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Unveiling the Intellectual Capital of a University: Teachers' Knowledge Maps

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Abstract: *Background:* The importance of the university's intellectual capital is obvious. In this resource, there is a great treasure that includes the knowledge, skills, competences, and expertise of the faculty. They are the teachers. Teachers' knowledge map is a digital visual that shows where knowledge can be found within a college, university, or school. The subsequent development of knowledge maps simplifies the processes of knowledge sharing within the organization and the society. The paper discusses the novel methodology for the development of such digital maps, which forms a multidimensional interactive knowledge portrait of university teachers and researchers. The described study was a part of METACARTA project – "MEthodology and Technology for developing digitAl knowledge maps for eduCAtion and Research TeAms". The project was based on the ontologies of university teachers' knowledge. These ontologies reflect and unveil the structure both of the knowledge areas of competence and faculty activities. This text is an extended, enriched, and revised version of the article presented in the proceedings of "The Internet and Modern Society InterSys2024 (IMS)" conference. *Purpose:* The paper discusses the methods used for the development of digital maps, revealing a multidimensional knowledge portrait of teachers and researchers in the case of business school. Methodology for building enterprise and/or conceptual knowledge maps is proposed and may be re-used by other knowledge engineers and managers. *Methods:* The methodology is supported by the ontology-based approach and significantly expands the traditional knowledge engineering palette of methods. Ontologies as conceptual models of the subject areas are one of the most promising approaches to the development of knowledge bases and knowledge graphs. The teachers' knowledge ontologies form the conceptual background of knowledge maps. The classical hierarchy of knowledge bodies is used and refined. The study of existing templates is made, and examples of knowledge maps layouts are analyzed and used for the draft of primary visual atlas. Some domain ontologies use the refined and customized SCOPUS / ASJC classifications of subject areas. In-depth interviews with faculty members were carried for empirical validation of the developed ontologies. The primary data was collected by filling the online questionnaire. *Results:* The approach and the methodology of visual mapping of the university faculty knowledge is proposed and described. It is based on the ontologies of faculty activities triad: teaching, research and consulting. The described ontologies reflect the structure of the teachers and researchers' activities and disclose the levels of knowledge assets within the disciplines of business education. *Conclusion:* The suggested methodology gives universities an opportunity to create knowledge maps in order to unveil hidden knowledge as well as to integrate these maps into the university knowledge management systems.

Keywords: Knowledge engineering, Decision making, Visualization, Ontology development, Knowledge mapping

1 Introduction

Modern universities face problems and challenges of managing their intellectual capital. The canonical model of intellectual capital (IC) should be revisited and revised using the tool of knowledge mapmaking to better adapt to the changing needs and contexts of universities within the knowledge economy. Universities need to go beyond simplistic, linear (Newtonian) models of evaluating and reporting intellectual capital. This means adopting more dynamic and holistic approaches that recognize the complex, interdependent nature of intellectual capital components. Teachers' knowledge is only a part of IC, but often it consists of tacit or even hidden knowledge which is seen only by students during classes. Modern university information management systems partially help only in processing this knowledge [Teixeira *et al.*, 2014]. Knowledge and experience as a special values assets are integrated in many interactive systems and sub-systems for a very long period [Newell, 1982; dos Santos Silva *et al.*, 2023; Bender *et al.*, 2024]. Routine procedures of visualizing and unveiling such knowledge assets may play a crucial role in deploying of different information systems and especially in knowledge management systems. The art and ability to deal with visual information is one of the mind's most powerful capacities. Visual thinking, high-level manipulation of abstraction schema and maps, are important to information management and provide the basis for a rich and intuitively satisfying channel of better understanding in man-machine interaction with the use of computer graphics and image processing.

This paper is devoted to the discussion of the knowledge mapmaking. Knowledge maps make company knowledge be available remotely and interactively. Such maps reflect the professional experience, expertise and knowledge of university teachers.

The described study is a part of a research project METACARTA (2023-2024) – "MEthodology and Technology for developing digitAl knowledge mas for eduCAtion and Research TeAms". The project was focused on solving the current problem of extracting, structuring and formalizing the knowledge of members of research and education teams to improve the quality of scientific communications and, information exchange in a large classical university in big city. The emphasis of the project was put on the ontology engineering. Ontologies as conceptual models of a knowledge domain are one of the most perspective approaches to the development of knowledge bases and knowledge graphs. Ontologies help to present and structure professional knowledge as systemic hierarchical graphs. They work as conceptual skeletons of the knowledge domains and faculty activities.

In information systems, ontologies serve as a theoretical and methodological framework for systemic modeling complex subject areas. The importance of ontology engineering is rapidly gaining the new adopters. The methodology of this study is based on the interdisciplinary framework including traditional polls and questionnaires for data collection and ontology engineering for developing the conceptual models of domains and activities.

Faculty activities were split into three categories: teaching, research and consulting. Several methodologies that deal with knowledge maps structure and templates are discussed [Harper and Trees, 2018]. However, at the moment there is no avowed methodology to develop faculty knowledge maps integrating all the activities in teaching and research. Therefore, the paper focuses on the methods of developing such digital maps, forming a multidimensional knowledge portrait module that can be later integrated into knowledge management systems.

Knowledge map is a powerful information visualization technique that allows connecting experts, accessing knowledge over time, identifying knowledge assets, existing knowledge resources and knowledge gaps [Zaman *et al.*, 2019]. The main tools that are most widely used in knowledge mapping, require the participation of both experts and analysts. Knowledge maps are closely related to competency maps and employee competency management, which are denoted as skills and competencies in corporate decisions.

The basis for the study of knowledge maps was laid by such authoritative researchers in the field of knowledge management as Wexler, Leibovitz, and also Davenport and Prusak. However, neither at the initial stage, nor now there is no consensus on the boundaries of the application of this tool and the key tasks to be solved. If the first author noted the strategic importance of a knowledge map for the firm's competitive advantage [Wexler, 2001], second focused on the analysis of gaps in knowledge and their filling [Liebowitz *et al.*, 2000], the latter considered knowledge map as a navigator while looking for the right specialist [Davenport and Prusak, 1998].

Recently, many researchers have been focusing on the advantages of information compression and visualization [de Alvarenga, 2008; Kudryavtsev *et al.*, 2022]. At the same time, a weak relationship was discovered between the needs of universities and new technologies in the field of knowledge engineering and visual ontological engineering. This paper is devoted to the co-design of ontologies of university professors' knowledge in teaching and research with the subsequent development of knowledge maps. These maps are simplifying the processes of searching and processing knowledge. Also they facilitate more effective communication and co-operation in research and teaching. The described approach made all the project respondents to reflect upon their educational and research work and on their professional knowledge focus. All the faculty members had to map their knowledge assets on the developed common taxonomies describing the general big picture of one university subdivision knowledge. These taxonomies allow depicting the activities of teachers from the point of view of their knowledge and competencies.

2 A Novel Methodology of Ontology-based Knowledge Mapping

Methods of ontology engineering have been widely developed for almost 30 years and was dealt by several teams of developers, starting with the pioneering work of Gruber and Uschold [Gruber, 1993; Uschold *et al.*, 1998] to the present [Patel and Jain, 2018; Krieg-Brückner *et al.*, 2021]. An ontology is built as a network consisting of concepts and relations between them. The relations can be of various types, for example, "is", "has a property", etc. Concepts and relations (or links) are universal for a certain class of concepts in the knowledge domain. Simpler models, such as mind maps and concept maps, can be used as a tool for visualizing the ontologies.

The number of steps of existing ontology design methodologies varies from 3 to 11, depending on the degree of detailing of each development phase. While the methodologies have different number of such steps, they all use basic stages which include identification of the scope, domain of knowledge map and the develop team, of the knowledge resources or materials, of the knowledge in each knowledge item, building knowledge map, evaluation, use, and further knowledge map development. Within METACARTA project the novel methodology was proposed and implemented. It is based on the analysis and integrating the previous experience and generalising of numerous knowledge engineering approaches. The discussed approach distinguishes three phases: preparatory, main (consisting of 4 stages), and final. The preparatory phase is necessary to focus and determine the goals of mapping, its users and practical tasks. And the final stage is intended the adoption within the organization.

The main phase of the proposed methodology is called ONE-VID, and it consists of 4 stages [Gavrilova *et al.*, 2023a,b] (**Figure 1**).

ONE-VID methodology includes 4 stages that are described below in more details:

I - Set of Ontologies Design (ON) (Ontology); II - Knowledge elicitation for ontology population (E) (Elicitation); III - Visual knowledge mapping (VI) (Visualization); IV - Knowledge map justification and dissemination (D) (Dissemination)

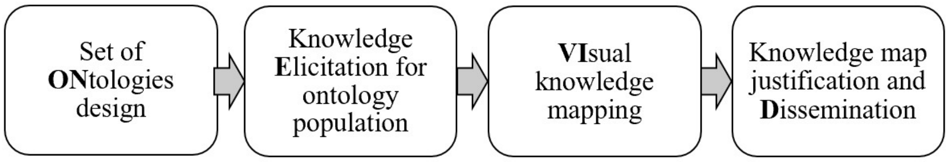

Figure 1. ONE-VID methodology.

Subject Area	Subject Area Classifications
Physical Sciences	Chemical Engineering
	Chemistry
	Computer Science
	Earth and Planetary Sciences
	Energy
	Engineering
	Environmental Science
	Material Science
	Mathematics
	Physics and Astronomy
	Multidisciplinary
Health Sciences	Medicine
	Nursing
	Veterinary
	Dentistry
	Health Professions
	Multidisciplinary
Social Sciences	Arts and Humanities
	Business, Management and Accounting
	Decision Sciences
	Economics, Econometrics and Finance
	Psychology
	Social Sciences
	Multidisciplinary
Life Sciences	Agricultural and Biological Sciences
	Biochemistry, Genetics and Molecular Biology
	Immunology and Microbiology
	Neuroscience
	Pharmacology, Toxicology and Pharmaceutics
	Multidisciplinary

Table 1. Ontology of the areas of competence ARCO: the case of the business education domain.

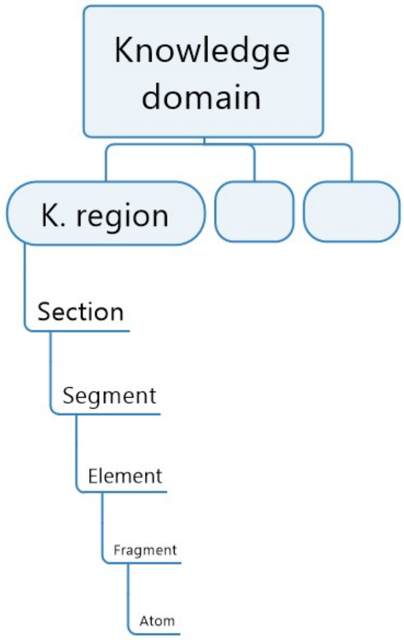

Figure 2. Knowledge levels acc. to [Wiig *et al.*, 1997].

3 Ontologies Design

The first stage of the methodology (ON) is focused on the development of a set of linked ontologies that create the conceptual framework of the future knowledge map. These ontologies fall into two categories: those describing the knowledge domain (in this project it is business education) and those describing various teacher's activities.

In order to develop the knowledge domain ontology, we analyzed the SCOPUS/ASJC classification (All Science Journal Classification) which includes 4 categories of sciences and 27 examples of sciences (see (**Table 1**).). Crosses on the figure are placed to mark the science domains that are included into business education.

One of the crucial points of any ontology design is determined by the chosen level of detailing. In literature the hierarchy of these levels was coined by Wiig [Wiig *et al.*, 1997] and is illustrated on (**Figure 2**).. In this pioneer article seven levels of knowledge assets are presented: knowledge domain, region, section, segment, element, fragment, and atom in **Figure 2**.

The knowledge domain ontology ARCO (AReas of COmpetence) (see Fig. 3) was designed by refinement and customization of the classification of the science areas SCOPUS/ASJC (Table 1). This ontology revitalizes and fills with blood the knowledge hierarchy by Wiig: **Figure 3**.

Later these segments will serve as the objects of knowledge maps and the basis for the visual landscape that describes the intellectual capital of the university.

The ARCO ontology presents the top-level ontology that is mapping the structure of the professional expertise by depicting the knowledge regions, sectors, segments, etc. The ARCO ontology can be re-shaped and re-engineered as it depends on the educational purposes, level and program. Now it includes more than 10 knowledge segments for the bachelor educational program of the university business school. Main knowledge regions include management, math, foreign languages, philosophy, etc. The regions may be divided into three sections: core, practical and instrumental. And further level – segmental – include all the main disciplines - operations management, economics and interdisciplinary domains. Practical knowledge regions are finance, HR, marketing, and entrepreneurship. Instrumental knowledge regions are IT and data analysis. Other categorizations are also pos-

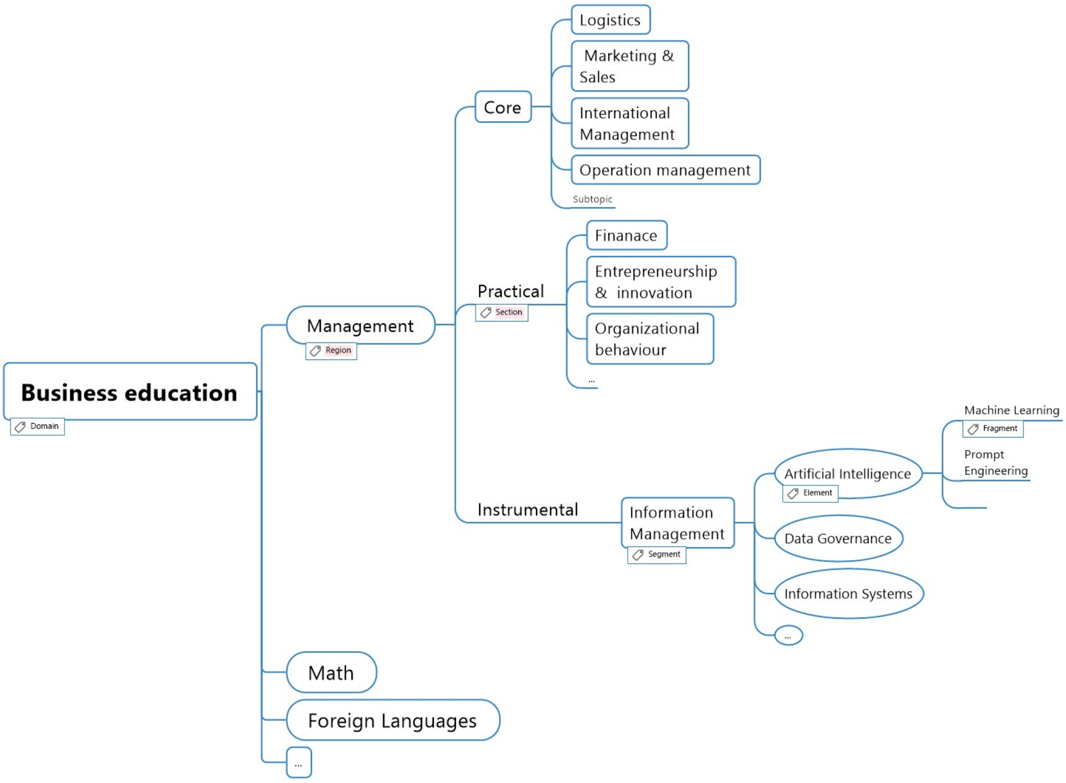

Figure 3. Ontology of the areas of competence ARCO: the case of the business education domain.

sible.

Further analysis of the results of knowledge of faculty teachers shows that knowledge domain in business education consists of various levels: smaller regions, segments and elements constituting the competency of the faculty teachers (see [Wiig *et al.*, 1997; Wiig, 2011, 2012]).

For practical purposes, as the research is based on the basic classification of subject areas SCOPUS/ASJC, in this paper we highlighted 4 description levels for knowledge assets in business education, IT in business education in particular (see **Figure 4**).

In the knowledge region of IT in business education there are various sections, for example, artificial intelligence, data governance, knowledge management. In each of these regions there are knowledge segments: for example, knowledge management systems; enterprise architecture; knowledge engineering, corporate information systems, knowledge management systems, business process management; digital commerce; digital marketing; e-government.

The university knowledge landscape depends not only on teaching, but also on other types of activity. This big picture of the university teacher's activities and studies is also helpful for the industry partners, especially in situations when they want to know whether the faculty want to be involved in cooperation and collaboration in R&D or consulting. Each faculty member's responsibilities include three or four types of work – teaching, research, practical consulting work, and administrative work. Figure 4 presents a simplified top-level ontology TRIO (TeacheR's actIvities and wOrks) describing faculty life (developed by Irina Leshcheva, described in

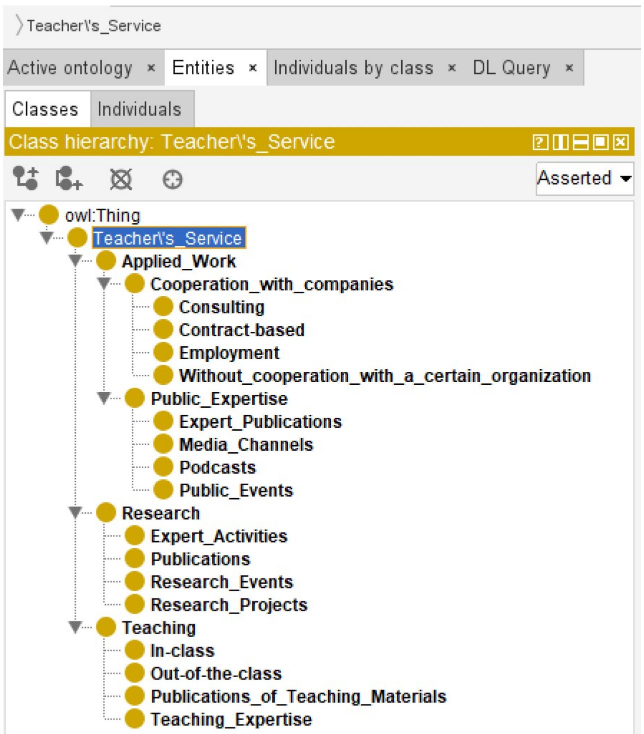

Figure 4. TRIO ontology of faculty activities.

[Gavrilova *et al.*, 2023b] . TRIO ontology was developed in PROTÉGÉ tool.

TRIO defines teaching, research and applied work, that combines administrative and consulting tasks. Teaching includes the following forms of activities: • delivering in-class lectures (courses); • performing out-of-the-class assessment and supervision; • preparing teaching materials and • dissemination of various types of teaching expertise / as well as levels of programs (bachelor/master, doctoral, executive and corporate), and types of involvement (course renewal, new course development, new training or business simulation development).

4 Knowledge elicitation for ontology population

The second stage of ONE-VID methodology was devoted to the data elicitation or acquisition and ontology population. For that purpose the special questionnaire was developed and disseminated among the faculty. 63 responses were collected and processed, that helps to gather and to analyze the specific data on the main competences of faculty members.

This stage allows to create instances of this ontology, filling it with specific knowledge and data. In our case, this is the knowledge and competence of university teachers. The data were collected by interviewing teachers of one business school that was chosen for this study in St. Petersburg.

The main steps of this stage were: questionnaire creation and data collection. 1. Step a. Questionnaire creation (was performed under conduction of Dr.Alkanova [Gavrilova *et al.*, 2023a]. First, the list of activities was identified for the three dimensions: a) Teaching expertise: levels of programs (bachelor/master, doctoral, and executive), types of involvement (course renewal, new course development, new training or business game development); b) Research expertise: types of projects (projects with external funding from research funds, projects with external funding from industry, projects with internal funding from the University), roles in the projects (Principal Investigator, Subject Matter Expert, Team member), types of project outcomes (e.g., theoretical models, analytical reports, research methodology, management methodology, etc.); c) Applied practice expertise: 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). Then fields of knowledge were specified base on SCOPUS ASJC System. The suggested sets of keywords were refined and adjusted, and keywords related to more than one area of knowledge were also identified.

Step b. Data collection and sample The logic of the questionnaire was as follows: each of the faculty members identified the areas of expertise, and then for each of the chosen areas marked the keywords that best describe the individual competences and level of experience per each of the three dimensions. Data collection was organized in self-assessment format online. Survey took several months and covered 63 faculty members. The resulting sample covered 90per cent of business school total full-time faculty list and all faculty members who were listed for potential active involvement in the school-industry interactions (there were several faculty members who were close to emeritus status at the time of data collection and were excluded from the targeted sample).

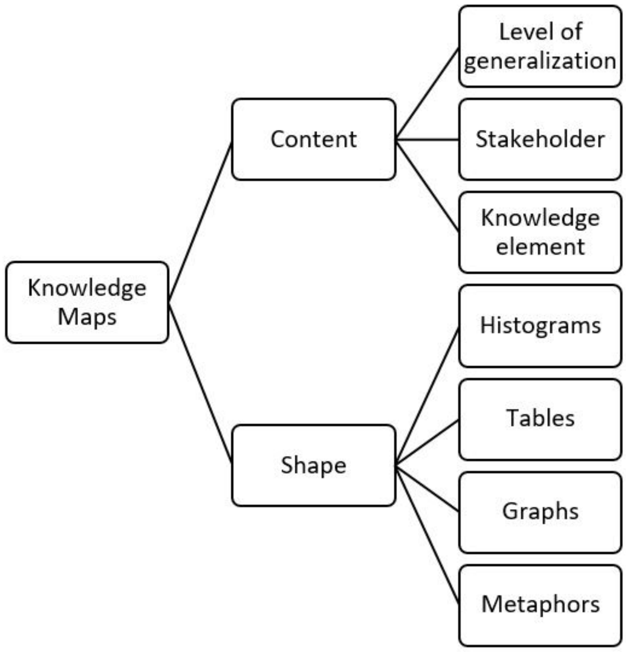

Figure 5. Knowledge maps main features framework.

5 Visual knowledge mapping

The third stage (Visualization) included knowledge maps development that visualize data and knowledge. These maps implement graphical representation of results of the statistical analysis of collected data. A big atlas (more than 40 patterns) of possible knowledge maps was gathered but only a short list of metaphors and visualization templates was chosen for future knowledge justification and dissemination (stage D).

Figure 5 illustrates the framework of the main features of knowledge maps for educational and research organizations depending on the content and shape of knowledge maps. Taking into account the content of knowledge map it is important to take into consideration the level of generalization, the personality and the functions of the stakeholder as well as the knowledge element. Choosing the shape for knowledge map development we can consider histograms, tables, graphs and metaphors.

This stage comprises using and selecting of metaphors and visualization templates. Over time, the amount of approaches to mapping and competing points of view only multiplied [Kudryavtsev *et al.*, 2022]. Technologies for working with employees' competencies are now actively developing, their review is given in the publications of the famous analyst Josh Bersin [Bersin, 2020] about the SkillTech market. According to the APQC study [APQC, 2021], more than 70 per cent of companies consider the knowledge map a priority tool for managing intellectual resources in an environment of instability and business transfor-mation. APQC has great experience in consulting in the field of knowledge management and knowledge maps.

At the moment, research in knowledge maps typology development covers a wide range of knowledge-intensive areas: from construction [Wang and Cheng, 2022] to artificial intelligence [Corea, 2019] and energy sector [Silva *et al.*, 2023]. Particular attention is paid to the knowledge maps of educational institutions and research teams [Hellström and Husted, 2004; Saurabh and Sairam, 2013; Sadeghi and Alireza, 2019; Ferreira and Paletta, 2023; Cardozo *et al.*, 2024], since in this area there is no business-specific desire to protect knowledge from transfer and reproduction. Recently there has been a trend towards convergence of research in the field of university knowledge maps and library sciences [Deng, 2019] and the integration of maps into the digital learning process [Flanagan *et al.*, 2019].

At the initial stage of METACARTA project a primary set of 5-7 diagrams types were selected to reflect the situation "as is". This preliminary set includes: - Table illustration; - Treemap representation; - Sun burst diagram; - Radar or spider diagram; - Word cloud view; - Heat diagram; - «River» drawing; etc. Two examples of knowledge maps are presented below. Figure 6 illustrates the primary word cloud based on the results of the survey.

Figure 6 includes broad areas of faculty expertise as well as the keywords that best describe their individual competences which give a big picture view of the faculty's academic interests.

The table in **Figure 7** presents an overview of the level of expertise of professors in the Department of Information Technologies in Management of the university-based business school. The collected data in the table present the names of professors (columns) and the corresponding fields of knowledge (rows). These knowledge segments included finance and accounting, international management, entrepreneurship and innovation, data analysis and decision-making methods, among others. These knowledge segments correspond to the level 4 of knowledge hierarchy presented in Fig. 3 and to the names of the disciplines of the educational programs of various levels. The level of expertise of each professor is determined by the sum of spheres of competence within multiple fields of knowledge, which are presented in the corresponding cells. Such tables can be used to identify areas of strengths and weaknesses among professors, and to allocate resources more effectively based on each professor's expertise. Further research could explore the relationship between the level of expertise of professors and the quality of their teaching and research outcomes. Finally, the table is a valuable tool for departmental decision-making and strategic planning related to the education and research activities in the field of Information Technologies in management and beyond. The resulting table provides an efficient and easy-to-read presentation of the level of expertise of each professor according to their self-assessment. However, it is important to note that this table can be adapted for use in other departments at the university by applying filters and modifying the data in accordance with the specific requirements of each department.

6 Knowledge Map Justification and Dissemination

The last stage of the proposed methodology contains the routine procedures of knowledge map justification and Dissemination (D). As some of teachers' knowledge maps contain personal and sensitive information the discussion and other action of showing the topicality and rightness were organized within departments. All the faculty showed great interest and activity in discussion on the reasonability and correctness of the study. The general feedback was positive. There was no free dissemination but dissemination upon request was available. Finally, as METACARTA was a pilot study, future knowledge mapping project is planned to be launched as the final stage of the proposed methodology is devoted on the adoption within the organization.

7 Conclusion

Major part of university intellectual capital is not properly articulated and described in order to create value for stakeholders and society. These challenges are crucial for universities in order to effectively manage and utilize their intellectual capital in the current knowledge-intensive environment. Universities as well as other educational organizations are very complex subject areas. It is a challenging experience to universities and other educational organizations to produce the knowledge intensive services desired by their customers.

Organizational learning allows university faculty members to continue in advancing of their professional growth and development individually and as a team. Academics are focused on the efficient use of collective intellectual assets. Their knowledge should be visible and accessible.

Knowledge map is a visual aid that shows where knowledge can be found within a group or organization and how to find those with the most expertise. It is an excellent solution to knowledge dissemination and management. The presented study is a part of a research project METACARTA "MEthodology and Technology for developing digitAl knowledge maps for eduCAtion and Research TeAms". The project was focused on solving the current problem of extracting, structuring and formalizing knowledge of members of research and educational teams to improve the quality of scientific communications and, information exchange.

The key novelty factors of the study are: a) its unique integration of ontological approach to knowledge modelling, b) its specific applicability to any university or its department, c) the obviousness and clarity of visual approach.

This paper discussed the practical novel methodology of university knowledge maps development based on ontologies. The described approach helps to create information landscape in the form of simple and clear maps which present a multidimensional knowledge portrait of academics and researchers. Visual big picture provides a supportive environment for the organizational team members. These individual portraits may be integrated into the collective portrait of the department or the school in general to retain and transfer knowledge in the process of organizational learning. Knowl-

Figure 6. Word cloud example.

Knowledge Segment	Employee 13	Employee 19	Employee 3	Employee 30	Employee 35	Employee 48	Employee 63	Employee 8	Total
B. International Management and International Business							3	4	7
C. Information Systems and Information Management	4	2	3	4	7	3	7	5	35
D. Entrepreneurship and Innovation			1					5	6
E. Marketing and Sales					1		2		3
F. Organizational Behavior and Human Resource Management								1	1
G. Economics, Ecosystems, Markets, and Institutions								4	4
H. Data Analysis and Decision Making Methods				1	3		2		6
I. Urban and Regional Management and Planning				2				1	3
J. Strategic Management and Organizational Development			5	3				4	12
K. Operations Management and Project Management					4	1			5
L. Interdisciplinary and Other Fields of Knowledge	5	1	6	3				4	19
Total	9	3	15	13	15	4	14	28	101

Figure 7. A table depicting one department's knowledge.

edge maps of an educational organization reveal its intellectual capital and help management in decision-making, external users in finding partners for research projects, and students and colleagues in general awareness and improving interactions and communications.

The proposed four-stage methodology for knowledge maps development is based on ontologies design. It is aimed at extracting, structuring and formalizing the knowledge of members of educational and research academic teams to improve the quality of scientific communications and information exchange in an organization. The discussed approach distinguishes three phases: preparatory, main (consisting of 4 stages), and final. The preparatory phase is necessary to focus and determine the goals of mapping, its users and practical tasks. The main phase of the ONE-VID methodology consists of 4 stages: (1) Set of ontologies design (ON): development of ontologies for subject regions and levels of knowledge assets in the knowledge domain, development of role ontologies of the activities of employees, for the presentation and analysis of their activities. (2) Knowledge elicitation for ontology population (E); (3) Visual knowledge mapping (VI): collection of primary and secondary data, their processing and visualization, creation of a questionnaire, data collection, processing. (4) Knowledge map justification and dissemination (D): mapping and visualization by key segments of knowledge (owner, location, level of expertise).

A preliminary set of knowledge maps was generated. It is based on the proposed methodology and collected data. Also the framework of the main features of knowledge maps was developed for the next phase of the study. This phase will be aimed at generating of visual digital atlas for educational and research organizations. Such atlases will be valued as both organisational intellectual capital and a source of competitive advantage as they provide a visual orientation for managers or experts who wish to locate, evaluate or develop knowledge in an organizational context. Also such atlas can be integrated into the university knowledge management systems. It could be used to establish the flow of the internal and external information in order to increase the efficiency of organizational learning and disclose the intellectual capital of the organization.

Declarations

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Authors' Contributions

All authors read and approved the final manuscript.

References

APQC (2021). Knowledge mapping concepts and tools. https://www.apqc.org/resource-library/resource-collection/knowledge-mapping-concepts-and-tools, Accessed: 09 October 2025.

Bender, A., Souza, E., Bender, I., Corrêa, U., and Araujo, R. (2024). Integrating domain knowledge in multi-source classification tasks. *Journal on Interactive Systems*, 15(1):591–614. DOI: https://doi.org/10.5753/jis.2024.4096.

Bersin, J. (2020). *HR Technology Market*. Global Human Resource.

Cardozo, M., de Jesus, G., de Sousa, M., Iatecola, A., Melgaço, M. F. L., de Carvalho, G., Silva, V., Buchaim, D., Moura Cardozo, A., Correia, R., Buchaim, R., and da Cunha, M. (2024). Mapping the learning styles of medical students in brazil. *BMC Med Educ.*, 24(1):47. DOI: https://doi.org/10.1186/s12909-024-05028-7.

Corea, F. (2019). Ai knowledge map: How to classify ai technologies. In *An introduction to data*, pages 25–29. Springer. DOI: https://doi.org/10.1007/978-3-030-04468-8_4.

Davenport, T. H. and Prusak, L. (1998). *Working knowledge: How organizations manage what they know*. Harvard Business Press.

de Alvarenga, R. C. D. (2008). Strategic knowledge management in brazilian organizations: A case of old wine in new bottles or a strategic shift? *Estratégia e Negócios, Florianópolis*, 1(1):66–83.

Deng, Y. (2019). *Construction of higher education knowledge map in university libraries based on MOOC*. The Electronic Library.

dos Santos Silva, D. E., Guerino, G. C., and Valentim, N. M. C. (2023). Analyzing the learners' experience of an experimental hci course in a remote context. *Journal on Interactive Systems*, 14(1):341–353. DOI: https://doi.org/10.5753/jis.2023.3243.

Ferreira, S. and Paletta, F. (2023). Mapping the knowledge management education and professional landscape in brazil. *Library Trends*, 72(2):216–233. DOI: https://dx.doi.org/10.1353/lib.2024.a941425.

Flanagan, B., Majumdar, R., Akçapınar, G., Wang, J., and Ogata, H. (2019). Knowledge map creation for modeling learning behaviors in digital learning environments. In *Companion Proceedings of the 9th International Conference on Learning Analytics and Knowledge (LAK'19)*, pages 428–436. Society for Learning Analytics Research (SoLAR).

Gavrilova, T., Alkanova, O., and Kuznetsova, A. (2023a). Ontology-based methodology for knowledge maps design. In *International Conference on Intelligent Information Technologies for Industry*, pages 250–259. Springer. DOI: https://doi.org/10.1007/978-3-031-43789-2_23.

Gavrilova, T., Kuznetsova, A., and Leshcheva, I. (2023b). On the issue of the development of ontologies of scientific and educational work (in russian). *Twenty-first National Conference on Artificial Intelligence with International Participation, CAI-2023. Proceedings of the Conference*, 1:60–67.

Gruber, T. (1993). A translation approach to portable ontology specification. *Knowledge acquisition*, 5(2):199–220.

Harper, M. and Trees, L. (2018). Knowledge mapping in action. apqc report.

Hellström, T. and Husted, K. (2004). Mapping knowledge and intellectual capital in academic environments: A focus group study. *Journal of Intellectual Capital*, 5(1):165–180. DOI: https://doi.org/10.1108/4691930410512987.

Krieg-Brückner, B., Mossakowski, T., and Codescu, M. (2021). Generic ontology design patterns: Roles and change over time. *Advances in Pattern-Based Ontology Engineering*, 51:25.

Kudryavtsev, D., Gavrilova, T., Grinberg, E., and Kubelskiy, M. (2022). Map of the maps: Conceptualization of the knowledge maps. *Joint Proceedings of the BIR 2022 Workshops and Doctoral Consortium co-located with 21st International Conference on Perspectives in Business Informatics Research (BIR 2022), (13-th Workshop on Information Logistics and Digital Transformation ILOG 2022)*, 3223:14–23.

Liebowitz, J., Rubenstein-Montano, B., McCaw, D., Buchwalter, J., Browning, C., Newman, B., and K., R. (2000). The knowledge audit. *Knowl. Process Mgmt.*, 7:3–10.

Newell, A. (1982). The knowledge level. *Artificial intelligence*, 18(1):87–127.

Patel, A. and Jain, S. (2018). Formalisms of representing knowledge. *Procedia Computer Science*, 125:542–549.

Sadeghi, M. M. and Alireza, S. (2019). Presenting a model for the development of a knowledge map of science and technology incuba-tors based on process maps (case study: university science and technology incubators). *Scientific Journal of Strategic Management of Organizational Knowledge*, 1(3):43–76.

Saurabh, S. and Sairam, A. S. (2013). Professors–the new youtube stars: education through web 2.0 and social network. *International Journal of Web Based Communities*, 9(2):212–232.

Silva, V., Pereira, A., and Relva, S. (2023). Knowledge mapping: A review of the energy transition applied to brazil. *Energy Transition in Brazil*. DOI: https://doi.org/10.1007/978-3-031-21033-4_2.

Teixeira, A. V., Laurindo, A. M., and Duarte, M. F. (2014). Knowledge management practices: a case study in the brazilian industry. *EDULEARN14 Proceedings*, pages 6895–6901.

Uschold, M., King, M., Moralee, S., and Zorgios, Y. (1998). The enterprise ontology. *The knowledge engineering review*, 13(1):31–89.

Wang, L. and Cheng, Y. (2022). Exploring a comprehensive knowledge map for promoting safety management research in the construc-tion industry. *Engineering, Construction and Architectural Management*, 29(4):1678–1714. DOI: https://doi.org/10.1108/ECAM-11-2020-0984.

Wexler, M. N. (2001). The who, what and why of knowledge mapping. *Journal of knowledge management*, 5(1):249–264.

Wiig, K. (2011). *The Importance of Personal Knowledge*

Management in the Knowledge Society. Routledge.

Wiig, K. (2012). Knowledge management: an emerging discipline rooted in a long history. In *Knowledge horizons*, pages 3–26. Routledge.

Wiig, K., de Hoog, R., and van der Spek, R. (1997). Supporting knowledge management: A selection of methods and techniques. *Expert Systems With Applications*, 13(1):15–27.

Zaman, G., Alghamdi, A., and Alowain, N. A. (2019). Knowledge mapping for research papers. *IJCSNS*, 19(10):158.