Using Knowledge Maps to Create a Business School Faculty Portrait

Tatiana Gavrilova[1][a], Dmitry Kudryavtsev[2][b] and Olga Alkanova[1][c]
[1]*Graduate School of Management, St. Petersburg University, Saint-Petersburg, Russia*
[2]*Digital City Planner Oy, Helsinki, Finland*

Keywords: Knowledge Management, Knowledge Maps, Competency Maps, Business School Education, Higher Education.

Abstract: The primary university faculty activities are Teaching, Research, Applied practice (e.g. consulting), and Professional Service (including administrative activities). It often happens that the scope and specifics of faculty competencies and expertise are not well understood by colleagues within their university or outside. This paper presents a new approach for mapping faculty competencies in universities, focusing on three dimensions (3D): research, teaching, and applied practice. The approach was demonstrated at a business school, which is a part of a large university. The need for the knowledge map there was driven by the development of the new school strategy and the demand for more intense industry-university collaboration. The survey method was applied for data collection and involved 63 faculty members. The data about the faculty's expertise was structured using predefined subject areas and presented in the form of digital knowledge maps. These maps represent areas of expertise, including well-developed and underdeveloped areas, providing a comprehensive overview of faculty capabilities. The suggested approach gives universities an opportunity to create such knowledge maps for evidence-based talent and knowledge management.

1 INTRODUCTION

With the growing complexity of all processes and products in the rapidly changing environment, it is becoming crucial to manage knowledge assets with their locations and owners. This is essential both for individuals to be able to solve challenging problems and increase personal effectiveness and for organizations to gain a competitive advantage and mitigate risks caused by the concentration of knowledge among several experts. Universities are great knowledge hubs where faculty members communicate with students, do research in their narrow fields, and collaborate with companies that order consulting services. In all three cases, the faculty member's professional profile and expertise remain closed to an outside observer. Even within the department, it might not be known about each employee's activities. The same thing happens at the scale of institutes and universities.

The purpose of this paper is to discuss the methodology for constructing knowledge maps that create the possibility to visualize both professional personal portraits of the faculty members and a generalized knowledge portrait of a university unit using the case of a university business school.

The general idea behind the proposed method is to capture various areas of faculty activity through precise categorization and map it towards the knowledge fields. Based on international practice in higher education, we suggest the following three activity categories to be addressed: teaching, research, and applied practice. Whereas the first two are relatively clear, the third one implies all faculty member's activities that relate to the practical (industrial) application of their knowledge. This third area may include anything from consulting to part-time jobs in the private sector or elsewhere.

Knowledge mapping is a powerful method of information visualization that enables society or companies to connect experts, access knowledge in time, identify knowledge assets and flow, and identify

[a] https://orcid.org/0000-0003-1466-8100
[b] https://orcid.org/0000-0002-1798-5809
[c] https://orcid.org/0000-0002-2530-6765

Gavrilova, T., Kudryavtsev, D. and Alkanova, O.
Using Knowledge Maps to Create a Business School Faculty Portrait.
DOI: 10.5220/0012181000003598
In *Proceedings of the 15th International Joint Conference on Knowledge Discovery, Knowledge Engineering and Knowledge Management (IC3K 2023) - Volume 3: KMIS*, pages 185-193
ISBN: 978-989-758-671-2; ISSN: 2184-3228

existing knowledge resources and knowledge gaps (Faisal et al., 2019).

This paper suggests that a combination of quantitative and qualitative analysis methods can capture different aspects of expertise and create digital knowledge maps, that can provide rich navigation for understanding the multitude of faculty' intellectual potential. We also discuss the knowledge acquisition procedures and the forms of the questionnaires that were filled by the faculty members.

The resultant knowledge maps represent the range of well- and under-developed areas in visual form and the points of expertise concentration. The concluding portrait gives a better understanding of the faculty competencies, equips the academic community with a better search for collaborators or competitors, and helps students find research advisors and experts for consultation. Such knowledge maps help obtain a practical advantage of knowledge management and improve practices across organizational cultures and academic communities.

The logic of the paper is in line with the design science research and is the following: the current section 1 provides the motivation for creating a new approach, section 2 provides a literature review and highlights the existing research gap, the faculty knowledge mapping approach and corresponding method are described in section 3, while section 4 provides a demonstration of this approach and method.

2 LITERATURE REVIEW

The concept of knowledge maps seems to be non-unified and non-formalized due to the lack of widespread adoption of generally accepted concepts (Balaid et al., 2016; Hu. 2022). At the same time, knowledge maps are already deeply integrated into business life in knowledge-intensive companies with a long chain of information requests and inquiries (Eppler, 2004). In this case, knowledge maps are becoming a crucial tool that allows documenting every grain of knowledge inside the object of mapping, in our case, the organization, and helps any user of the map to find any necessary existing information.

The classic of visual approach to knowledge management Martin J. Eppler (2004) proposes the following classifications of knowledge maps:

1. Knowledge source maps (where the knowledge is),
2. Knowledge asset maps (what kind of knowledge we have),
3. Knowledge structure maps (how the knowledge is organized and interconnected),
4. Knowledge application maps (which knowledge is needed for performing activities, producing
required results, and achieving goals),
5. Knowledge development maps (how specific knowledge is developed).

The first two types are in the focus of the current paper.

Knowledge Mapping in an Academic Context

(Moradi et al, 2017) applied data-driven methods for creating knowledge maps for the university. They created two types of knowledge maps – Collaboration map and Expertness map – to support the decision-making of two deans – the Dean of Research and Dean of Education. They used data about staff research and educational activities for creating their maps, but they didn't reflect the applied practice activities of employees.

Anthony (2021) suggested a knowledge mapping-based system for university alumni collaboration, but this system mostly addresses alumni and does not provide enough details regarding the method for staff knowledge/competency assessment and presentation.

The works of (Dorn, 2007; Sánchez, Carracedo, et al., 2018) suggest student competency maps, which can be used for curriculum design.

Thus, it can be summarized that knowledge and competency mapping is actively used in an academic context, but there is a lack of holistic methods for mapping faculty competencies, which take into account not only expertise in research and teaching but also in applied practice. This combination is of particular interest and novelty.

3 THE 3D-FACULTY KNOWLEDGE MAPPING APPROACH

The presented approach suggests an assessment of the faculty's competencies along the three main dimensions (3D):

- Research (R),
- Teaching (T) and
- Consulting and applied practice (C).

So, the expertise of an employee in each area should be analysed using these dimensions. Also, competencies of organizational units and an organization in general are described using them.

This approach can be implemented using these steps:
1. Specify goals and requirements
2. Select experience indicators for each dimension of faculty's competencies
3. Define knowledge areas
4. Define data collection method(-s)
5. Collect and verify data
6. Analyse data
7. Create knowledge maps

Goals and requirements (step 1) help making decisions during the next steps (e.g. what experience indicator to select, what visualization to choose for representing knowledge maps).

Table 1: Possible faculty experience indicators (activities).

Dimension	**Examples of experience indicators (activities)**
(T) Teaching	• Type of involvement (e.g., program development, course development, lecturing, practical classes, assistantship) • Level of educational program (e.g., bachelor, master, executive, doctoral) • Level of contribution (from teaching by the general curriculum to developing unique programs and courses) • Type of courses (e.g., large cohort courses, small cohort courses, seminars, trainings, workshops) • Level of supervised works at different levels (e.g., course paper, graduation paper, group project)
(R) Research	• Type of publications (e.g., articles, textbooks, monographs) • Level of publications (e.g., by journal quartiles, by journal rankings) • Participation in research grants (e.g., level of funding, type of research project) • Role in the project (e.g., from head of project to junior researcher) • Type of research contribution/development (e.g., methodology, conceptual framework, applied framework, research method)
(C) Consulting and applied practice	• Type of involvement (e.g., external consultant, part-time expert, part-time employee, full-time employee) • Years of practical experience • Practical publications (e.g., case studies, handbooks, manuals, expert interviews, expert articles) • Expertise in consulting (e.g., by roles, by levels of responsibilities)

Within step 2 each of the three dimensions of faculty competencies should be further decomposed into experience indicators based on one or multiple criteria depending on the needs of the educational institution (see examples in Table 1).

A choice of experience indicators should be synchronized with the goals of mapping (e.g., with the current positioning to identify stronger or weaker areas or with a prospective vision to determine the directions for growth).

The three types of experience are then combined with knowledge areas. These areas can be described using any knowledge organization system (Step 3): list of terms, taxonomy, ontology etc. Usually, some sort of hierarchy will be required to deal with a multitude of subject areas.

As soon as knowledge areas are specified, the next step is to organize (step 4) and perform (step 5) data collection, either using the questionnaire that will be filled in by the faculty or via the integration of existing data. The resultant data should combine faculty knowledge areas with expertise indicators, which are represented through the performed activities and achievements.

The collected data should be analyzed (step 6). Data analysis is based on the assignment of scores for specific experience indicators (previous activities) and the aggregation of these scores. Data analysis provides final data for creating knowledge maps (visual representations).

Data visualization for presenting faculty knowledge (step 7) can be done in different formats (e.g. bar charts, radar charts, treemaps, sunburst diagrams, e.g.https://datavizcatalogue.com). Different diagrams should be created for different target audiences and tasks. The resultant diagrams can be either static or dynamic (interactive dashboards). Static representations can be produced using the diagramming functionality of spreadsheet software (e.g. MS Excel), while dynamic ones can be created using BI tools (e.g. MS Power BI, Tableau). Different data visualization tools can also be used, e.g. RAWGraphs. So, data visualization techniques and tools consider data about faculty expertise and knowledge as another type of data. Thus, these techniques and tools help to visualize knowledge maps.

4 METHOD APPLICATION: THE CASE OF THE UNIVERSITY BUSINESS SCHOOL

For the empirical test of the approach, we chose a relatively small business school owing a place in the Financial Times European Business School Rankings.

4.1 Defining the Goals

The need for the knowledge map was driven by the preparation for the new school strategy development and the demand for more intense industry-university collaboration. The following questions were addressed through the knowledge map:

1. What are the areas with the primary/least expertise?
2. What knowledge areas are strong or need to be strengthened from a teaching, research, and/or consulting (applied practice) perspective?
3. Can the school take or offer consulting, R&D, or educational projects on the specific topic? Whether the required competencies exist and are available?
4. Which faculty member can be involved in the consulting, R&D, or educational project on the specific topic?

These questions were taken as the starting point in the process of the data collection.

4.2 Selection of the Experience Indicators

Then, the experience indicators for each dimension were selected:

A. For Teaching:

- By level of contribution: course renewal, new course development, new training or business game development,
- By level of educational program: bachelor/master, doctoral, and executive.

B. For Research:

- By types of projects based on grants categorization: projects with external funding from research funds, projects with external funding from industry, projects with internal funding from the university,
- By the role in the project team: Principal Investigator (PI), Subject Matter Expert (SME), Executor (doer).
- By the types of deliverables created over the research career (e.g., theoretical models, analytical reports, research methodology, management methodology, etc.)

C. For Consulting (Name of Applied Practice in the Business School):

- experience in consulting in different roles (project architect, project leader, expert, consultant, communicator),
- experience in close-to-consulting teaching practices (case development, study consulting projects supervision, R&D experience).

4.3 Knowledge Areas Definition

To define and decompose the subject area, it was decided to refer to the All Science Journal Classification (ASJC) System, which is used in SCOPUS. Categories that are relevant to business schools were selected, then they were assembled and merged (in some cases) in order to form a one-level list of subject areas. It should be noted that in the list, both thematic areas (e.g., marketing and sales, entrepreneurship and innovation, finance and accounting, etc.) and the cross-subject area "methods of data analysis and decision making" were identified. The category "interdisciplinary and other areas" was also added to the list, designed to identify the unique knowledge of employees.

The next step was to decompose each subject area to provide the necessary details for expertise specification. In order to avoid subjectivity and bias we decided not to create a taxonomy, but rather to combine high-level areas (classes) with keywords, inspired mainly by (Kiu C., Tsui E., 2011). To form and refine the list of keywords, the titles of courses taught were analyzed, and, if necessary, in-depth interviews with representatives of expertise areas were conducted. The suggested sets of keywords were refined and adjusted, and keywords related to more than one area of knowledge were also identified.

4.4 Data Collection Method Design, Questionnaire Creation

Since objective data for many experience indicators was missing we decided to collect data about faculty expertise via a questionnaire. The logic of the questionnaire was the following: each faculty member first selects the areas in which she considers herself to possess some expert knowledge (in any of the three dimensions), and then for each of the chosen areas marked the keywords that best describe the individual competences and selected experience indicators for each of the three dimensions.

Table 2: Data structure for subject area X.

Employees	Keywords				Teaching experience				Research experience				Consulting experience				
					Experience in course renewal			..	Research projects with external funding from research funds			.	Industrial consulting project				.
	KW 1	KW 2	KW 3	…	Bachelor/ master	Doctoral	Executive	…	Principal Investigator (PI)	Subject Matter Expert (SME)	Executor (doer)	…	Project architect	Project manager	Subject Matter Expert (SME)	Executor (doer)	…
Employee 1					1	1				1	1					1	
Employee 2					1	1			1	1	1					1	
Employee 3							1						1	1	1	1	
…																	

4.5 Data Collection and Verification

When this self-assessment data is collected, it should be cleaned and verified through either expert cross-checks (e.g., through related departments) or secondary sources and databases (to confirm research and teaching activities).

The survey took place in 2019-2020 academic year. We received responses from 63 faculty members, which constitutes about 90% of all business school faculty. Table 2 represents the resulting data structure that was repeated for each subject area.

4.6 Data Analysis

In order to assess faculty expertise different values were assigned to various experience items:

Employee expertise = $\{AreaExp_{ij}\}$, where $AreaExp_{ij}$ is the expertise of employee i in subject area j.

$AreaExp_{ij} = \{KW_{ij}, Exp_{ij}\}$, where:

- KW_{ij} – a list of keywords, which represents employee i fields of expertise in subject area j,
- Exp_{ij} – experience level of employee i in subject area j

Expij = TeaExpij + ResExpij + ConExpij, where:

- $TeaExp_{ij}$ – teaching experience level of employee i in subject area j
- $ResExp_{ij}$ – research experience level of employee i in subject area j
- $ConExp_{ij}$ – consulting experience level of employee i in subject area j

In order to assess the business school expertise in a certain subject area the following formula was applied:

$SA_j = \sum Exp_{ij}$

The "dimensional" (T, R, C) expertise of the business school in a certain subject area j is the following:

- $TeaExp_j = \sum TeaExp_{ij}$
- $ResExp_j = \sum ResExp_{ij}$
- $ConExp_j = \sum ConExp_{ij}$

Experience level in each dimension is calculated in a similar manner as a sum of scores for different activity items, for example:

$ResExp_{ij} = \sum ResExpActivityScore_{ijx}$, where

i – employee, j – subject area,

x – specific research experience activity item

These items were usually a combination of 2 or more experience aspects, for the assessment of research experience the first experience aspect was "Types of research projects" and the second aspect was "Role in the project". As a result, example research experience activity items were:

- Principal Investigator (PI) in Research projects with external funding from research funds
- Executor in Research projects with internal funding (from the University)

Scores for each experience activity item were defined by the knowledge mapping team together with the business school transformation leaders; see the scores for faculty research experience assessment in Table 3.

Table 3: Scores for faculty research experience assessment.

Research experience aspect 1 (Types of research projects) \ Research experience aspect 2 (Role in the project)	Principal Investigator (PI)	Subject Matter Expert	Executor
Research projects with external funding from research funds	4	3	2
Research projects with external funding from business or public authorities	4	3	2
Research projects with internal funding (from the University)	3	2	1
Research projects without funding	1	1	1

There is a limitation of the approach that the amount and quality of work within any dimension are not represented in the evaluation scheme.

4.7 Creation of Knowledge Maps

Survey data analysis resulted in a set of knowledge maps, which helps to answer questions from section 4.1. Some knowledge maps were "static" and created using MS Excel, while others were dynamic/interactive and created using MS Power BI. Some examples of created knowledge maps are presented below.

Figure 1 demonstrates 3D knowledge map for the business school under investigation, it shows the total level of the business school expertise in different subject areas. It is based on the following data: {$TeaExp_j$, $ResExp_j$, $ConExp_j$ and SA_j}. This map helps to identify the most "powerful" subject areas and may support business school strategy development. It is also possible to look at and sort by the particular dimension for specific purposes, e.g. at the teaching dimension during teaching-related decision-making.The map shows that "Strategic management and business development" is the strongest knowledge area of the business school, while "Economics and Econometrics" – is the weakest. This chart can also be sorted based on the teaching, research and consulting dimensions. Such sorting by dimension helps to see that the primary consulting experience of the school is in "Strategic management and business development", while leading teaching expertise is in "Operations management and project management".

We did not analyze it in verbal form, but Figure 1 shows the entire structure and the relative shares of each activity (teaching/research/consulting) in the main competency areas. For example, it is seen that the school lacks consultants and researchers in econometrics

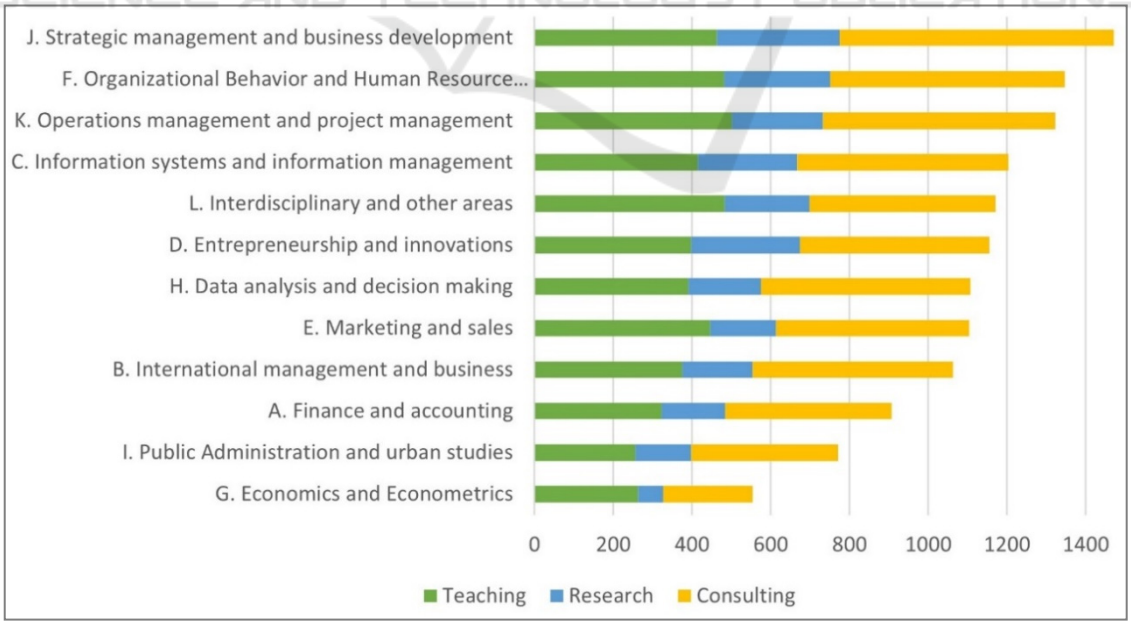

Figure 1: 3D knowledge map for the selected business school.

Figure 2: Number of faculty members with expertise in the specific field within "J. Strategic management and business development" subject area.

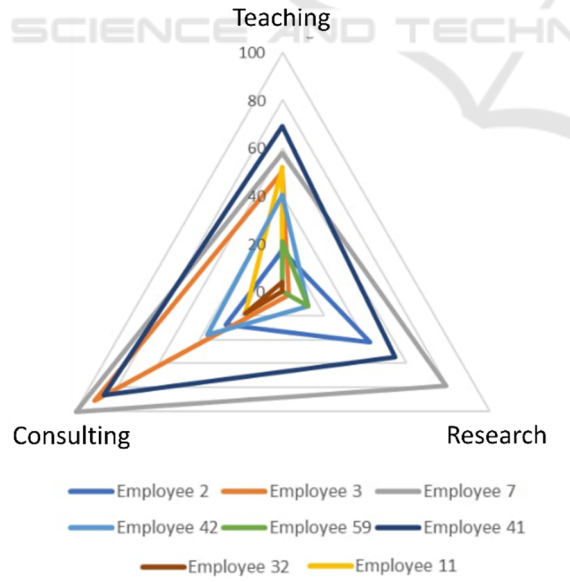

Figure 3: Multidimensional faculty profiles for the subject area "Strategic management and business development".

Figure 2 demonstrates the details of the business school's expertise in the specific subject area – "J. Strategic management and business development" was selected as the leader in total expertise level. It represents the number of employees, which selected keywords as their area of expertise. The more detailed specification of knowledge areas (fig. 2) helps answer question 3 from section 4.1 - Can the school take or offer consulting, R&D, or educational project on the specific topic? Whether the required competencies exist and are available?

Each faculty member may have different experience levels within each dimension, so 3D faculty profiles may easily show these differences – see Figure 3. Such diagrams help to understand the strengths and weaknesses of each employee.

Figure 3 shows that employees 7 and 41 are "stars" in "Strategic management and business development" from all perspectives. While Employee 3 is very important for doing consulting projects, Employee 2 – is for doing research and Employee 11 – if we think about new teaching initiatives in the area. This chart helps answering question 4 from section 4.1 – "Which faculty member can be involved in the consulting, R&D, or educational project on the specific topic?".

Only a part of knowledge maps was presented in the paper, while the data collected (see section 4.5) allowed generating other representations, which included treemaps, sunburst diagrams, bar charts, radar charts, and tables. MS Excel and MS Power BI were used to generate the required views.

5 CONCLUSION & DISCUSSION

In the ever-evolving landscape of higher education, it is imperative for institutions to have a clear understanding of their faculty's expertise to foster more robust industry-university collaborations and strategic planning. The presented research addresses this critical need, introducing an innovative approach for knowledge mapping within a business school environment. This approach, focusing on the three main dimensions: Research (R), Teaching (T), and Consulting and Applied Practice (C), seeks to holistically capture the multifaceted expertise of faculty members.

Our empirical examination of this approach was conducted in a renowned business school, providing valuable insights into its practical application. The resultant knowledge maps, which utilized diverse visual templates from bar to sunburst charts, illuminated both the strengths and areas of development within the faculty's expertise. Such comprehensive visualizations not only bolster the academic community's capacity to identify potential collaborators or competitors but also enhance students' ability to pinpoint suitable research advisors and consultation experts.

However, like all research, this study is not without its limitations. The primary method of data collection, a questionnaire, introduced a degree of subjectivity into the results. It's inherent in human nature to sometimes either overestimate or underestimate one's capabilities, which could have influenced the final knowledge maps. Moreover, the current methodology, while effective, requires a significant manual input, signaling the need for more automated processes.

In light of these findings and limitations, future research avenues become apparent. There's a pressing need to develop automated or at least semi-automated, data-driven methods for knowledge mapping. Such advancements would not only enhance the accuracy of the maps but also make the process more efficient, catering to larger institutions with vast faculty numbers.

In summation, this research has contributed a structured approach for visualizing the intellectual capital within academic institutions, particularly in a business school setting. As higher education institutions continue to evolve, tools and methodologies such as this will prove instrumental in facilitating informed decision-making in the realm of academic expertise and collaboration.

ACKNOWLEDGEMENTS

The work of Tatiana Gavrilova and Olga Alkanova was partially supported by grant of Russian Science Foundation (project N 23-21-00168).

REFERENCES

Anthony Jr, B. (2021). Information flow analysis of a knowledge mapping-based system for university alumni collaboration: a practical approach. *Journal of the Knowledge Economy*, *12*(2), 756-787.

Balaid, A., Abd Rozan, M.Z., Hikmi, S.N. and Memon, J. (2016) Knowledge Maps: A Systematic Literature Review and Directions for Future Research, International Journal of Information Management, Vol 36, No. 3, pp 451–475.

Dorn J., Pichlmair M. A (2007) Competence Management System for Universities // Proc. European Conf. on Information Systems (ECIS), St. Gallen, Switzerland. P. 759–770.

Eppler, M. J. (2004) Making Knowledge Visible Through Knowledge Maps: Concepts, Elements, Cases, in: Handbook on Knowledge Management (Vol 1), Berlin Heidelberg: Springer, pp 189–205.

Faisal, H., Rahman, A. and Zaman, G. (2019) Knowledge Mapping for Research Papers, International Journal of Computer Science and Network Security, Vol 19, No. 10, pp 158–164.

Hu, Z. (2022). Visual knowledge mapping analysis of research of digital image processing, In Thirteenth International Conference on Graphics and Image Processing (ICGIP 2021) (Vol. 12083, pp. 173-177). SPIE.

Kiu, C. C., & Tsui, E. (2011). TaxoFolk: A hybrid taxonomy–folksonomy structure for knowledge classification and navigation. Expert systems with applications, 38(5), 6049-6058.

Mazzocchi, F. (2018) Knowledge organization system (KOS). Knowledge Organization 45, no.1: 54-78. Also available in ISKO Encyclopedia of Knowledge Organization, eds. Birger Hjørland and Claudio Gnoli, accessed 1 September 2023 URL: http://www.isko.org/cyclo/kos

Moradi, R., Taheri, K., & Mirian, M. S. (2017). Data-driven methods to create knowledge maps for decision making in academic contexts. Journal of Information & Knowledge Management, 16(01), 1750008.

Sánchez Carracedo, F., Soler, A., Martín, C., López, D., Ageno, A., Cabré, J., Garcia, J., Aranda, J. and Gibert, K. (2018) Competency Maps: An Effective Model to Integrate Professional Competencies Across a STEM Curriculum, Journal of Science Education and Technology, Vol 27, No. 5, pp 448–468.