

# Preparing for Smart Cities' Future Competences: Trends Arising Through Keyword and Review Analysis



Paraskevi Tsoutsas and Ioannis Ch. Lampropoulos

## 1 Introduction

People nowadays require key competences in their daily operations and transactions, given the rapidity of recent technological breakthroughs and their influence in all fields. The demand for new essential competences in a lifelong context has raised high expectations for education and lifelong learning while also broadening the range of competences required.

The concepts “competence” and “skill” are often used as synonyms and in the literature, there are numerous definitions available for these words. We adopt the definition of Cedefop (2015); a competence is the “ability to apply learning outcomes adequately in a defined context (education, work, personal, or professional development) or the ability to use knowledge, skills and personal, social and/or methodological abilities, in work or study situations for professional and personal development.”

The most important skills are influenced by the current business environment, the employment market, the rising information economy, the enhanced globalization, and task automation (Cedefop, 2019; Kotak & O’Neill, 2021; Semeijn & Nikolova, 2021; Tsoutsas et al., 2018). Gaining competences plays an exponential function in anticipating the global labor patterns of the near future in this disruptive landscape (Iliescu, 2021; Fitsilis et al., 2018). In education, rapid social, economic, and technological changes have prompted the development of a flexible and educable workforce, resulting in the redefinition of educational approaches and competences that learners should acquire at various levels of their education in order to become

---

P. Tsoutsas (✉) · I. C. Lampropoulos  
University of Thessaly, Thessaly, Greece  
e-mail: [ptsoutsas@uth.gr](mailto:ptsoutsas@uth.gr); [ilampropoulos@uth.gr](mailto:ilampropoulos@uth.gr)

competent citizens and significant contributors to their countries' development (EC, 2006).

This research was conducted to extort and present recent data on competency issues and trends in a dynamic, unpredictable, complex, and ambiguous ecosystem such as smart cities that reveal the points of convergence among diverse domains and research disciplines. We analyze the concepts that derive from the keywords that the literature production contains about skills and competences. Keywords analysis is staged to visualize the research patterns in domains. We present a co-occurrence map for author keywords and additional keywords, and the results are segmented into sections, where each section is discussed. Web of Science (WOS), which provides access to multiple databases that provide comprehensive data for many different academic disciplines, was used to collect publications on the topic. Our goal was to get an overview of the authors' keywords used, and we hoped to identify subtopics by using VOSviewer (VoS) (Van Eck & Waltman, 2010). The terms competences (or synonyms) and smart city (or similar terms) had to appear in the topic, title, abstract, or keywords of last decade's articles. By the keywords were identified using VoS, we selected 110 keywords. The map revealed many subtopics and some relatively new concepts related to key competences in selected studies. Another objective of this research is to determine which are the primary domains where skills are researched, as well as any future trends that may emerge from these domains. As a result, we continued by analyzing the competence review papers from the previous 2 years and present our findings.

This work contributes to the theoretical understanding on the topic of competences by giving a keyword map of the competence notion. The co-occurrence analysis of related phrases will at the very least provide a clearer knowledge of how these terms relate to competences, whereas the study of literature reviews will characterize the current and future dynamics that competences may have in many areas.

The rest of this paper is structured as follows: In Sect. 2 related work is presented, Sect. 3 describes the method which was followed and the procedure for searching, identifying, and selecting the articles, Sect. 4 provides the results, and the last section concludes the paper.

## 2 Related Work on Competences

Competence has a multidisciplinary history, which is evident today as many disciplines are interested in its definition and application. For the last decade, the competence topic is an engaging one, generating interest among researchers.

As the amount of research on intercultural competence (ICC) has increased over the last two decades, a thorough evaluation of the various literature and its growth process is doing in research by Peng et al. (2020). The study conducted a bibliometric analysis for the knowledge domain of intercultural competence. Through analysis, they provide empirical observation from multiple perspectives in

intercultural competence research. According to their results, there is an emphasis and future direction of research for scholars, which is conducive to the expansion of the researchers' ideas and the in-depth exploration in pedagogy, management, medicine, and neurology.

In Antera (2021), the many interpretations of the concept of professional competence are analyzed and studied in relation to vocational teaching. The researcher discovers similar concept attributes as well as nearby ideas related with professional competence using a conceptual analysis approach, which follows the data collecting procedure of a systematic literature study. According to her findings, only a few studies provide adequate professional competence concept definitions. Furthermore, the scholars agree on the major characteristics of professional competence, such as the contextual and developmental nature of professional competence. Since complex concepts like the one under consideration can generate misunderstanding, the author recommended that their use should be accompanied by a description of its multiple meanings.

Zait (2017), in his study, attempt to identify the main necessary competences for smart cities' development regarding civilizational competences and their effect in smart cities' development. Civilizational competences, soft skills, or human-related characteristics of cities highly influenced by culture (at national, regional, organizational, and individual levels), according to their findings, are critical for the development of smart, competitive cities. They group the civilizational competences into four categories, enterprise culture, discursive culture, civic culture, and daily culture and argue that in order to develop smart cities, we must first define them, then determine their antecedents or influencing factors, and last measure them.

The literature of competences encompasses many surveys, yet all emphasize specific areas and methodologies used which provides a distinction between each context the concept is used, although the research is all part about the same notion. This study is the first survey that focuses on competences in whatever area of the smart city domain, covering papers published in journals indexed by the Web of Science database after 2010.

### 3 Research Method

Bibliometric is a statistical technique for analyzing bibliographic data from articles and books, such as titles, keywords, authors, and cited references. It is used to measure the productivity of institutions and countries, as well as define current trends and forecast future research foci. The term bibliometric was first coined by Alan Pritchard in his paper "Statistical Bibliography or Bibliometrics" (Pritchard, 1969). For this study it used the bibliometric technique to "analyze and illustrate the literature on the research topics of 'Skills' and 'Competences'."

## **3.1 Data Source and Search Strategy**

### **3.1.1 Data Source**

The data source was built using secondary data by journal and conference articles that were identified by searching the online database Web of Science (WOS) for the time span from 2010 to 2021. The choice of this database is due to the global reputation this instrument has, as it represents a main source for finding publications with the greatest impact while providing data for bibliometric analysis. The analysis tool used in the study was VOSviewer.

### **3.1.2 Procedure for Searching, Identifying, and Selecting Articles**

An advanced search was conducted for the retrieval of data, and the inclusion criteria for the selection of relevant articles that were taken into consideration for the performance of this research are:

- (i) Published after 2010 and including August 2021 in order to extract the most current research and trends in this field.
- (ii) Contain the specified search descriptors (skill, competences, smart cities) and their synonyms (e.g., intelligent cities) either in title, keywords, or abstract.
- (iii) Are related to the field of human skill and competences.
- (iv) Are related to skills in professional development at any stage of the education system or lifelong learning.

The following exclusion criteria were applied: (i) studies in competences aside from humans; (ii) unpublished data or not published in conference papers, book chapters, and journal articles; (iii) studies with animals; (iv) studies including participants with disabilities, diseases, or disorders; and (v) not written in English language.

### **3.1.3 Search Summary**

A total of 152 relevant articles were identified in the database using the aforementioned search strategy as it is depicted in Fig. 1. By excluding duplicates, the total number of articles was reduced to 146, and these are selected to be included in the research.

The data retrieved from this first phase studies were first interconnected and metrically presented using the VoS software. Following that, at a second phase of the research, only review papers were selected published between January 2019 and August 2021, and an analysis was conducted as it is presented in Sect. 4.2.

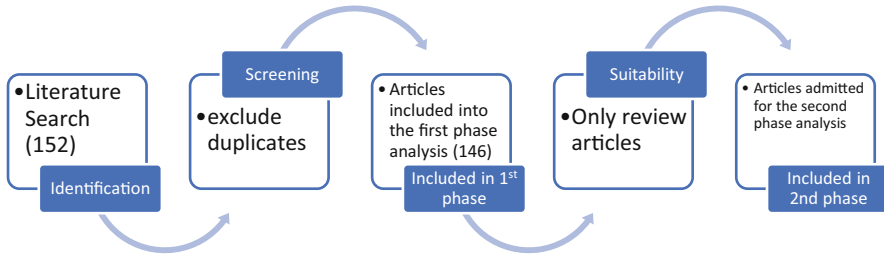


Fig. 1 Flow diagram for selection of articles

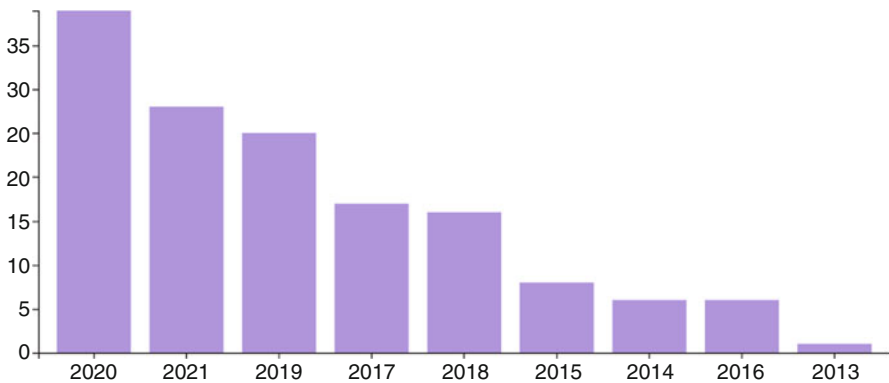


Fig. 2 Annual scientific production per year (Source: WOS)

### 3.1.4 Data Extraction

The information that were extracted from each article included: the names of the first three authors, year of publication, title, keywords, type of study, domain of research, and abstract. All retrieved data were entered in a spreadsheet and merged into a single file.

Then, data were imported into the VoS software, they were analyzed and bibliometric products (maps, graphs, spreadsheets) were generated. In the analysis and interpretation of developed studies, descriptive, quantitative, and correlational techniques have been combined with the semantic application of keyword study through the VoS software. Content analysis was performed to reduce the amount of data and identify category clusters (Patton, 1990). Through the analysis, a comparative analysis of articles and concepts has been carried out, and their visual representation has been conducted.

It is clear that there is a growing interest in the publications on the topic over time, since we see an evolution from the first articles appeared in 2013 (Fig. 2).

To best serve the research aims, we present in the next section how we examine and determine from the dedicated literature the intellectual correlations of the competency concept. This will allow us to examine the existing ties between the

notion of competence and other significant concepts, as well as emphasizing the most crucial relationships that we have uncovered between them.

## 4 Data Analysis Presentation and Discussion

The findings are presented in two stages. In Sect. 4.1 we show the network graph produced by the analysis of keywords, thereby responding to the first objective of the study. In Sect. 4.2, we discuss on the analysis that was done on review studies on competences over the previous 2 years.

### 4.1 *Keyword Clustering and Classification*

This section covers the aspect of the analysis where keywords from the articles are clustered to perhaps unveil dominant research areas which have emerged in the past studies. We have used the VOSviewer software to exhibit the analysis of keywords required. The VOS stands for “visualization of similarities” and uses its exclusive mapping and clustering techniques. The size of a node is proportionate to the number of occurrences of a keyword, and the link between nodes represents the number of co-occurrences of these keywords. The higher the number of co-occurrences between two keywords, the lesser is the distance between them. A thesaurus file was developed and used to eliminate the problem of acronyms, plurals, dashes, etc. in the keywords.

The resulting map is highlighted in Fig. 3, which shows that after mapping and clustering operations, there were four decisively formed distinct clusters from 110 clustered keywords. The figure displays the co-occurrence for the most cited and strongly correlated keywords. The circle color shows the thematic cluster each keyword belongs to, and the size of nodes indicates the frequency of occurrence. The curves between the nodes represent their co-occurrence in the same publication. The shorter the distance between two nodes, the larger the number of co-occurrence of the two keywords. The distinct clusters and the keywords each one contains indicate the trends for the study of related terms used by researchers in their discipline. The keywords in each resulted group are semantically linked to target the research papers that are also related to more terms of this group, rather than just focusing on targeted papers simply containing the specific keyword:

- Cluster 1—Smart city (in red): The “smart city” term registers the most substantial values here with the terms learning, system, environment, technology, data, and economy to follow. Other important keywords to highlight in this cluster are network, platform, IoT, and communication technologies. It is the cluster with the largest number of terms and occurrences, which are 25 and 389, respectively.



**Table 1** Top ten keywords for each theme

	Label	Oc	L	LS		Label	Oc	L	LS
Cluster 1: Smart city	Smart city	59	86	987	Cluster 3: Education	Approach	32	84	541
	Learning	30	85	507	Development	29	85	541	
	System	27	84	438	Student	22	82	390	
	Environment	22	85	436	Work	18	82	313	
	Technology	22	82	395	Education	16	82	344	
	Data	21	82	344	Practice	15	77	262	
	Economy	21	82	358	Challenge	12	76	239	
	Web service	19	82	370	Teacher	12	75	250	
	Framework	15	82	280	Project	10	71	198	
Network	15	78	243	Curriculum	9	63	160		
Cluster 2: Knowledge	Competence	26	85	465	Cluster 4: Skill	Skill	46	86	723
	Knowledge	20	83	358	Process	28	84	537	
	Analysis	17	83	329	Model	25	82	404	
	Solution	17	83	332	Study	22	84	367	
	Concept	16	81	323	Experience	14	78	238	
	Context	16	82	273	Research	14	82	258	
	Use	15	81	308	Activity	11	68	201	
	Need	14	80	299	Assessment	10	67	157	
	Level	13	78	250	Opportunity	10	74	189	
Implementation	10	75	211	Change	9	74	174		

Oc: Occurrences, L Links, LS Link strength

Table 1 presents for each cluster the top ten most frequently used phrases, listed from most frequently used to least frequently used assigned by VOSviewer under each cluster, as well as the occurrences, links, and link strength value for each of the terms.

In Fig. 4 we see the most co-occurred terms in all studies.

In Fig. 5, we can observe the representation of the density overview of the clusters, broadcasting the most visited concepts in the literature, correlated with the competence and skill concept. By default, colors range from blue to green to yellow. The terms “smart city,” “skill,” “competence,” “economy,” “system,” “study,” “student,” and “technology” have the most visible hallows on the map, and this is in alignment with their leading clusters’ positions and highest values in their cluster when it comes to the occurrences. It is also interesting to note the appropriation between items belonging to different clusters. In this respect, we notice how “competence” (cluster 2) is very close to “skill” (cluster 4), since they are frequently used interchangeably and are considered equal, which is very close to “education” (cluster 3).

The density of yellow circles determines the most prominent relationships by strongly correlated keywords which lead to sets of concepts that are studied together



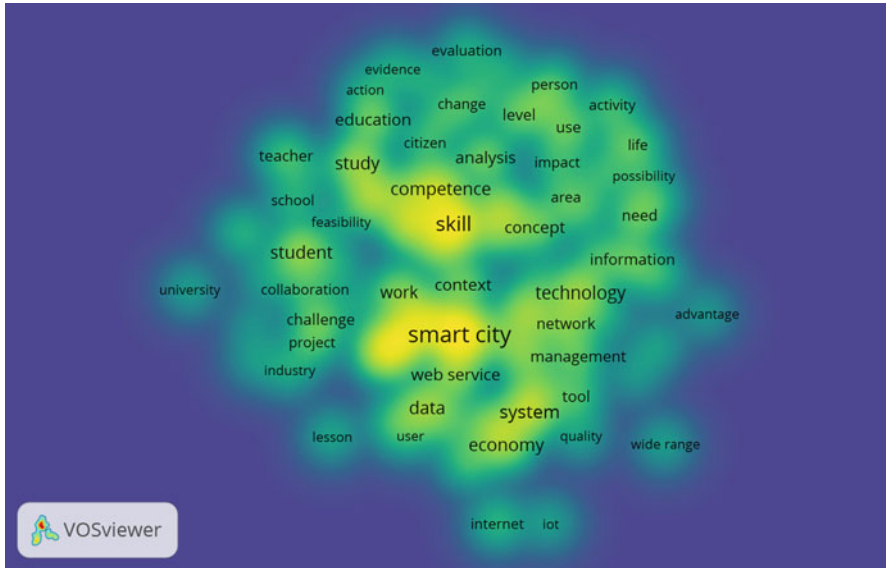


**Fig. 4** Most cited terms

and could reveal specific competences. By combining Fig. 3 and Fig. 4, we can observe representations of networks of correlated concepts that could abstractly describe competences to be researched in smart city domains. One such network contains the concepts smart city, web services, data, and users. Further research will enable us to validate that the co-occurrence of concepts leads to the need of developing composite competences. For example, the correlation of concepts such as: smart city, network, management, system, and economy could allow us to conclude that a competence for digital economy management may be needed.

#### **4.2 Most Reviewed Domains**

While the first specified aim of the research has been reached in the previous section, a complementary analysis process was conducted to achieve the second defined objective. Our intention was to highlight the areas of interest which is studied by researchers in the field of competences independent of the smart city, in order this

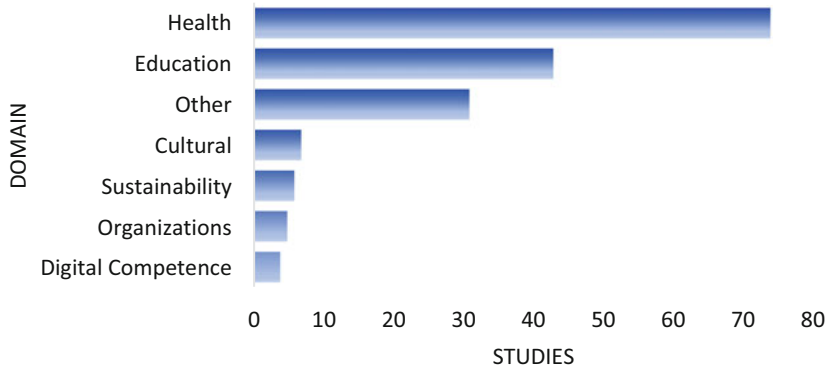


**Fig. 5** Density visualization of the clustered keywords

to be an inspiration for exploration in the most specific field of the smart city. Undoubtedly, it is clear that the majority of the resulting domains are relevant to the field of interest of which is smart city competences. More precisely, in order to gain understanding of the different domains, the terms skill and competences are reviewed; we conducted an analysis of the literature review articles published between January 2020 and August 2021, without taking into account the filter for the smart city domain. Each review was critically appraised by the authors of the paper. By analyzing only the review articles, it is observed that the majority of the articles are concerned with the health field and especially the university education of the health executives which is based both on the level of digital capacity and on the adjustment of the programs of studies. Especially during the situation of Covid-19 pandemic, it seems that the areas in which most research has been recorded can contribute to the scientific community for further research so that, by each subject of education, the scientific community can offer all the necessary directions that will be used by government agencies for the maximum efficiency of human capacity per object of activity.

Figure 6 shows the research areas where it is observed that the fields of health and education are the sciences that are particularly active in the study of skills in these areas.

The advent of Covid-19 in connection with the rapid growth of technology has led to digital capability as one of the burning issues (Zhao et al., 2021). Digital competence is one of the main skills in the education system in order to acquire the appropriate knowledge, attitudes, and skills in a safe, appropriate, and decisive way



**Fig. 6** Areas of research for competence review studies

that will contribute to both education and the professional sectors (Esteve-Mon et al., 2020). In the field of health sciences, Jimenez et al. (2021) urge the scientific community to find alternative ways of providing high levels of public health care, while Antera (2021) shows the need for a complex tool that will facilitate the design of knowledge, intelligence, performance, and skills that will allow measurement and study.

At the university level, according to Pedromo and Gonzalez-Martinez (2020), most of the recorded research is in Spain, while in Latin American countries, a small range of work is presented, although digital skills in higher education show a growing trend due to the demand for information technology and communications (Ocana-Fernandez et al., 2020). The research of Fernandez-Batanero et al. (2020) emphasize the importance of digital competence and the lack of teacher training in information communication technologies. University professors, in particular, must be highly skilled in order to face the new digital society and its new challenges (Esteve-Mon et al., 2020), while Kiat Bong and Chen (2021) argue that digital access must be student-free. Regarding the professional competence of teachers, the work of Antera (2021) shows a gap in the study of professional competence at a collective level, while Ingrid (2021) emphasizes the gap and at the same time the importance of socio-emotional skills in education and professional success. Socio-emotional skills are important for health and well-being in social relationships and life in general.

Tarraga-Minguez et al. (2021) highlight a significant gap in teacher training programs in digital competence. Curricula need to be adjusted to find possible ways of teaching and assessment which will reduce the gap between school, society, and work (Gonzalez-Salamanca et al., 2020; Tsoutsas et al., 2022a). For the curricula, Galleli et al. (2020) propose a revision of the curricula in order to harmonize them with the organizational framework that connects higher education with the labor market.

Particular emphasis is placed on research and sustainability where it is a highly developing field for viability and skills, with teachers playing an important role in their transformational skills for sustainability education. Teachers perform a particular task that requires different abilities, skills, as well as critical knowledge of factors related to environmental injustice either in society or within the school environment (Corres et al., 2020). The role of teachers in sustainable development aims at the development of tomorrow's citizens who will have to take responsible action in the future in order to solve the problem (Chen & Liu, 2020). Capacity for environmental sustainability according to Dzhengiz and Niesten (2020) is also determined by managers who if they have the necessary knowledge and develop environmental skills can improve environmental sustainability.

Additionally, the study of the selected articles identifies various gaps that need to be further explored in order to be able to develop specific strategies in the abilities of people, aiming at a process of effective interaction between people and the environment. Liu et al. (2020) propose further research for a systematic evaluation of the effectiveness of the framework and the investigation of innovative educational interventions that will ensure that the training of both students and professionals will be timely and effective. Javier and Purificación (2020) and Salmon et al. (2020) also support the importance of further research training and moreover, the need to update educational programs from the initial stages of the educational process, so that no stage of the educational system is excluded.

Minarevic and Tokic Zec (2021) emphasize the importance of further study in the attitudes of students and teachers by comparing practices with different countries being implemented around the world. Schoon (2021) in the context of exploring socio-emotional abilities emphasizes the importance of holistic evaluation in all cultures in order to reflect the formation, development, and possible changes that need to be made. Regarding the integration of technology in teacher training programs, Fernandez-Batanero et al. (2020) emphasize the importance of reviewing curricula in order for future professionals to be fully trained.

In the context of sustainability, Galleli et al. (2020) propose to conduct theoretical studies that will study human skills related to sustainability by incorporating management models that will combine strategy, organizational, and human skills.

In conclusion, the evaluation of the study articles on skills results in interesting analyses without emphasizing the gap in the literature by the researchers and the proposal of specific studies that will contribute significantly to the field of skills development.

## 5 Conclusions and Future Work

The current growth trends predict a large increase in the number of publications on smart cities' competences. It is particularly important to benefit from such a great number of research articles about skills and omnipotences and gather useful data. The goal of this research was twofold, firstly to address through bibliometric

analysis the emerging of different issues and future trends in smart city competences and secondly to go over recent competency reviews on the field and reveal the most important thesis and motivate relevant research in smart cities' competences.

The Web of Science core collection database was used as the data source, and VoS was applied for analysis of the metadata of the retrieved articles. The tendency of research in the field of skills and competences with the analysis of scientific collaboration network and keyword co-occurrence is depicted in networked graphs by using cluster analysis. Through the analysis of keywords, they identified four clusters of themes covered by the research study about competences in smart cities. With this work we depict a different aspect of the skill and competence researched bibliography in the field of smart cities. We have developed a network and a map which are based on the keywords given by the authors of all relevant research articles with the aforementioned concepts during the last decade. These graphs primarily justify the main concepts that are at the heart of the relevant research, and they can be used by researchers to find additional search terms or to limit the scope of their topic. Moreover, they can conclude other research interests that scientists research in different disciplines for the same subject.

To reach the second indicated goal, a complementary analysis technique was used. According to a survey of reviews, the most investigated domains in terms of skills are health and education. Special mention is given to the fields of education and digital skills as well as the study of intercultural behaviors. In addition to the education sector, which seems to have occupied the scientific community, the health sciences sector also has a wide range of literature studies, which is of research interest in emerging emergencies such as Covid-19.

As future work we plan to investigate a larger set of concerns and challenges that arise in the field of continuous professional development, which many sources emphasize (Cedefop, 2015; Fitsilis & Kokkinaki, 2021) and the importance of having a strategy to implement a unified continuum of professional development by exploiting appropriate tools (Tsoutsas et al., 2022b) and technologies.

**Acknowledgments** This work was supported by the Erasmus+ KA2 under the project "DevOps competences for Smart Cities" (Project No.: 601015-EPP-1-2018-1-EL-EPPKA2-SSA).<sup>1</sup> This paper 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.

## References

- Antera, S. (2021). Professional competence of vocational teachers: A conceptual review. *Vocations and Learning*. <https://doi.org/10.1007/s12186-021-09271-7>
- Cedefop. (2015). *Skills, qualifications and jobs in the EU: The making of a perfect match? Cedefop reference series No. 103*. Office for the Official Publications of the European Union. Retrieved from <http://www.cedefop.europa.eu/en/publications-and-resources/publications/3072>

---

<sup>1</sup> SmartDevOps project website is <https://smartdevops.eu>

- Cedefop. (2019). *Skills for green jobs: 2018 update*. Retrieved from <https://www.cedefop.europa.eu/en/publications-and-resources/publications/3078>
- Chen, S.-Y., & Liu, S.-Y. (2020). Developing students' action competence for a sustainable future: A review of educational research. *MDPI*, *12*(4).
- Corres, A., Rieckmann, M., Espasa, A., & Ruiz-Mallen, I. (2020). Review educator competences in sustainability education: A systematic review of frameworks. *MDPI*, *12*(23).
- Dzhengiz, T., & Niesten, E. (2020). Competences for environmental sustainability: A systematic review on the impact of absorptive capacity and capabilities. *Journal of Business Ethics*, *162*, 881–906.
- EC. (2006). *Key competences for lifelong learning /online/*. Retrieved from <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32006H0962:EN:HTML>
- Esteve-Mon, F. M., Llopis-Nebot, M. A., & Adell-Segura, J. (2020). Digital teaching competence of university teachers: A systematic review of the literature. *IEEE Revista Iberoamericana de Tecnologías del Aprendizaje*, *15*(4), 399–406.
- Fernandez-Batanero, J. M., Montenegro-Rueda, M. M., Fernandez-Cecero, J., & Garcia-Martinez, I. (2020). Digital competences for teacher professional development. Systematic review. *European Journal of Teacher Education*. <https://doi.org/10.1080/02619768.2020.1827389>
- Fitsilis, P., Kokkinaki, A. (2021). *Smart cities body of knowledge*. Retrieved from <https://smartdevops.eu/scbok/>.
- Fitsilis, P., Tsoutsas, P., & Gerogiannis, V. (2018). Industry 4.0: Required personnel competences. *Industry 4.0*, *3*(3), 130–133. In *3rd International scientific conference on industry 4.0*. Varna.
- Galleli, B., Hourneaux, J., & Munck, L. (2020). Sustainability and human competences: A systematic literature review. *Benchmarking: An International Journal*, *27*(7).
- Gonzalez-Salamanca, J. C., Lucia Agudelo, O., & Salinas, J. (2020). Key competences, education for sustainable development and strategies for the development of 21st century skills. A systematic literature review. *MDPI*, *12*(24).
- Iliescu, A. N. (2021). Conceptual atlas of the knowmad literature: Visual mapping with VOSviewer. *Management Dynamics in the Knowledge Economy*, *9*(3), 379–392.
- Ingrid, S. (2021). Towards an integrative taxonomy of social-emotional competences. *Frontiers in Psychology*, *12*.
- Javier, C., & Purificación, C. (2020). From competences to key competences in early childhood education. Comparative and upgrading of the competences in the curriculum. *Propósitos y Representaciones*, *8*(1).
- Jimenez, C. L., Lopez Poyato, M., Casado Montanes, I., Guix-Comellas, E. M., & Fabrellas, N. (2021). Paediatric nursing clinical competences in primary healthcare: A systematic review. *Journal of Advanced Nursing*, *77*(6), 2662–2679.
- Kiat Bong, W., & Chen, W. (2021). Increasing faculty's competence in digital accessibility for inclusive education: A systematic literature review. *International Journal of Inclusive Education*. <https://doi.org/10.1080/13603116.2021.1937344>
- Kotak, A., & O'Neill, K. (2021). *Work in progress: Emerging smart city occupations*. Information and Communications Technology Council (ICTC).
- Liu, J., Gill, E., & Li, S. (2020). Revisiting cultural competence. *The Clinical Teacher*, *18*(2), 191–197.
- Minarevic, V., & Tokic Zec, R. (2021). Intercultural competences in initial teacher education—Comparative analysis. *Croatian Journal of Education*, *22*(4).
- Ocana-Fernandez, Y., Valenzuela-Fernandez, L., & Morillo-Flores, J. (2020). The digital competence in the university teacher. *Propósitos y Representaciones*, *8*(1).
- Patton, M. Q. (1990). *Qualitative evaluation and research methods* (2nd ed.). Sage Publications.
- Pedromo, B., & Gonzalez-Martinez, O. A. (2020). Digital competences in faculties: A systematic review. *EDMETIC*, *9*(2), 92–115.
- Peng, R. Z., Zhu, C., & Wu, W. P. (2020). Visualizing the knowledge domain of intercultural competence research: A bibliometric analysis. *International Journal of Intercultural Relations*, *74*, 58–68.

- Pritchard, A. (1969). Statistical bibliography or bibliometrics. *Journal of Documentation*, 25(4), 348–349.
- Salmon, M., Ahmad, G., & Saleem, I. (2020). The concept of competence: A thematic review and discussion. *European Journal of Training and Development*, 44(6/7), 717–742.
- Schoon, I. (2021). Towards an integrative taxonomy of social-emotional competences. *Frontiers in Psychology*, 12.
- Semeijn, J. H., & Nikolova, I. (2021). Career challenges in smart cities: A sociotechnical systems view on sustainable careers. *Human Relations*, 74(5), 656–677.
- Tarraga-Minguez, R., Suarez-Guerrero, C., & Sanz-Cervera, P. (2021). Digital teaching competence evaluation of pre-service teachers in Spain: A review study. *IEEE Revista Iberoamericana de Tecnologias del Aprendizaje*, 16(1).
- Tsoutsas, P., Damasiotis, V., Tsifora, E. (2022a). Accounting students perceptions from internship that trigger adaptations in training after Pandemia. Challenges and emerging strategies for global networking post COVID-19, January 2022, ISBN: 9781799888567.
- Tsoutsas, P., Fitsilis, P., & Iatrellis, O. (2022b). Towards an ontology for smart city competences. In *Proceedings of the 25th pan-Hellenic conference on informatics (PCI 2021)*, ACM.
- Tsoutsas, P., Fitsilis, P., & Ragos, O. (2018). Services simulation in industry 4.0: A comparison of simulators. In *3rd International scientific conference on industry 4.0*. Varna.
- Van Eck, N. J., & Waltman, L. (2010). Software survey: VOSviewer, a computer program for bibliometric mapping. *Scientometrics*, 84(2), 523–538.
- Zait, A. (2017). Exploring the role of civilizational competences for smart cities' development. Transforming government: People, process and policy.
- Zhao, Y., Llorente, A. M. P., & Cruz Sanchez Gomez, M. (2021). Digital competence in higher education research: A systematic literature review. *Computers & Education*, 168.