
The Domain Analysis Clinic: a singular advance in domain analysis for knowledge organization

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Abstract

Domain analysis is a primary approach to the representation of shared ontological bases in knowledge organization. The growth of domain analysis as a paradigm is demonstrated over a period of two decades. The Domain Analysis Clinic, or DAC is a core methodology generated for focused concept discovery combining meta-analytical theoretical research with the formation of domain-specific knowledge organization systems. The emergence of the DAC as a tool for meta-analysis and discourse analysis has demonstrated the efficacy of focused concept formation for taxonomic representation as well as for theoretical discovery in KO. The evidence presented here strongly directly suggests the continued honing and maturity of domain analysis as a paradigm in KO.

Keywords: Domain Analysis, Knowledge Organization, Domain Analysis Clinic (DAC), Taxonomic Representation

1 Domain analysis as a paradigm in knowledge organization

Domain analysis—the set of tools employed to articulate the shared ontological base of a domain—has become the primary empirical approach to the science of knowledge organization. As such, it is a critical precursor to the applied branch of knowledge organization (KO) (Smiraglia 2015b). That is, domain analysis (DA) is required to grasp the content of a domain in a way that can be used to create efficacious knowledge organization systems (KOSs). The term “domain analysis” arises from a trend toward post-modernism in knowledge organization (KO) heralded by Mai (1999; 2008; 2011) and echoed by Tennis (2003) and Smiraglia (2013). Mai's opening parry in 1999 included a review of "modernists" in KO (548):

Traditional theories of classification (Dewey, Bliss, Ranganathan, Richardson, Sayers, etc.) have at their heart the idea of a universe of knowledge. The idea is that all knowledge is interwoven into a great web. That there is some pre-established links [sic] between all knowledge, and that the tasks of classification systems are to represent this web of knowledge. This could be named the modern theory of classification.

and (551):

The moderns base their view of the world in the idea that there exist [sic] a world of ideas outside the human, and that the task of science and classification is to represent this world of ideas or universe of knowledge.

He continues in this ground-breaking paper to demonstrate the postmodern view that (554) "a knowledge organization, therefore, is a social construction. It is not a reflection or mirror of an already there structure;" and that "the view of knowledge organization should change from a [sic] (intended) reflection of the universe of knowledge to a pragmatic tool in the mediation between author and user. In subsequent papers Mai develops this theme by defining "actors, domains and constraints" (2008), the identification of which becomes the primary goal of domain analysis, and challenges the science of KO to (2011, 727) "move beyond modernity and found [KO] on a contemporary late-modern understanding of meaning, objects, and interpretation." Meanwhile, active researchers in KO defined specific empirical approaches such as Tennis' (2003) two axes of domains (192) "two analytical devices [called] *axes* ... [that] might be used by a domain analyst in operationalizing his or her definition of a domain"; these two axes are intension (inward depth) and extension (external breadth) that define the living boundaries of a domain for analysis. Smiraglia (2013) offers a timely meta-analysis of domain analytical studies, demonstrating the epistemological characteristics of the interior forces underlying the performance of Tennis' axes and the identification of Mai's actors, domains and constraints.

Thus, over the first decade and a half of the twenty-first century post-modern thought moved the science of KO away from the search for a single unified system (i.e., a "universal" classification) and toward a future that might be populated by domain-specific KOSs co-existing in an environment of interoperability. Gnoii and Szostak (2014) mused that what they then termed "universal" KOSs (which we now would call "general" KOSs) would be critical for interoperability. They generated a set of hypotheses for empirical research suggesting a divergence between phenomenon-based and what they call "domain-specific" KOSs. However, we now know

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that the dichotomy they address is really between phenomenon-based and discipline-based KOSs (Smiraglia and Szostak 2018; 2022). Phenomenon-based domain specific KOSs are, of course, completely feasible (Szostak and Smiraglia 2019; Smiraglia and Szostak 2021; 2022).

The idea of domain analysis as a suite of methods for application in the science of information was promulgated by Hjørland and Albrechtsen (1995) and further cemented in by Hjørland in 2002. Acceptance of the set of methodologies in information, most of them empirical, has varied over time; much informetric analysis in information takes the form of studies of communication among scientists and does not explicitly declare sidedness as DA, although the methods applied could be said to be domain analytical. It is in the science of KO that domain analysis has blossomed from its introduction by Hjørland and Albrechtsen (1999) and clearly bracketed by two special issues of the journal *Knowledge Organization* in 2003 (v. 30, nos. 3-4) and 2015 (v. 42, no. 8) devoted to domain analytical research (Smiraglia and López-Huertas 2015) and a double issue (v. 47, no. 7 2020-v. 48, no. 1 2021) devoted to domain ontologies. The special appeal of DA in KO is aligned with repeated calls by the founder of KO Ingetraut Dahlberg (cf. 2006; 2011) for the systematic implementation of empirical means for concretizing conceptual entities.

In the ensuing decades DA has emerged as a paradigm in KO. Analyses of progress in DA in KO appeared in Smiraglia (2012; 2015a; 2015b). Critical elements of DA as an empirical paradigm emerge from Tennis' two axes and Smiraglia's definition of paradigm. According to Tennis (2008, 194) critical considerations about any domain align along two axes:

Areas of Modulation and Degrees of Specialization. Areas of Modulation set the extension of the domain and Degrees of Specialization set the intension. Each of these axes has two parameters. Areas of Modulation must state 1) the totality of what is covered in the domain analysis – the extension and 2) what it is called – its name. The Degrees of Specialization must 1) qualify the domain – state its focus and 2) state where the domain is positioned against other domains – its intersection.

Smiraglia's 2012 meta-analysis yielded an operational definition (2012, 114):

A domain is best understood as a unit of analysis for the construction of a KOS. That is, a domain is a group with an ontological base that reveals an underlying teleology, a set of common hypotheses, epistemological consensus on methodological approaches and social semantics.

The definition was further honed when the parameters of the operational definition were effectively applied to the accumulated scholarship of individual scholars, specifically information scientist S.R. Ranganathan (Smiraglia 2013) and theologian Deirdre Good (Smiraglia and Beak 2015). Another hallmark was the implementation of DA for the generation of KOSs related to natural disasters (Wu 2016).

The eleven approaches originally proposed by Hjørland in 2002 were revised by Smiraglia in 2015a based on meta-analysis of all DA published in KO. That analysis indicated a growing interest in discourse analysis as a complement to common informetric methods. The most recent comprehensive treatment of DA is Hjørland (2017).

2 IKOS and the DAC

The Institute for Knowledge Organization and Structure, Inc. (<https://knoworg.org>) is a private, not-for-profit research foundation devoted to discovery, generation and dissemination of implementations in the order and structure of knowledge (IKOS 2020). A primary goal of IKOS is to use empirical means for knowledge evolution—that is, the work of the institute is to further empirical research by conducting and disseminating empirical research that leads to both advanced theory and implementation of new knowledge organization systems (KOSs). Smiraglia (2020) placed the 2017 founding of the IKOS in the context of the evolution of the science of knowledge organization as promulgated by its founder Ingetraut Dahlberg (cf. Dahlberg 1982; 2006; 2011). Specifically Dahlberg (2011, 89) called for the establishment of research institutes that would bring together synergistically interdisciplinary scholars for systematic concept exploration—the elaboration of concept schema (ontologies, taxonomies, etc.).

The unique method of the IKOS is the Domain Analysis Clinic, or DAC (2019, 1): “a focused, invitation only, research event during which experts ... gather ... to solve imminent, critical problems in the organization of knowledge.” The term “clinic” is derived from practices in clinical research in the health sciences, in which theoretical research is combined with meta-analysis in the context of clinical treatment. In other words, the DAC takes place in the context of meta-analytical theoretical research that can be immediately applied in the form of derived KOSs,

which in turn can yield new data in the manner of clinical trials. According to Smiraglia (2020, 72):

In the IKOS DAC we combine precise experimental methods such as those used for ontology extraction from a domain's corpus (Smiraglia 2015) with qualitative methods appropriate to the particular research question. In every instance, the DAC begins by compiling and comprehending the complete corpus of research directly relevant to the research questions. Thus our assembled experts know where fillable gaps exist in prior knowledge, as well as how to generate methodologies for knowledge discovery.

Four DACs are operating in the institute at present:

DAC1: Meta-Analysis of Knowledge Organization. DAC1 has generated the online "Formal Taxonomy of Knowledge Organization" <https://knoworg.org/a-formal-taxonomy-of-knowledge-organization-version-1-2/>

DAC2: The Phenomena of Music for Classification. DAC2 has stipulated new facets of musical phenomena to be incorporated in the Basic Concepts Classification and has generated a formal thesaurus of musical form and genre terms derived from the Library of Congress "LCGFT Music Terms" <https://knoworg.org/lcgft-music-terms/>

DAC3: Gay Male Nomenclatures. DAC3 seeks to frame the ontical problems of sociocultural phenomena of expression in gay male communities.

DAC4: Nursing Information Behavior. DAC4 has generated the online "CT-NIB Core Taxonomy of Nursing Information Behavior" <https://knoworg.org/a-core-taxonomy-of-nursing-information-behavior-ct-nib-version-1-1/> and mapped it to NANDA International Nursing Diagnoses vocabulary.

The clinic methodology follows a general framework derived from domain analysis. There are three steps:

- Meta-analysis
- Precise experimental methods for ontology extraction
- Qualitative approaches as dictated by knowledge gaps

Obviously, the critical preparatory elements are the constitution of the group, which must include experts in the domain of study as well as experts in the generation of ontology and the construction of taxonomy. This blend is a particular trademark of our institute. The second critical preparatory element is the construction of the corpus—an exhaustive repository of the research on the specific phenomenon. We first gather a bibliography from queries to the group, then we sort and delimit until we are certain the corpus is both precise (no noise) and exhaustive. Then we gather texts so the group may consult the specific texts and so the texts may be submitted to co-word analysis. At this point the group is ready to begin its work. Each clinic constitutes a special application of the tools of domain analysis. These are described in detail in the next section of this report.

3 Four DAC Cases

3.1 DAC1: Meta-Analysis of Knowledge Organization

The foundational clinic was carefully planned to help guide IKOS toward specific problems in the ontology of knowledge organization. The use of meta-analysis to plot the parameters of KO allowed the clinic a broad overview of the science of KO from the point of view of its founder Dahlberg as well as from that of IKOS' founder Richard Smiraglia. Researchers were invited to attend with this text (Smiraglia and Fox 2018):

The idea of the clinic is to bring together a group of invited researchers for two days to work together to identify and fill specific gaps in knowledge organization. For our first DAC we will, fittingly, look meta-analytically at the domain of knowledge organization itself.

Participants were invited to participate based on their research profiles. Joseph Tennis, whose writing concerning the epistemic foundations of KO is considered foundational, was invited to participate as keynote speaker. The other participants were Melodie J. Fox (Milwaukee School of Engineering), Elizabeth Milonas (New York City College of Technology CUNY), Christine Marchese (SUNY Nassau Community College), Joseph Henry (Westminster Choir College), and Sergey Zhrebchevsky (Long Island University). The group was led by Senior Fellow Smiraglia.

In the end Tennis was able to join only by distance technology; the others all gathered at the institute, then in Shorewood, Wisconsin.

A corpus of research was constructed and shared with participants. The corpus included all domain analytical studies of KO itself as well as a set designated as “core” writings, including: three texts designated as syntheses (Smiraglia 2013; 2015a; 2015b). Core vocabulary that was thought to contain elements of a taxonomy of the science of KO was made available in Dahlberg’s “Classification System for KO Literature” (1999) and in the unpublished index to Smiraglia’s 2014 *Elements of Knowledge Organization* (Smiraglia 2018). The rest of the selected readings include various domain analyses of ISKO publications or chapters, and core writings by Tennis. Participants were asked to inculcate the contents of the corpus and then to prepare specific data in advance of the clinic. Specific assignments were:

- Identify key concepts (potential meta-level classes) in Dahlberg’s classification crosswalked with those in the Smiraglia Index
- Identify “facets” apart from hierarchies in Dahlberg’s classification and Smiraglia’s Index
- Gather all concepts (themes, categories, etc.) from the corpus in table form
- Gather elements of discourse from Tennis, Smiraglia and Guimaraes (Guimaraes et al. 2012; Guimarães and Tennis 2012).

Participants were asked not to prepare presentations, but rather to bring data files (spreadsheets, tables, figures, etc.) that could be further analyzed by the group. From this a taxonomy of core ontological concepts in KO was constructed. Terms were regularized, definitions were linked from the online ISKO *Encyclopedia of Knowledge Organization* (<https://www.isko.org/cyclo/>) (*IEKO*) and other texts as appropriate. This formal taxonomy (known as FTKO) has been described in Smiraglia et al. (2020) and is maintained by the institute online at: <https://knoworg.org/a-formal-taxonomy-of-knowledge-organization-version-1-2/>. The final corpus bibliography is also maintained online at: <https://knoworg.org/meta-analysis-of-the-knowledge-organization-domain-corpus-bibliography/>. Further focused discussion generated a narrative of the discourse surrounding KO, which helped uncover a major gap concerning concepts related to human identities. In June 2022 Version 1.2 of the FTKO was published online, following

data analysis of the *IEKO* to discover core terminology added in the preceding two years. A description of the update is in Smiraglia et al. (2022).

3.2 DAC2: Phenomena of Music for Classification

The second clinic “Classifying the Phenomena of Music” was created to look meta-analytically at the classification of music, using non-traditional sources of musical data to identify specifically classifiable phenomena of music that could be used as a facet of the phenomenon-based Basic Concepts Classification (BCC <https://sites.google.com/a/ualberta.ca/rick-szostak/Basic-Concepts-Classification>). This work was aligned with the Digging Into the Knowledge Graph (<http://di4kg.org/> research project and was led by Rick Szostak (University of Alberta), and Smiraglia. Participants were Deborah Lee (City, University of London), Richard Griscom (University of Pennsylvania), J. Brad Young (IKOS) and Joshua Henry (Westminster Choir College).

The corpus of relevant literature mixed traditional classifications that include music with the small number of classifications of music. To move beyond the library classification of musical documents to the classification of music in the LOD cloud required a focus on the actual phenomena of music that might be classifiable.

The corpus contains some classic texts about music classification and some recent writings by music librarians. To this was added writing by Rick Szostak (e.g. Szostak 2012a and b) about the classification of phenomena and the BCC. The corpus included critical recent research by Lee, including her dissertation (Lee 2017) and a selection of published work (e.g., Lee and Robinson 2017). There also was a selection from the Music Information Retrieval (MIR) movement, including the 2003 review article by Downie, but also some recent work more focused on user needs in MIR.

Specific tasks were:

- Summarize the classical approaches by identifying facets in the “classical” texts from music librarianship

- Make a table of the “facets” of music classification, with particular regard to meta-analysis of the concepts of music facets in our corpus
- Make a table of the grammar of describing music phenomena
- Make a table of classes of music phenomena, again with regard to meta-analysis of our corpus, but excluding the MIR texts
- Summarized (another table perhaps) the phenomena of music user needs in the MIR writings
- Extract and summarize the music examples from the research on comparison of UDC and BCC
- Co-word analysis of the corpus

The DAC produced facets for medium of performance, form/genre/type, and format of music (Szostak and Lee 2020; Smiraglia and Szostak 2021). The fact for form/genre/type was based on work from the music library community and the Library of Congress. A major decision was that the concepts of form and genre could not be separated. Form and genre terms for music that were included in the online Library of Congress thesaurus of form and genre terms (LCGFT <https://www.loc.gov/aba/publications/FreeLCGFT/freelcgft.html>) were extracted and the list is maintained now on the IKOS website: <https://knoworg.org/lcgft-music-terms/> and was published in written form as well (Henry 2020). An additional facet based on concepts from the MIR research is being considered to include auditory concepts such as listener emotion, holistic user experience, or task complexity. A comparison of musical classification strings from the Universal Decimal Classification (UDC) to potential strings from the BCC was reported by Smiraglia and Szostak (2022).

3.3 DAC3: Homosexual Nomenclatures

The newest clinic is devoted to taxonomic comprehension of the private nomenclatures of male homosexuals. The clinic was composed in mid-2020 but the pandemic has seriously slowed the group’s work. The clinic is led by Daniel Martínez-Ávila (Universidad Complutense de Madrid)) and Smiraglia. Invited members are Fabio Pinho (Federal University of Pernambuco

UFPE), K.R. Roberto (University of Illinois at Urbana-Champaign) and Francisco Arrais Nascimento (Universidade Estadual Paulista Júlio Mesquita Filho - UNESP). The charge to the clinic was composed by Martínez-Ávila (Smiraglia and Martínez-Ávila 2020):

In a new scenario of social relationships that is anchored in the new economy of desire and performance, the sexual-affective interactions make use of technologies and applications to mediate relationships and represent identities. These technologies and applications also offer new characteristics and opportunities for a social organization of knowledge that determine the possibilities of locating and retrieving information. The knowledge organizers in this context are part of the same community that uses the system. This community, however, does not always perceive the technologies and the interactions of the rest of the users of the system as a safe space, thus using codes, metaphors, orthophemisms, and other figures of speech to represent themselves. While some of the means and features that this self-classificationist practice sometimes uses seem to be ineffective for standardization and information retrieval purposes, they might well follow other reasons that have been very helpful for the survival and strengthening of the community. Preliminary studies have suggested that self-naming and self-classification in the domain of male gayness and alternative sexualities emerge as a form of resistance against the hegemonic norm that was historically constructed upon prejudices, stereotypes and power relations. The aim of this project is to query the reasons, characteristics and consequences of this kind of knowledge organization using as an example the self-representation of gay males in social applications of interaction.

The bibliographic corpus was been constituted and refined in 2021. Preliminary meta-analysis revealed a focus in the corpus on library applications of LGBTQ terminology (Smiraglia 2022). The clinic has begun to examine self-identification nomenclature discovered in gay male social media environments, using appropriate ethnographic methods to gather data.

3.4 DAC4: Nursing Information Behavior in the Pandemic

The idea for the NIB (Nursing Information Behavior) clinic was formed early in the COVID-19 pandemic when it became clear that home care nurses were forced onto the frontlines of a very dangerous—some said warlike—environment. We were drawn to the work of Edmund

Pajarillo (2005; 2020), who set out the theory of NIB and identified the theoretical core—its “nub” of uncovering, discovery, and recovery. We wondered how this theoretical core might withstand the pandemic, and we also were hopeful that our work would contribute to easing the plight of the frontline nurses.

We constituted a team—Pajarillo as domain expert together with Milonas, Zhrebchevsky and Smiraglia. We first digitized Pajarillo’s 2005 dissertation and then submitted it to co-word analysis using the Provalis ProSuite. This yielded a set of core terms that could constitute a base taxonomy of NIB. This was first published on the IKOS website in early 2020. We then sought to make live links to nursing information sources, but were prevented by paywalls around the most important, which is NANDA-L, the international nursing information classification. Instead of live links, we linked outward from our taxonomy citing NANDA-L whenever possible. We also filled out our taxonomy using the glossary from Pajarillo (2005). This taxonomy was updated online in July 2020 (<https://knoworg.org/a-core-taxonomy-of-nursing-information-behavior-ct-nib-version-1-1/>).

We then considered how we might usefully consult active nurses. We decided that an ethical stance was to do nothing to disturb the lives of nurses but instead to seek evidence from public media. We searched news outlets and discovered a core of 42 video interviews regarding home care nursing during the pandemic. We gathered these videos, then generated transcripts, and loaded the transcripts into Provalis Pro Suite’s QDataMiner module. Members of the team independently (for methodological triangulation) conducted two rounds of open coding, finding core keywords and categorizing them. The two rounds of coding yielded comparable lists but with interesting differences, as is often the case in qualitative research. By comparing the two we arrived at a set of a dozen axes, which we then used for axial coding of the transcripts. From the axial coding we developed a narrative analysis, which demonstrates both the emergence of new terminology that becomes candidate for the taxonomy and evidence of usage to help us understand the evolution of the ontological aspects of the terms. New terminology representing both the facts of the pandemic (COVID-19, mitigation factors, etc.) and the emotional impact on home care nursing has been generated to supplement the nursing information behavior taxonomy. This work

is ongoing at present and includes attempts to incorporate nursing practitioners as they are available.

This work has been summarized in Milonas et al. 2020; Smiraglia et al. 2020.; Smiraglia et al. 2021.

4 Methodological advances

The work of the DACs has demonstrated first and foremost the power of Dahlberg's ideas about focused concept formation. In the case of the DACS on KO, phenomena of music and nursing information behavior in the pandemic we have seen the efficacy of meta-analysis performed by a highly-skilled group of domain scholars combined with highly-skilled scholars of KO and KOSs. Each group has swiftly produced functional KOSs accompanied by advanced theoretical perspectives. Each group has also pointed to otherwise unidentified gaps in thinking about domain ontologies and their representation. Each group has uncovered aspects of surrounding discourse that have theoretical implications both for the domain itself and for its representation in KOSs.

For example, the meta-analysis of KO DAC efficiently formulated a core taxonomy of KO terms, harvested sets of appropriate definitions of each term and linked the taxonomy to ongoing research represented in the *IEKO*. In this way the group demonstrated the efficacy of Dahlberg's call to focus on specific conceptual arenas. But through the analysis of surrounding discourse the DAC also was able to point to the total absence of core KO terminology concerning concepts of human identity, a major gap in the domain.

Likewise, the music phenomena DAC easily verified the need for standard elements of music: form/genre/type, format and medium of performance. The incorporation of elements from standard thesauri also was swiftly accomplished and these now are available to serve as facets of the phenomenon-based BCC. Discourse analysis in this case pointed toward the impossibility of separating concepts of form and genre together with the absence of terms in traditional classifications of music identifying type of music (e.g., funeral music, happy music, etc.) aside from general audience indicators for juvenile or liturgical uses. Discourse analysis also pointed to

the need for a facet representing musical phenomena such as emotional impact or what musicologists call “reception”—how the music is received by listeners. A shift in focus from the classification of musical documents for library circulation to the idea of classifying musical phenomena in the LOD Cloud revealed the absence of further auditory tenets such as duration or performance, tempi, timbre, etc. Again, these represent important gaps in prior approaches to the KO of musical phenomena.

The nursing information behavior in the pandemic DAC has been the most prolific to date. Similarly, the clinic swiftly generated a core taxonomy and just as swiftly linked it to the major existing domain vocabulary. The analysis of nursing practice in the domain via quasi-ethnographic methods has not only informed the evolution of the domain ontology for taxonomic representation, it has also yielded major discourse surrounding the emotional aspects of the COVID-19 pandemic.

The evidence presented here strongly directly suggests the continued honing and maturity of DA as a paradigm in KO. Perhaps more significantly, the critical importance of the use of discourse analysis alongside traditional empirical meta-analytical methods is clearly demonstrated for the continued theoretical growth of the science of KO.

Finally, it is clear that the shift of the KO domain to a post-modern approach to ontology discovery has opened the door to the major achievements of the clinical research application demonstrated by the DAC project. The generation of domain-specific ontologies and their transformation into application-oriented taxonomies shows the power of the complex mix of domains in the global environment of the twenty-first century.

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