We represented them through free facets of ILC3, allowing to combine every pair of concepts. "Food allergen", for example, was expressed as *sh94ipl**9430**sb* "caused by food", that is a combination of two classes: *sh94ipl* "allergy" and *sb* "food", linked by facet ***9430*** "caused by *pathogen*".

5. Conclusion

Our results show that integration of everyday terminology and conceptual categories of health professionals can be represented and organized in a general faceted classification through special and common facets of ILC3, using bound, parallel or free syntax according to the needed meaning. The classification can manage linguistic variations in English as well. That brings us to conclude that a reconciliation between epistemological and ontological approaches to knowledge organization can be

reached by combination of the contextual data, as collected through the analysis of information practices, with the versatility of freely faceted systems like ILC3.

Therefore, ILC3 can be considered as a boundary object (Star 1989) that merges terminological and conceptual approaches to knowledge organization, similarly to onto-terminological systems studied and designed by the TOTh community (Roche 2007, Carsenty 2021, Sanfilippo 2021). We suggest that such combination of approaches should be taken in consideration in the design of medical KOSs, to represent the terminology and conceptualizations used by healthcare professionals, which is necessary to support information processing and searching by final users. The 11th version of the International Classification of Diseases, for example, already integrated terminological functionalities to fulfill healthcare professionals coding needs (Zeng and Yi 2022).

The integration of allergy knowledge in ILC3 will soon be completed by further terms coming from different kinds of textual documents used by allergy professionals: titles and abstracts of scientific articles, messages from a general-public health forum, and clinical documents redacted in the Allergy Unit. As such documents are produced by different actors – researchers and allergists, patients and the wider public, professionals from the Allergy Unit – it will be interesting to see how terminological and conceptual varieties resulting from such complexity may be represented and organized in a general faceted classification.

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Résumé

La représentation de la terminologie et de la conceptualisation des professionnels de santé est nécessaire pour accompagner les traitements et les recherches d'informations effectués par les usagers finaux. Dans cet article, nous évaluons la possibilité de représenter et d'organiser la terminologie et la conceptualisation utilisées quotidiennement par les professionnels d'allergologie dans une classification générale à facettes. Nous montrons que l'expression d'une telle terminologie et d'une telle conceptualisation est possible dans la troisième version de l'Integrative Levels Classification, notamment *via* ses facettes spéciales et communes. Par conséquent, nous constatons qu'il est possible de réconcilier des approches épistémologiques et ontologiques de l'organisation des connaissances, et nous suggérons qu'une telle combinaison devrait être prise en considération lors de la conception de systèmes d'organisation des connaissances en médecine.