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Procedia Computer Science 192 (2021) 4845–4852

Procedia Computer Science

www.elsevier.com/locate/procedia

25th International Conference on Knowledge-Based and Intelligent Information & Engineering Systems

How to visualize the competence: the Issue of Occupational Information Network Visualization

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Abstract

The competencies standards for the occupational information are expressed by classification of identifies and categorizes skills, competencies, qualifications, and occupations relevant for labor market and education. Based on the knowledge, skills, competencies factor's relationship analysis the metadata profile can be generated. However, there is a problem with visualization of an occupational competence or set of competence related to occupational information. In the paper, some useful dashboard's concept for occupational competence visualization is presented. The proposed dashboard is driven, visualization intensive, interactive, and directly supports data exploration, reporting, and decision making. All competence visualization is based on the ESCO dataset. We want to show how competence's visualization can be helpful during job selection or education path selection.

Keywords: ESCO; competence visualization; dashboard

1. Introduction

Competence can be defined in many ways. After analyzing various definitions, we decided to distinguish two main determinants of competence. The first group of definitions is situated around the 'ability' concept, for example: competence is demonstrated ability to apply knowledge and skills [1]; competency can be defined as the fundamental abilities and capabilities that an employee should have to do a job well [2]. While, the second group of definitions is situated around the 'performance' concept: competence is effective performance within a domain/context at different levels of proficiency [3]. In the rest of the paper, we follow the HR-XML Consortium definition a competency can be defined as ''A specific, identifiable, definable, and measurable knowledge, skill,

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10.1016/j.procs.2021.09.263

ability and/or another deployment-related characteristic (e.g. attitude, behaviour, physical ability) which a human resource may possess and which is necessary for, or material to, the performance of an activity within a specific business context''.

In many cases, competencies should not be analyzed without an appropriate context (e.g. digital competence). Common context allows combining of many competencies into a common competence framework. The most important competence framework is the European Digital Competence Framework for Citizens (DigComp) [4], which is consists of 21 competencies. DigComp refers to the confident and critical usage of the full range of digital technologies for information, communication, and basic problem-solving in all aspects of life. The EntreComp is a second important competence framework. The European Entrepreneurship Competence Framework (EntreComp) covers a comprehensive description of the knowledge, skills, and attitudes that people need to be entrepreneurial and create financial, cultural, or social value for others [5]. EntreComp consists of 15 competencies. Moreover, we have competence framework dedicated to being digitally competent educator (DigCompEdu) [6] or Framework of Visual Literacy Competences for Engineering Education [7]

In the paper, we focused on the other competence framework related to occupational information. In this case, the number of competence is more than 10000+. Therefore you need visualization methods to see them all. In the paper, some useful dashboard's concept for occupational competence visualization is presented. Similar approaches can be found in [8] or [9]. However, the approach from [8] is limited to the relatively small dataset and in [9] the authors are more focused on admirative access for students and instructors to assess information inferred in educational systems. The proposed in this paper dashboard is driven, visualization intensive, interactive, and directly supports data exploration, reporting, and decision making. All competence's visualization is based on the ESCO dataset.

2. Background

2.1. Dashboards

A dashboard is a visual-oriented display of the most important data and information needed to achieve defined goals and objectives that are consolidated and arranged on a single screen so the information can be viewed at a glance [10]. A dashboard is a visual display of data used to monitor conditions and/or facilitate understanding [11].

There are several advantages of the dashboard for complex data visualization [12]. The most important is the dashboard provides a one-place presentation of critical information. The user can quickly understand data and respond quickly in one place. On the one hand, the dashboard allows decision-makers to see a variety of data that affects their decision-making process. On the other hand, the dashboard allows decision-makers to focus only on the items over which they have control.

One of the dashboard drawbacks is a misplaced visualization not even allowing for quick scanning and understating of key metrics. Another typical issue is not the intuitive user interface.

2.2. Competence visualization

The rapid development of computer visualization techniques has led to the possibility of complex data visualization and the creation of a special virtual space for educating the new generation [13]. In most cases, the competence visualization is a competence-focussed visual analytics tool for visual compete assessment. A good example is a radar plot [14], [15]. The radar plot enables easy comparison of strengths and weaknesses across the range of competencies, though another visualization will typically be more useful to follow up on specific areas if there is a large number of competencies displayed [14].

One of the major challenges that are currently addressed in the context of competence visualization is the identification of the capabilities and limitations of students [9]. The decision-making process would have a better efficacy if it were possible to identify the real state of knowledge of each student individually, it would be possible to seek adequate visual metaphor or storytelling data approach [16] to remedy the individualized limitations of each student.

2.3. Occupational competences standards

For many years work has been underway on an occupational structured classification of data. The taxonomy of skills and competencies can be a base for supporting tools for filling in and translating online forms like CVs or job offers [17]. The desired occupational classification had to meet several conditions [18]: multilingual, interoperable (Linked Open Data), enabling skills-based matching, not normative & avoiding harmonization, collaboration with stakeholders, "Meta Tool".

The initial work has been done by the European Dictionary of Skills and Competences Project DISCO I (2004-2008) and DISCO II (2010-2012) (http://disco-tools.eu/disco2_portal/index.php). The DISCO Project follows the European Parliament and Council definitions of knowledge, skills, competencies, and learning outcomes [19]:

- 'Knowledge' means the outcome of the assimilation of information through learning. Knowledge is the body of facts, principles, theories, and practices that is related to a field of work or study. In the context of the European Qualifications Framework, knowledge is described as theoretical and/or factual.
- 'Skills' means the ability to apply knowledge and use know-how to complete tasks and solve problems. In the context of the European Qualifications Framework, skills are described as cognitive (involving the use of logic, intuition and creative thinking) or practical (involving manual dexterity and the use of methods, materials, tools and instruments).
- 'Competence' means the proven ability to use knowledge, skills, and personal, social, and/or methodological abilities in work or study situations and in professional and personal development. In the context of the European Qualifications Framework, competence is described in terms of responsibility and autonomy.
- 'Learning outcomes' means statements of what a learner knows, understands, and can do upon completion of a learning process. These are defined in terms of knowledge, skills, and competence.

Several national skills standards follow the DISCO, for example: AMS-Qualifikationsklassifikation (Austria), Kompetenzenkatalog (Germany), ROME (France), Taxonomy DB (Sweden), O*NET (USA).

3. Competence visualization dashboard concept

In this chapter, we will discuss in detail how to develop a dashboard for occupational competence visualization. In the beginning, we define the dataset and discussed some occupational data processing methods. Because the dataset is complex we have defined some multidimensional data structure in order to analyze the occupational competence data in deep.

3.1. Dataset

The discussion based on the ESCO v1.0.8 dataset. The dataset is free and can be downloaded from the ESCO European Commission site (https://ec.europa.eu/esco/portal). ESCO (European Skills, Competences, Qualifications and Occupations) is the European multilingual classification of Skills, Competences and Occupations. According to the ESCO site, the ESCO dataset provides descriptions of 2942 occupations and 13.485 skills linked to these occupations, translated into 27 languages (all official EU languages plus Icelandic, Norwegian and Arabic).

The ESCO is a classification in form of the controlled vocabulary thesaurus [20]. In the ESCO model the concepts are connected via relationships, e.g. broader term/narrower term, synonyms. A concept can be understood as a cognitive unit of meaning or an abstract idea; it is sometimes defined as a "unit of knowledge" [21]. The ESCO model can be seen as a knowledge representation of a topic – in our case skills and competencies – that offers the possibility of making explicit existing relationships between concepts. Moreover, according to European Commission, the ESCO has to support job mobility across Europe and therefore a more integrated and efficient labor market, by offering a “common language” on occupations and skills that can be used by different stakeholders on employment and education and training topics.

The ESCO is made of the three interrelated pillars: (1) occupations pillar, (2) the knowledge, skills, and competencies pillar, (3) the qualifications pillar. In the next part, we will focus only on the occupations pillar and the knowledge, skills, and competencies pillar because these pillars are mostly related to the education process.

The occupations pillar doesn't cover the job context. While, the job is a set of tasks and duties carried out, by one person for a particular employer, the occupation is a set of jobs whose main tasks and duties are characterized by a high degree of similarity [22]. Moreover, the ESCO's occupations pillar is based on International Standard Classification of Occupations (ISCO-08), which has been developed by the International Labour Organisation (ILO).

The knowledge, skills and competencies pillars are developed according to Life Long Learning postulate [19]. According to this assumption, the knowledge is the body of facts, principles, theories, and practices that is related to a field of work or study. Knowledge is described as theoretical and/or factual and is the outcome of the assimilation of information through learning. The skills are the ability to apply knowledge and use know-how to complete tasks and solve problems. Skills are described as cognitive (involving the use of logical, intuitive and creative thinking) or practical (involving manual dexterity and the use of methods, materials, tools and instruments). Finally, competence is the proven ability to use knowledge, skills, and personal, social and/or methodological abilities, in work or study situations, and in professional and personal development.

3.2. Model

To develop a multidimensional data structure of occupational competence visualization, we started with the integration of different ESCO files [28]. The ESCO dataset is downloaded as the packed of several different tables. At beginning, we integrated the skills table with occupationSkillRelations table. For each skill, ESCO offers the skill's type and preferred term, a description, a scope note (if applicable, clarifying the boundaries of the concept), the skill type (knowledge or skill/competence knowledge or skill/competence). Moreover, because of previous integration, we got a list of all ESCO occupations where the skill can be used. In the next step, we joined the result table with the occupations table. Each ESCO occupation consists of a preferred term (the most used expression to that specific occupation), the reference to the corresponding ISCO group, a short description of the occupation, a scope note explaining which specific occupations are in or out of the scope of the preferred term (if applicable). It also offers information on regulatory aspects and, where relevant, reference to narrower occupations. Most importantly, each occupation is related to essential and optional knowledge, skill and competence concepts, describing in detail with skills and knowledges are essential for people willing to work in the area, and which are optional.

Special attention was given to the ISCO group. The ISCO group code is a four-level classification of occupation groups managed by the International Labour Organisation. The ISCO level 1 consists of the following occupations: Managers, Professionals, Technicians and Associate Professionals, Clerical Support Workers, Services and Sales Workers, Skilled Agricultural, Forestry and Fishery Workers, Craft and Related Trades Workers, Plant and Machine Operators and Assemblers, Elementary Occupations, Armed Forces Occupations. Through classifications, we also have access to other levels (2,3, and 4). The levels can be used for clustering and filtering.

In the next step, we introduced the number of action verbs [23]. The action verbs list is based on the action verbs from the European Dictionary of Skills and Competences (DISCO). The action verbs are used in learning outcomes descriptions to clarify the level of expertise expected for carrying out tasks in particular contexts [24]. Moreover, the action verbs can be related and clustered according to Bloom's Taxonomy [25]. In the last step, we indicate different levels of complexity and different requirements to the occupations by matching action verbs with skills description. We used the NLP method to recognize if there is an action verb in the description. A similar approach can be found in [26] or [27].

3.3. Cases

In this section we want to show most interesting example of the visualization. Naturally, there is more propositions in our project. We plan to provide an online interactive desktop in the future. Unfortunately, the initial visualizes was prepared in Microsoft PowerBI and it is not available as the free version for open Internet sharing.

The visualizations are organized based on level 1 of ISCO codes. This means that all visualizations are organized around the main 10 ISCO occupational groups. The first group of visualization is based on the tags cloud concept and NLP analysis for occupations description (fig. 1). We use the size to show the number of times a tag has been attached to a specific occupation word. Moreover, the tag's popularity is displayed by the items (using size as well) to which a tag has been used.

Let's discuss the obtained results. The process and use are the most popular actions. However, the process action seems to be related to more intellectual occupations. The development, monitor, plan actions are also important for these types of professions. On the other side of the spectrum of the complexities of the occupation intellectual work context the following actio0ns are important: order, perform, work.

Fig. 1. Tags clouds for ISCO occupations

We can assume that the knowledge is applied and put to use in skills and competencies. The ESCO standard captures this dimension by creating relations between knowledge, skills and competences. These relations can be qualified as essential or optional. Moreover, in fig. 2 the two clusters were developed. The first combine all objects related to the knowledge category, the second associates all objects related to skill/competence. The interesting result is a big disproportion between these two clusters. The skill/competence part is always much bigger than knowledge. The skill/competence are built as a continuous learning process during which the information is assimilated and the body of facts, principles, theories and practices that is related to a field of work or study.

The last graphic (on fig. 3) presents the reusability of knowledge and skill/competence between occupations. In order to make knowledge transferable, the knowledge has to be expressed in explicit form. Transversal knowledge, skills and competences are relevant to a broad range of occupations and economic sectors. They are often referred to as core skills, basic skills or soft skills, the cornerstone for the personal development of a person. Moreover, we distinguished cross-sector, occupation-specific, sector-specific and transversal types of knowledge (fig. 3). The biggest part is usually sector-specific and cross-sector.

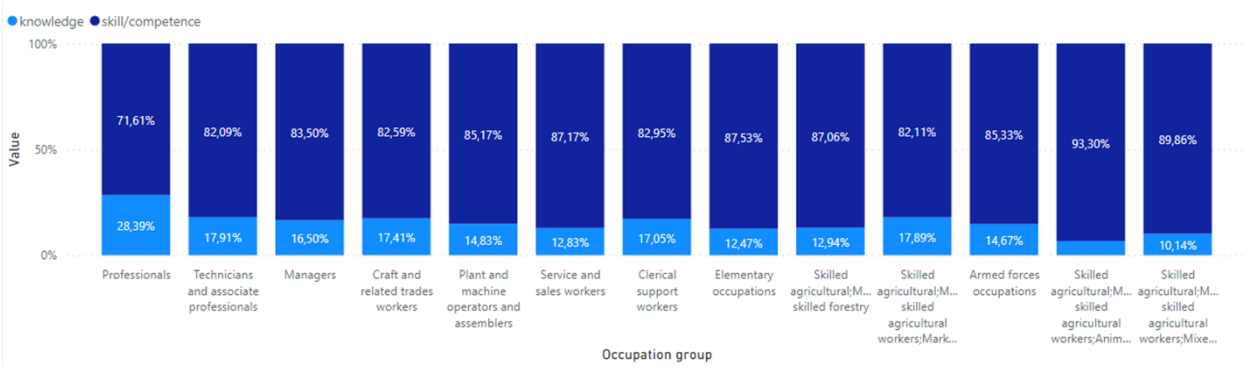

Fig. 2. The knowledge versus skill/competence relation

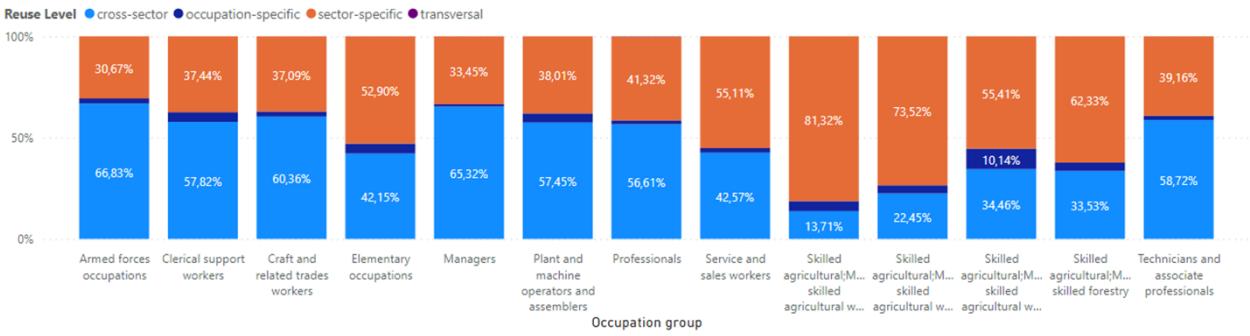

Fig. 3. Different types of knowledge reusability

4. Conclusion

Creating good visualization is a challenge. The same challenge is to prepare the high-quality data as well. Moreover, in the case of textual data, we are dealing with unstructured data. The processing of unstructured and semi-structured data requires special methods and is always error-prone. In our case, we used the natural language processing approach.

The visualization practice proves the following dilemma. On the one hand, we want to develop storytelling with data in order to communicate effectively with data. The visualization is a complex and graphic advantage. We have to understand the importance of context, recognize and eliminate the clutter and direct our audience's attention. On the other hand, the idiom “A picture is worth a thousand words” is not correct if you do not know how to read it. Even simple charts such as bar graphs can be ambiguous or, worse, incomprehensible. Users should stop just looking at charts, as if they were mere illustrations. Moreover, users must learn to read them and interpret them correctly.

Acknowledgements

This work was supported and co-funded by the Erasmus+ programmes of the European Union under the project number 2017-1-PL01-KA203-038537, "Digital Skills Accelerator" (DSA), http://www.digitalskillsaccelerator.eu/ and number 2019-1-PL01-KA202-065157, "Visual Literacy for Engineering Education" (VLEE), https://www.vleeproject.eu/. The European Commission support for the production of this publication does not constitute an endorsement of the contents which reflects the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

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