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Scoping Review on Research at the Boundary Between Learning and Working: A Bibliometric Mapping Analysis of the Last Decade

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Abstract

Context: The research field at the boundary between learning and working is multidimensional, fuzzy, dynamic, and characterized by high growth. A study that comprehensively maps and aggregates this research field is missing.

Approach: Using tools of bibliometric analysis (bibliographic coupling, co-citation analysis and co-occurrence analysis), we map the research at the boundary between learning and working in a scoping review study. Our study considers peer-reviewed articles published between 2011 and 2020 and recorded in Scopus. In total, 5,474 articles are included in our analysis.

Findings: Focusing on the intellectual structure of the research field, we identified the most publishing and most cited countries, journals, and authors, as well as latent collaborative networks among countries, journals, and authors. Furthermore, we used references and keywords to identify the conceptual structure of the research field and distinguished four types of conceptual clusters: motor clusters, highly developed and isolated clusters, emerging or declining clusters, and basic and transversal clusters.

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Conclusions: Research at the boundary between learning and working is highly parcelled out internationally. This scientific parcelling represents a disadvantage for exchanging ideas and accumulating knowledge. In addition to forming a parcelled field, a dividing line runs between centre, periphery and excluded countries and scientists. Especially scientists from developing countries and nations, economies in transition and those from post-conflict situations are excluded from the international discourse. This situation is more than just a disadvantage for the exchange of ideas and the accumulation of knowledge. Instead, there is a systematic bias in the research landscape here.

Keywords: Scoping Review, Mapping Review, Bibliometric Analysis, Work-based Learning, Workplace Learning, Technical and Vocational Education and Training, VET

1 Introduction

Vocational education and training systems and practices, unlike higher or general education, are considerably national in scope, which is why the field of vocational education and training (VET) practice and governance is highly parcelled out internationally (OECD, 2014). This has implications for research: the research field itself is broad, fuzzy, dynamic and characterised by high growth (McGrath et al., 2019). One reason for this growth and fuzziness is the multidimensionality of the interface of working and learning: Economical, political, institutional, social, and individual issues are at once affected. A second reason is that the economic-social crises of recent years have been particularly evident at this interface, which is why solutions are being sought precisely at this interface. This led to a massive increase in societal, economical, political and scientific importance of VET and VET research (Cedefop & OECD, 2021). Despite this high and growing importance, it is largely unknown how this vibrant field of research is structured intellectually and conceptually. The purpose of our study is to fill this gap to some extent by mapping and aggregating ten years of research at the boundary between learning and working, particularly in VET research.

The review type used is the *scoping review*, which is "used to map existing literature in a given field in terms of its nature, features, and volume. As such scoping reviews have also been called mapping reviews." (Peters et al., 2015, p. 141). Colquhoun et al. (2014) define a scoping or mapping review furthermore as "a form of knowledge synthesis that addresses an exploratory research question aimed at mapping key concepts, types of evidence, and gaps in research related to a defined area or field by systematically searching, selecting, and synthesizing existing knowledge" (pp. 1292–1293).

Scoping reviews are still rare in the vocational education and training research landscape (Gessler & Siemer, 2020). Nevertheless, some mapping approaches exisit: Bezerra et al. (2021) conducted a mapping of work-based learning research (period covered: no spe-

cific period, papers included N=410). Very close to this focus, Moosa and Shareefa (2020) executed a mapping of the most-cited publications on workplace learning (period covered: 1970–2019, papers included N=100). Further mapping reviews have focused on vocational education and training reform implementation (period covered: 1984–2017, papers included N=177) by Caves et al. (2021), digital technologies for situating vocational education and training (period covered: all years, papers included N=17) by Dobricki et al. (2020), transversal competences (period covered: 2010–2019, papers included N=34) by Calero López and Rodríguez-López (2020), Nordic research on educational and vocational guidance (period covered: 2003-2016, papers included N=290) by Haug et al. (2019), collaborative technologies for initial vocational education (period covered: all years, papers included N=26) by Schwendimann et al. (2018) and transfer of training (period covered: 1990–2015, papers included N=79) by Tonhäuser and Büker (2016).

The mentioned scoping reviews capture a specific aspect of research at the boundary between working and learning with either smaller (N=17, 26, 34, 79) or larger units of analysis (N=100, 177, 290, 410). To date, no study has attempted to map the entire field of vocational education and training research internationally. Such approaches inevitably lead to studies encompassing a large number of publications.

Using tools for bibliometric analysis, we mapped the research field at the boundary between learning and working in a scoping review study. The scoping review provides the methodological framework, ranging from database selection, article collection, analysis (here: using bibliometric analysis), interpretation, and conclusion. Another name for this type of research, which is a combination of scoping review and bibliometric analysis, is science mapping: The aim of sience mapping is to build bibliometric network and/or cluster maps which help to describe how a particular field of research is intellectually and conceptually structured (Cobo et al., 2011a.). Our first research question is therefore: How is the research field intellectually structured? To determine the intellectual structure, we analyse latent networks of countries, journals, and authors. Our second research question is: How is the research field conceptually structured? To determine the conceptual structure, we analyse the density and centrality of clustered references and keywords. We apply both research questions to research published between 2011 and 2020.

2 Data Selection and Data Analysis

This study uses bibliometric analysis, a technique that is increasingly being used as a tool and basis for monitoring the research content and performance within scientific disciplines (Zupic & Čater, 2015). The purpose of bibliometric mapping is "to provide an overview of the structure of the scientific literature in a certain domain" (van Eck, 2011, p. 1). We performed

a bibliometric field analysis to discover the intellectual structure and a bibliometric concept analysis to discover the conceptual structure of the field:

(1) The *bibliometric field analysis* was conducted to identify the most productive and most cited countries, journals and authors and their relatedness. Using the software VOSViewer (van Eck & Waltman, 2010), we first executed the descriptive analysis, followed by a network analysis based on bibliographic coupling and co-citation analysis. Finally, we clustered the units of analysis (countries, journals, authors).

(2) The *bibliometric concept analysis* was performed to identify the most cited references and the most commonly used keywords and their relatedness. Using the software SciMAT (Cobo et al., 2011b; Cobo et al., 2012a?), we first conducted a descriptive analysis, then a strategic map analysis based on a co-occurrence analysis, and finally clustered the units of analysis (references and keywords).

In the first step, we will describe the process of *data selection*, then the *data analysis* with the software (VOSViewer and SciMAT) and the bibliometric methods used (bibliographic coupling, co-citation analysis and co-occurrence analysis).

2.1 Data Selection

Data Source

Major databases for bibliometric analysis are Google Scholar (free access), Scopus (paid access, curated by Elsevier) and Web of Science Core Collection (paid access, curated by Clarivate). For the analyses in this paper, we relayed on Scopus, because Google Scholar "simply crawls any information that is available" (Harzing & Alakangas, 2016, p. 802). Google Scholar lacks quality control. On the other hand, Scopus is curated, has a fine-grade classification of document types, and the metadata for our analyses are available in good quality (Visser et al., 2021). Compared with the Web of Science Core Collection (WoS), Scopus has more comprehensive coverage, especially in Social Sciences (Martín-Martín et al., 2021). Overall, Scopus is better suited for our analysis than WoS.

Search Terms

The terms *vocational education and training* (VET) and *technical and vocational education and training* (TVET) are widely used internationally; nevertheless, the multidimensionality of the interface mentioned at the beginning require an expansion of the search term. In this study, we used the following terms to scan the title and the keywords: *Vocational education, vocational training, VET (and excluded veterin*), TVET, work-based learning,*

workplace learning, apprentice, skill formation, further education, further training, industrial education, industrial training, technical education and technical training.*

Delimitation of the search area

The search was limited to the document-type *article* and *review* and the period from 2011 to 2020. Another limitation was the subject area, which was restricted to the social sciences. Publications without country information of the author were excluded, and the source type was limited to journals, as these are the most widely noticed and therefore most accurately reflect the state of knowledge. The publication stage (final and in press) and the language (e.g., English, Spanish, French, German) were not restricted. The last search update took place on June 5, 2021. Delayed 2020 articles added to Scopus after that date were not included.

Eligibility and Appraisal

One strength of scoping reviews is that they can provide an overview of a research topic or area. Our study considers peer-reviewed articles published between 2011 and 2020 and recorded in Scopus. In total, 5,474 articles are included in our analysis. However, scoping reviews also have weaknesses. A central one is that scoping reviews "do not, for example, assess the quality of the evidence in primary research reports in any formal sense" (Arksey & O´Malley, 2005, p. 30). For this reason, the data source used (here: a curated database, Scopus, containing only peer-reviewed articles) is particularly important. As we relayed on papers published in peer-revied journals, recorded in Scoupus, we did no further quality-related check of the content of the papers. All identified studies from the field of social sciences that matched the search terms were included in our analysis without further quality control.

2.2 Data Analysis

In a comparative analysis of nine bibliometric software tools (Bibexcel, CiteSpace, CoPalRed, IN-SPIRE, Leydesdorff's Software, NetworkWorkbench Tool, Science of Science [Sci2 –Tool] VantagePoint and VOSViewer) the developers of SciMAT found that "not all the software tools are able to extract all the bibliometric networks, and, so, different tools have to be used to analyze a field from different perspectives" (Cobo et al., 2011a, p. 1400). We used two bibliometric software tools: VOSViewer and SciMAT. The strengths of VOSViewer lie in the visualisation of clusted networks (here: networks of countries, journals, and authors). Whereas we used SciMAT for the concept analysis (here: references and keywords). First, we will present the software then the techniques used for the extraction of data from the data corpus.

2.2.1 VOSViewer and SciMAT

VOSViewer is a software tool for constructing and visualising bibliometric networks. The strengths of VOSViewer lie in the visualisation of clusted networks. The software is the result of the PhD project of van Eck (2011), in collaboration with Waltman (van Eck & Waltman, 2007) at the Erasmus University of Rotterdam, the Netherlands.

Calculation of the relatedness of objects: The analysis starts in VOSViewer with the production of a data matrix based on bibliographic coupling, co-citations or co-occurrences. *Normalisation of the relatedness scores*: This data matrix is normalised in a second step to yield a similarity matrix. To calculate the similarity of the two items, the association strengths technique is used. In direct comparison, the probabilistic measures of the association strengths technique exhibit better normalisation than the set-theoretic measures of, for instance, the Jaccard index (van Eck & Waltman, 2009).

After construction of the data matrix, the network is visualised by means of, first, VOS mapping technique and, second, VOS clustering technique. In a comparison of the VOS mapping technique with more familiar multidimensional scaling (MDS), the authors found that MDS is prone to circularity, whereas VOS does not have this problem. "We have found that maps constructed using the VOS approach provide a more satisfactory representation of the underlying data set than maps constructed using either of the MDS approaches" (van Eck et al., 2010, p. 16).

Nodes (and their relations) in a map can be either graph-based or distance-based in terms of how they are visualised. "Distance-based maps are maps in which the distance between two items reflects the strength of the relation between the items. A smaller distance generally indicates a stronger relation" (van Eck & Waltman, 2010, p. 525). For graph-based maps, the criterion for visualisation is not distance or proximity to show the strength of relationships but aesthetically pleasing graphs, which is why unlimited iterations are possible in approximating the visual optimum (e.g., Fruchterman & Reingold, 1991). In short, distance-based representations are more informative than graph-based maps. VOSViewer produces *distance-based maps* and uses a mapping technique for the construction of the maps, which the authors call *visualisation of similarities* (VOS).

The VOS clustering technique can be regarded as an alternative to other clustering techniques, such as hierarchical clustering (van Eck, 2011, p. 19). Clusters can produce conflicts; for example, "having well-separated clusters of items may conflict with having distances that accurately reflect the similarity or relatedness of items" (van Eck, 2011, p. 117). Mapping and clustering can nevertheless be viewed as complementary: Mapping produces detailed maps on continuous data, while clustering produces coarse maps on binary data (Waltman et al., 2010). A cluster "is a set of closely related nodes. Each node in a network is assigned to exactly one cluster. The number of clusters is determined by a resolution parameter. The higher the value of this parameter, the larger the number of clusters" (van Eck & Waltman, 2014, p. 295).

Waltman and van Eck use an algorithm they call a *smart local moving algorithm* to detect and optimise the clusters (Waltman & van Eck, 2013).

SciMAT (Science Mapping Analysis Software Tool) was developed at the University of Grenada in Spain by Cobo, López-Herrera, Herrera-Viedma and Herrera (Cobo et al., 2012). The workflow is comparable with the described process of VOSViewer: Network extraction with a data matrix as a result, normalisation with a similarity matrix as a result, mapping combined with clustering and, finally, the visualisation. Different network extraction techniques are offered, such as co-occurrence, coupling and direct linkage, and different normalisation techniques can be used, such as association strengths, Salton's cosine and the Jaccard index. To get the map and its associated clusters, a clustering technique must be applied. The developers implemented, among other techniques, the simple center algorithm, which we used in our study for two reasons: The simple center algorithm is an accepted and often used algorithm in co-word-studies. Furthermore, "the simple centers algorithm automatically returns labelled clusters, so a post-process to label the clusters is not needed." (Cobo et al., 2011b, p. 149). The labels of the clusters in Figures 7 and 8 have their origin in the application of this algorithm.

We used SciMAT for the concept analysis. SciMAT adds another analysis step to the already described analysis process: Callon's density and centrality measures, as network measures are detected for each identified cluster (Callon et al., 1991; Cobo et al., 2012). The result of this additional analysis is a strategic map with four sectors (Figure 1).

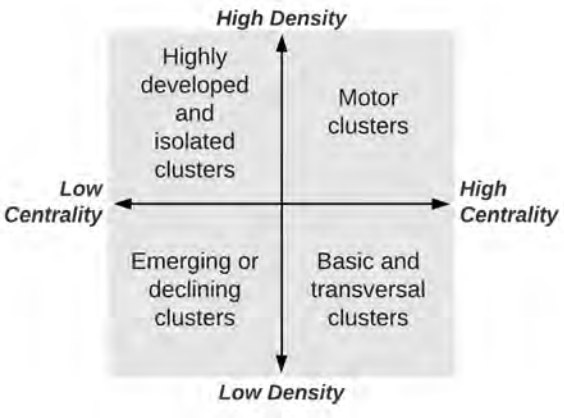

Figure 1: Strategic Map (Based on Cobo et al., 2012, p. 1618)

Themes in the quadrant *motor clusters* (top right) with high density and high centrality measures "are both well developed and important for the structure of the research field" (Cobo et al., 2018, p. 265). Themes in the quadrant of *highly developed and isolated clusters* (top left)

with high density and low centrality are highly specialised, with intense internal ties within the cluster but weak external ties with other clusters. Themes in the quadrant emerging or declining clusters (bottom left) are "both weakly developed and marginal. The themes in this quadrant have low density and low centrality and mainly represent either emerging or disappearing themes" (Cobo et al., 2018, p. 265). Themes in the *quadrant basic and transversal clusters* (bottom right) have high centrality but low density. Themes in this quadrant are important, with mainly general, basic themes.

2.2.2 Bibliographic Coupling, Co-Citation Analysis and Co-Occurrence Relations

Bibliographic coupling is "about the overlap in the reference lists of publications. The larger the number of references two publications have in common, the stronger the bibliographic coupling relation between the publications" (van Eck & Waltman, 2014, p. 287). It is defined as follows: "A single item of reference used by two papers was defined as a unit of coupling between them" (Kessler, 1963, p. 10). Therefore, if two entities (e.g. authors) share the same reference(s), they are bibliographically coupled. The strength of the link increases with the number of shared references. Another method to identify similarities between entities is via popular co-citation analysis (Figure 2). *Co-citation* "is defined as the frequency with which two documents are cited together" (Small, 1973, p. 265).

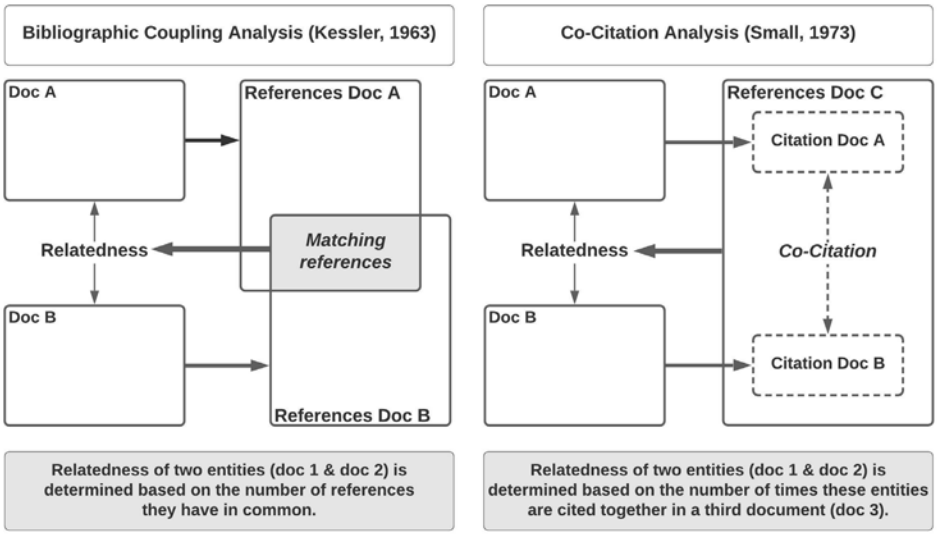

Figure 2: Comparison Between Bibliographic Coupling and Co-Citation Analysis

Co-citation analysis relies on a third document (Figure 2: Doc C) to identify links between documents. Because of this prerequisite, it is difficult to discover links between documents that have been published recently. Bibliographic coupling is, conversely, "able to cluster very recent papers" (Boyack & Klavans, 2010, p. 2391). In the search for the most accurate cluster solution of "pure citation-based approaches, bibliographic coupling gave the most accurate solution, followed closely by co-citation analysis" (Boyack & Klavans, 2010, p. 2402). Bibliographic coupling was used to identify the thematic similarities or latent collaboration between countries and journals. To identify the latent collaboration between authors by detecting the most cited authors, we used co-citation analysis. Bibliographic coupling and co-citation analysis are used to analyse the intellectual structure of the scientific research field with a focus on networks of countries, journals and authors (Cobo et al., 2011a).

A co-occurrent relation is, in contrast to bibliographic coupling and co-citation analysis, "established between two units (authors, terms, or references) when they appear together in a set of documents; that is, when they co-occur throughout the corpus" (Cobo et al., 2012, p. 1611). The more frequent the number of common occurrences or co-occurrences, the stronger the relation between the units (here: References and keywords). A third document (figure: Doc C), as in the case of co-citation analysis, is not required. In addition, an identical match, as in the case of bibliographic coupling, is not required. Co-occurrence analysis can detect latent patterns linking different entities. Co-occurrence analyses are used to analyse the conceptual structure of the scientific research area with a focus on references and keywords (Cobo et al., 2011a).

The processing of cited references is a challenging task because the form of citations can differ. "VOSviewer starts by parsing cited references in order to identify their constituent elements, such as author names, publication years, source titles, volume numbers, and so on" (van Eck & Waltman, 2020, p. 31). After parsing the references, a match key for each reference is constructed by combing the name of the first author, the publication year, the volume (if not available the journal title) and the beginning page number (or, if the beginning page number is not available, the article number). If no match key can be constructed, the DOI is used, and if no DOI is available, the raw reference string is used as the match key. Match keys were constructed for each document. If matching match keys between documents exist, a bibliographic coupling link is established. Bibliographic coupling links between countries, journals and authors are "aggregated from the level of individual documents to the aggregate level" (van Eck & Waltman, 2020, p. 32).

3 Results

3.1 Data Corpus

Basic information about the selected data is shown in Table 1.

Table 1: Data Corpus

Variable	Timespan				
	2011–2012	2013–2014	2015–2016	2017–2018	2019–2020
Documents	830	864	1,093	1,128	1,561
Authors	1,654	1,868	2,416	2,729	3,884
Average citations per documents	13.30	10.66	7.93	5.35	2.41
Average cit. per year per doc.	1.27	1.26	1.22	1.20	0.96
References	29,952	33,754	43,003	46,307	65,426
References per doc	36.09	39.07	39.34	41.05	41.91
Author's keywords per doc	2.82	2.91	3.04	3.11	2.96
Authors of single-authored documents	305	288	305	310	342
Authors of multi-authored documents	1,349	1,580	2,111	2,419	3,542
Single-authored documents	320	307	334	326	365
Multi-authored documents	510	557	759	802	1196
Documents per author	0.50	0.46	0.45	0.41	0.40
Authors per document	1.99	2.16	2.21	2.42	2.49
Co-authors per documents	2.24	2.36	2.50	2.63	2.79

Analysis with r pagage bibliometrix (Aria & Cuccurullo, 2017). Article N = 5,474.

The number of articles has increased by 731 in 10 years, from 830 to 1,561. This represents an increase of 88%. While the growth of articles was moderate from 2011 to 2018, there has been considerable growth since 2019. Furthermore, the number of authors has risen even more sharply, by 2,230, from 1,654 to 1,561 in 10 years. This represents an increase of 135%. Overall, it can be noted that the number of indexed actors in the field has increased. The figures show that the subject area studied has gained considerable scientific importance over the last 10 years.

The number of single-authored articles increased only slightly by 45 articles over the study period, from a total of 320 in 2011 and 2012 to a total of 365 articles in 2019 and 2020. This small growth corresponds to an increase of 14%. In contrast, the number of multi-authored articles increased massively by 686 articles over the study period, from a total of 510 articles in 2011 and 2012 to a total of 1,196 articles in 2019 and 2020. This growth corresponds to an increase of 135%. While the ratio of single-author articles to multi-author articles was 39.61% in 2011/12, the ratio in 2019/2020 is 23.77%. The number of authors per article has

also grown from about 2 in 2011/2012 to 2.5 in 2019/2020. How are these values to be interpreted? Harzing and Alakangas (2016) found in their study that social sciences and humanities academics published papers with 2 to 2.5 authors. The determined number of 2.5 authors per article is thus not conspicuous in the context of these disciplines. However, it should be noted that the number of authors per article is increasing, which may be an indicator that the problems studied have become more complex. In addition, the scientific field as a whole can be described as cooperation-oriented, with almost 80% of articles being multi-author.

3.2 Analysis of Countries

3.2.1 Local Most Productive and Most Cited Countries

Based on a bibliographic coupling link analysis, the local (in the data corpus) most productive (in the sense of the number of papers published) and most cited countries are shown in Table 2. In the bibliometric data, each author is indicated with his or her institutional affiliation, which in turn determines the country affiliation. Thus, the country affiliation does not refer to the nationality of the scientist, but to the nationality of the science environment, the science institution and community hosting her of him.

The threshold for including a country in the analysis was set to a minimum number of 30 published articles per country. Thirty-four countries met the threshold. For each of the 34 countries, the number of articles (Art.) and citations (Cit.), the article effectiviness (AE) and the total bibliographic coupling links strengths (TBCLS) were calculated. The number of articles for a country refers to the total number of articles in the selected local data corpus. The number of counted citations of a country refers to the total number of citations of an article that Scopus records for the respective article. The counting method used to calculate the TBCLS was fractional. Fractional counting means that the weight of a bibliographic link is fractionated and thus proportionally divided and distributed among the countries of the co-authors. If multiple author countries are involved in an article, for example, and the total number of author countries is 3, then the bibliographic coupling links of a co-authorship country has a weight of 1/3. The countries in Table 2 are sorted in descending order according to the total bibliographic coupling link strengths (TBCLS).

Table 2: Local Most Productive and Most Cited Countries

Country	Art.	Cit.	AE	TBCLS	Country	Art.	Cit.	AE	TBCLS
United Kingdom	965	8440	8.75	12360	Denmark	73	710	9.73	1534
United States	695	6912	9.95	9888	Austria	51	358	7.02	1490
Germany	428	3526	8.24	8592	Italy	75	391	5.21	1241
Australia	517	5792	11.20	8399	Taiwan	80	884	11.05	1196
Netherlands	283	4018	14.20	6913	Brazil	109	232	2.13	1080
Switzerland	188	1431	7.61	4760	Portugal	45	215	4.78	1012
Finland	132	1499	11.36	3928	South Korea	43	263	6.12	999
Canada	179	2353	13.15	3822	Indonesia	82	231	2.82	978
Sweden	178	1382	7.76	3740	India	76	472	6.21	937
China & Hong Kong	155	825	5.32	2840	Ireland	42	296	7.05	823
Belgium	75	937	12.49	2715	Turkey	73	213	2.92	815
Spain	237	979	4.13	2405	Greece	47	118	2.51	796
Norway	87	564	6.48	2251	Nigeria	51	95	1.86	786
South Africa	117	738	6.31	2005	Russia	241	701	2.91	745
New Zealand	72	578	8.03	1851	Chile	35	92	2.63	614
France	155	528	3.41	1739	Slovenia	30	102	3.40	492
Malaysia	162	538	3.32	1610	Thailand	34	62	1.82	339

Art. = Articles, Cit. = Citations, AE: Article Effectiveness = Citations/Articles, TBCLS = Total Bibliographic Coupling Link Strengths; analysis and calculation by VOSViewer.

The country with the highest number of publications (N=965) and citations (N=8440) is, by far, the United Kingdom, followed by the United States of America and Australia. The country with the highest publication effectiveness is the Netherlands (14.2), followed by Canada and Belgium. The country with the highest total bibliographic coupling links is again the United Kingdom (12360) followed by the United States of America and Germany.

3.2.2 Bibliographic Coupling Between Countries

Bibliographic couling means that if two documents share the same reference(s), they are bibliographically coupled. Since the representation of the visualisation in Figure 3 is distance-based, this means that the closer two countries are in the network, the more similar the literature references used. We made the following assumption: The similarity of the used literature references between countries can be interpreted as the similarity of thinking between countries. After the calculation of the strengths of the total bibliographic coupling link, we clustered the network two times: The first time with a resolution of 1.0 (Figure 3a) and the second time with a coarser resolution of 0.8 (Figure 3b). The distance-based graph does not change, as this graph is based on the bibliographic coupling links between each country, but the clusters are different.

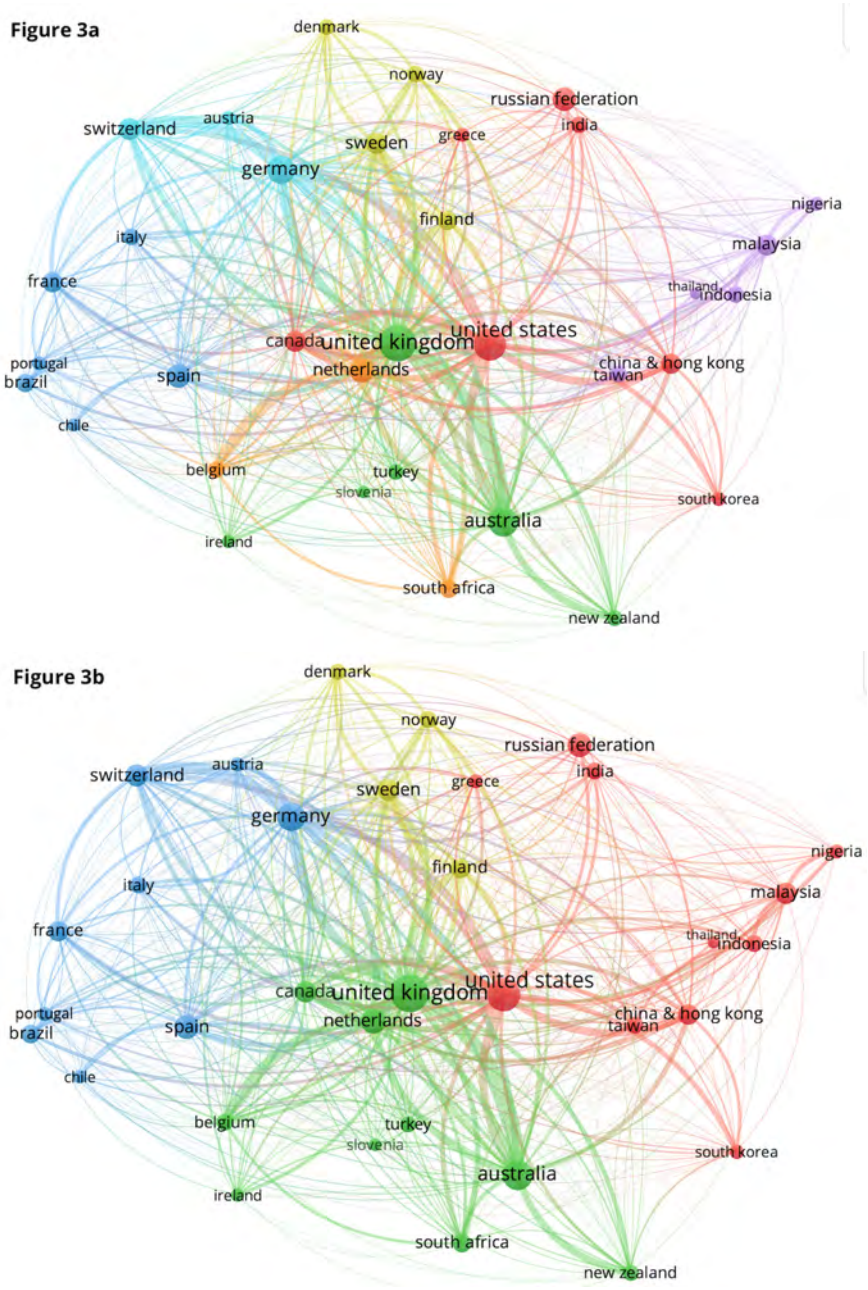

Figure 3: Bibliographic Coupling Between Countries (Weights: TBCLS)

Brief summary of the method – the key parameters used to calculate and visualise the country network and clusters: The type of analysis is a bibliographic coupling. The unit of analysis is countries. The threshold is a minimum of 30 documents from one country. We selected all

countries that resulted (N=34). Relatedness was calculated using the fractional count method and an attraction coefficient of 2 and a repulsion coefficient of 1. Normalisation of relatedness values was performed using the association strength technique. Cluster resolution was set to 1.0 in Figure 3a and 0.8 in Figure 3b.

In Table 3, the two solutions (Figure 3a and Figure 3b) are presented. The countries are sorted within the cluster in descending order based on their total bibliographic coupling link strengths.

Table 3: Clusters of Countries Based on Bibliographic Coupling

Cluster		Countries	Cluster	Colour 3b
1	Red	United States of America, Canada, China & Hong Kong, South Korea, India, Greece, Russian Federation	1	Red[1]
2	Purple	Malaysia, Nigeria, Taiwan, Indonesia, Thailand		
3	Blue	Spain, France, Italy, Brazil, Portugal, Chile	2	Blue
4	Cyan	Germany, Switzerland, Austria		
5	Green	United Kingdom, Australia, New Zealand, Ireland, Turkey, Slovenia	3	Green[2]
6	Orange	Netherlands, Belgium, South Africa		
7	Yellow	Finland, Sweden, Norway, Denmark	4	Yellow

[1] without Canada, [2] with Canada; analysis and calculation by VOSViewer

The seven-cluster solution (Figure 3a) partly confirms assumptions of homogeneity: The German-speaking countries Germany, Switzerland and Austria are grouped within one cluster (cyan), and the Romance-speaking countries Spain, France, Italy, Portugal, Brazil and Chile are grouped in another cluster (blue). Malaysia, Indonesia, and Thailand together form a Southeast Asia cluster (purple), but this cluster also includes Taiwan and Nigeria. Nigeria is surprising at first glance, but understandable because Nigeria and Malaysia have a great closeness in TVET development and cooperation (Mohammad & Ismail, 2019). Taiwan is more closely situated to China in the distance-based map (therefore a high bibliographic coupling) but, after clustering, placed together with Malaysia, Indonesia, Thailand, and Nigeria within one cluster (purple). The researchers from Finland, Sweden, Norway, and Denmark form another regional cluster (yellow), as do the United Kingdom, Australia, New Zealand and Ireland, together with Turkey and Slovenia (green). The Netherlands, Belgium and South Africa together form a small sixth cluster (orange), and the United States of America, along with the Russian Federation, Canada, China & Hong Kong, India, Greece, South Korea a seventh large cluster (red). In the four-cluster solution, some clusters remain largely stable (red, blue, green and yellow), while others merge: the German-speaking and the Romance-

speaking countries are forming a joint cluster, the clusters led by the United Kingdom and the Netherlands, and the clusters led by the United States and Malaysia form another cluster.

The similarity of thinking appears to be influenced by historical-cultural, regional-economic and/or political factors (e.g., Finland, Sweden, Norway, and Denmark; Malaysia, Indonesia, and Thailand; United Kingdom, Australia, and New Zealand). Partial correspondence exists with typologisations that also lead to clusters: In the seven-cluster version, the German-speaking cluster (Germany, Switzerland, and Austria) can be clearly identified as countries with a *collective skill formation system*; however, while the UK and USA are in our analysis in different clusters, both should be situated in one cluster named *liberal skill formation system*. Also, Sweden and France are in different clusters in our analysis, but both countries should be merged in a cluster named the *statist skill formation system* (Busemeyer & Trampusch, 2012; Busemeyer & Iversen, 2012). Greinert (1999, 2004) distinguishes three prototypes of vocational training regimes: A dual-corporatist model, as implemented in Germany; a state-regulated bureaucratic model, as implemented in France; and a liberal market economy model, as implemented in the United Kingdom. In the seven-cluster solution, our analysis agrees with Greinert's, but in the four-cluster solution, Germany, and France merge into one cluster. Only the United Kingdom is in a different cluster. Also, the typology of Pilz does not fit to the identified clusters: Pilz (2016) assigns the USA, India, and China to different purposes. In both cluster analysis versions, these countries form a common cluster. However, this need not be a contradiction insofar as the typologisation by Greinert and Pilz represents a finer level of detail than the clusters presented here. Furthermore, despite the diversity of Scandinavian VET systems (Jørgensen et al., 2018), researchers from Finland, Sweden, Norway, and Denmark form a joint cluster. We can draw the following conclusion: Despite the diversity of vocational education and training systems in different countries, there is a high degree of convergence within clusters and divergence between clusters in thinking, which is expressed in the formation of different bibliographic coupled clusters.

3.3 Analysis of Journals

3.3.1 Local Most Productive and Most Cited Journals

Based on a bibliographic coupling link analysis, the local most productive and most cited journals are shown in Table 4. The threshold for including a country in the analysis was set to a minimum number of 5 published articles per country. The 30 journals with the highest bibliographic coupling link strengths were selected. For each of the 30 journals, the number of articles (Art.) and citations (Cit.), the article effectiviness (AE) and the total bibliographic coupling links strengths (TBCLS) were calculated. The number of articles for a journal refers to the total number of articles in the selected local data corpus. The number of citations

counted for a journal refers to the total number of citations of an article that Scopus records for the respective article. The counting method to calculate the TBCLS was full counting: Each bibliographic coupling link of a journal has a weight of 1. The coverage period in Scopus (Cov.) was checked, as not all journals cover the full period from 2011 to 2020. The coverage of the *Journal of Technical Education and Training* started in 2016, and the coverage of the *International Journal for Research in Vocational Education and Training* in 2014. The journals in Table 4 are sorted in descending order according to the total bibliographic coupling link strengths (TBCLS) of the individual journal.

Table 4: Local Most Productive and Most Cited Journals

Journal	Cov.	Art.	Cit.	AE	TBCLS	C^1	C^2
Journal of Vocational Education and Training	[1]1996	281	2232	7.94	35506	1	1
Vocations and Learning	2009	98	1330	13.57	25507	2	2
Journal of Workplace Learning	1997	132	1115	8.45	24122	2	2
Higher Education, Skills and Work-Based Learning	2010	146	684	4.68	16384	3	3
Research in Post-Compulsory Education	1996	111	476	4.29	12579	4	3
Journal of Education and Work	2005	79	601	7.61	12290	1	1
International Journal of Training Research	2012	113	404	3.58	10298	6	1
International Journal for Research in VET	2014	99	463	4.68	9358	1	1
Education and Training	1959	70	657	9.39	8783	3	3
Studies in Continuing Education	[2]1978	35	270	7.71	7898	2	2
Advances in Health Sciences Education	1996	33	684	20.73	7060	5	2
Journal of Further and Higher Education	1977	54	313	5.80	6212	4	3
Empirical Research in VET	2009	80	465	5.81	5627	1	1
Professional Development in Education	2009	16	117	7.31	3453	2	2
International Journal of Lifelong Education	1982	17	85	5.00	3173	1	1
Studies in Higher Education	1976	19	275	14.47	3081	4	3
Teaching and Teacher Education	1985	15	533	35.53	2815	2	2
Medical Education	1966	16	1094	68.38	2724	5	2
Teaching in Higher Education	2005	12	162	13.50	2466	3	3
BMC Medical Education	2001	47	741	15.77	2278	5	2
British Journal of Educational Technology	1970	19	386	20.32	2229	2	2
Medical Teacher	1979	36	1559	43.31	2172	5	2
Learning Organization	1994	10	98	9.80	1987	2	2
Zeitschrift für Erziehungswissenschaft	2008	28	168	6.00	1925	1	1
Formation Emploi	[3]2012	54	51	0.94	1880	1	1
Industry and Higher Education	1996	16	47	2.94	1808	3	3
Sport, Education and Society	1996	8	43	5.38	1721	4	3
Bitish Journal of Sociology of Education	1980	19	202	10.63	1693	4	3
Journal of Technical Education and Training	2016	72	155	2.15	1651	6	2
European Journal of Education	2005	17	121	7.12	1646	1	1

Cov. = Covered years in Scopus (according to Scimago), Art. = Articles, Cit. = Citations, AE: Article Effectiveness = Citations/Articles, TBCLS = Total Bibliographic Coupling Link Strengths, C^1 = Six-cluster-solution, C^2 = Three-cluster-solution; [1] the journal changed in 1996 with the first issue of Volume 48 its title from *The Vocational Aspect of Education* to the *Journal of Vocational Education and Training*. [2] without the years 1983 – 1987, [3] the coverage ends in 2019; analysis and calculation by VOSViewer.

The journal with the highest number of publications is, by far, the Journal of Vocational Education and Training (N=281) followed by the journals Higher Education, Skills and Work-Based Learning (N=146) and the Journal of Workplace Learning (N=132). The journal with the highest number of citations is also, by far, the Journal of Vocational Education and Training (N=2232) followed by Vocations and Learning (N=1330) and Journal of Workplace Learning (N=1115). The journal with the highest publication effectiveness is Medical Education (68.38), followed by Medical Teacher (43.31) and Teaching and Teacher Education (35.53). Despite this high effectiveness of the medical journals, the Journal of Vocational Education and Training, Vocations and Learning and the Journal of Workplace Learning show the highest total bibliographic coupling link strengths, which means that they have the highest bibliographic embeddedness in the considered research field.

3.3.2 Bibliographic Coupling Between Journals

To identify the reference overlap between journals, we again used the bibliographic coupling method. Since the representation of the visualisation in Figure 4 is distance-based, this means that the closer two journals are in the network, the more similar the literature references used.

Brief summary of the method – the key parameters used to calculate and visualise the journal network and clusters: The type of analysis is a bibliographic coupling. The unit of analysis is journals. The threshold is a minimum of 5 articles from one journal. We selected the 30 journals with the highest total link strengths in the data corpus. Relatedness was calculated using the full counting method and an attraction coefficient of 2 and a repulsion coefficient of 1. Normalisation of relatedness values was performed using the association strength technique. Cluster resolution was set to 1.1 in Figure 4 and 1.0 in Figure 5.

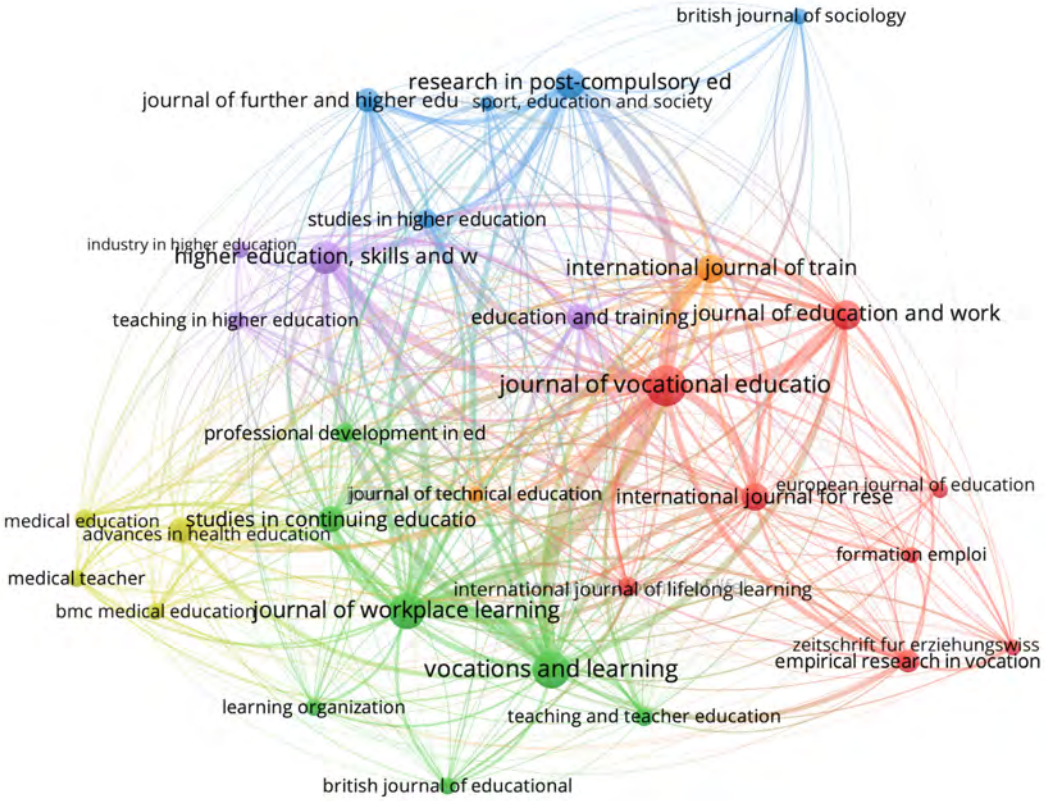

Figure 4: Bibliographic Coupling Between Journals With six Clusters (Weights: TBCLS)

After the calculation of the total bibliographic coupling link strengths, we clustered the network with a resolution of 1.1 (greater detail) and received 6 clusters (Figure 4) with 8 (red), 7 (green), 5 (blue), twice 4 (purple and yellow) journals and one cluster with 2 journals (orange). The biggest cluster, with 8 journals (red), can be considered "VET research with high reference to educational research". The second core cluster, with 7 journals (green), can be described as "VET research with a focus on workplace learning and professional development". Accordingly, the third cluster (yellow), "VET research in medical education", is located close to this second green cluster. Equally appropriately, the purple cluster with 4 journals is positioned close to the second and third clusters, with its focus on "work-based learning and higher education". This purple cluster is followed by a blue cluster that focuses more on "higher education and continuing vocational education and training". The smallest orange cluster is unusual because the respective journals are embedded in other clusters due to the high bibliographic coupling link strengths with other journals. Regionality[1] could be an explanation for this phenomenon.

1 The *International Journal for Training Research* focuses on VET in Australia and internationally, and the Technical Journal of Edcuation and Training on VET in the the South Asian region and internationally.

In the second approach, we clustered the journals with a regular resolution (1.0) and received a three-cluster solution (Figure 5).

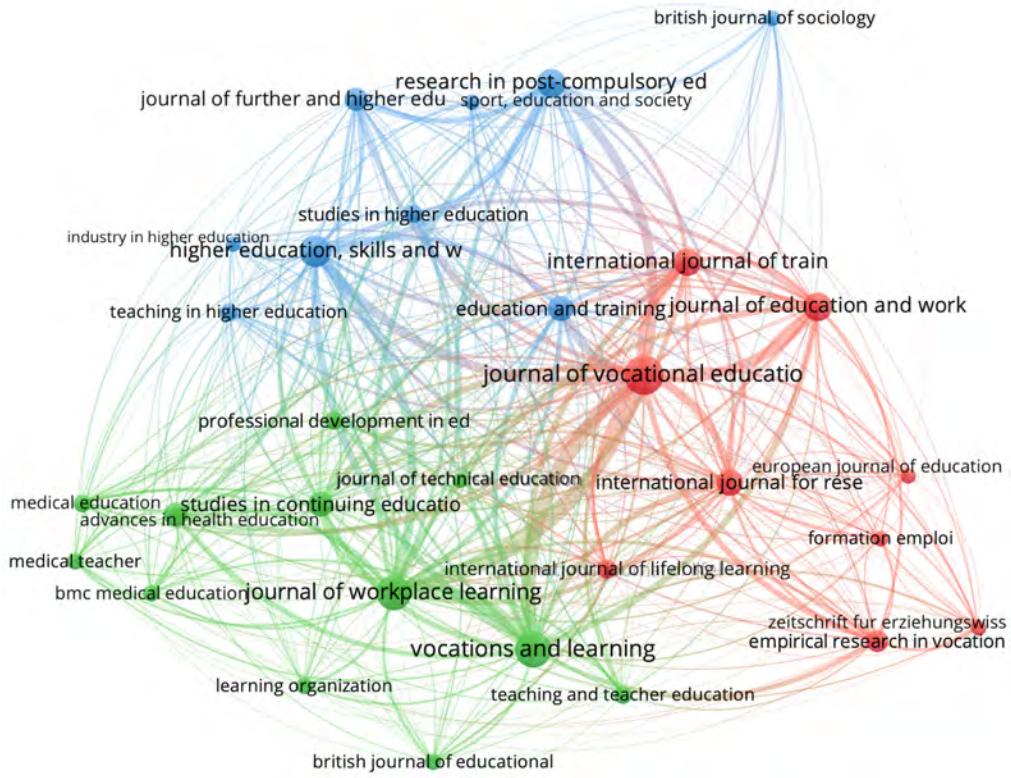

Figure 5: Bibliographic Coupling Between Journals With Three Clusters (Weights: TBCLS)

The three-cluster solution (Figure 4) reinforces the trend already visible in the six-cluster solution: The cluster "VET research with high reference to educational research" (red) has increased; the clusters "VET research with a focus on workplace learning and professional development" and "VET research in medical education" merged into "workplace learning, professional development and medical education" (green); and the two clusters "work-based learning and higher education" and "higher education and continuing vocational education and training" merged into "work-based learning, higher education and continuing vocational education and training" (blue). The small orange cluster (Figure 4) has dissolved and is now embedded. It is recognisable that the research field as a whole is not mono-disciplinary, with only one scientific approach, but multi-disciplinary.

3.4 Analysis of Authors

3.4.1 Most Productive Authors

The most productive authors within our data sample, along with their most cited articles published between 2011 and 2020, are listed in Table 5.

Table 5: Most Productive Authors With 10 or More Articles

Author	Cou.	Art.	Most cited article in the data corpus (2011–2020)	Year	Cit.
Pilz, M.	DE	28	"Typologies in Comparative Vocational Education: Existing Models and New Approach"	2016	37
Cattaneo, A.	CH	21	"The 'Erfahrraum': A Pedagogical Model for Designing Technologies in Dual Systems"	2015	30
De Bruijn, E.	NL	18	"Authentic and Self-Directed Learning in Vocational Education and Training: Challenges to Vocational Educators"	2011	92
Tran, L.	AU	17	"Mobility as Becoming: Bourdieuian Analysis of the Factors Shaping International Mobility"	2016	79
Billett, S.	AU	14	"Learning through Work: Emerging perspectives and new challenges "	2013	92
Smith, R.	UK	13	"New Public Management in an Age of Austerity: Knowledge and Experience in Further Education"	2013	33
Rosvall, P.	SE	13	"The Vocational-Academic Divide in Neoliberal Upper Secondary Curricula: The Swedish Case"	2017	29
Gurtner, J.	CH	12	"The 'Erfahrraum': A Pedagogical Model for Designing Technologies in Dual Systems"	2015	30
Baartman, L	NL	12	"Students' Learning Processes during School-Based Learning and Workplace Learning in Vocational Education: A Review"	2012	85
Nylund, M.	SE	11	"The Vocational–Academic divide in Neoliberal Upper Secondary Curricula: The Swedish Case"	2017	29
Chan, S.	NZ	11	"Learning Through Apprenticeship: Belonging to a Workplace, Becoming and Being, Vocations and Learning"	2013	35
Lester, S.	UK	11	"Work-based Doctorates: Professional Extension at the Highest Levels"	2012	48
Avis, J.	UK	10	"Socio-Technical Imaginary of the Fourth Industrial Revolution and Its Implications for Vocational Education and Training: A Literature Review"	2018	33
Simmons, R.	UK	10	"Ordinary Lives: An Ethnographic Study of Young People Attending Entry to Employment Programmes"	2011	19
Taylor, A.	CA	10	"'Made in the Trade': Youth Attitudes Toward Apprenticeship Certification"	2011	20
Smith, E.	AU	10	"What Makes a Good VET Teacher? Views of Australian VET Teachers and Students"	2017	11

Cou. = Country, Art. = number of articles in the sample, "most cited" Cit. = number of scopus citations of the named article; analysis and calculation by VOSViewer.

Of the 16 authors, three are from the United Kingdom, three from Australia, two from the Netherlands, two from Sweden and Switzerland and one each from Canada, Germany, and New Zealand. The most productive authors are Pilz from the University of Cologne in Germany followed by Cattaneo from Swiss Federal University for Vocational Education and Training in Switzerland and de Bruijn from Open University in the Netherlands.

3.4.2 Most Cited Authors

To identify the most cited author, we used co-citation analysis. Co-citation analysis relies on a third document to identify links between two other documents. The citation analysis is not limited to the publications included in the data corpus: the articles in the corpus have references within the data corpus but also outside of it, especially from a temporal perspective. Thus, its limitation is not based on the decade considered, as in the above analysis of the most productive authors of the last decade, but on the authors' assumptions about which authors are relevant to their own work. We set the threshold to 50 citations of an author, calculated the total co-citations links strengths, and selected the 250 authors with the greatest total co-citations link strengths (TCCLS). The resulting co-citation network is shown in Figure 6.

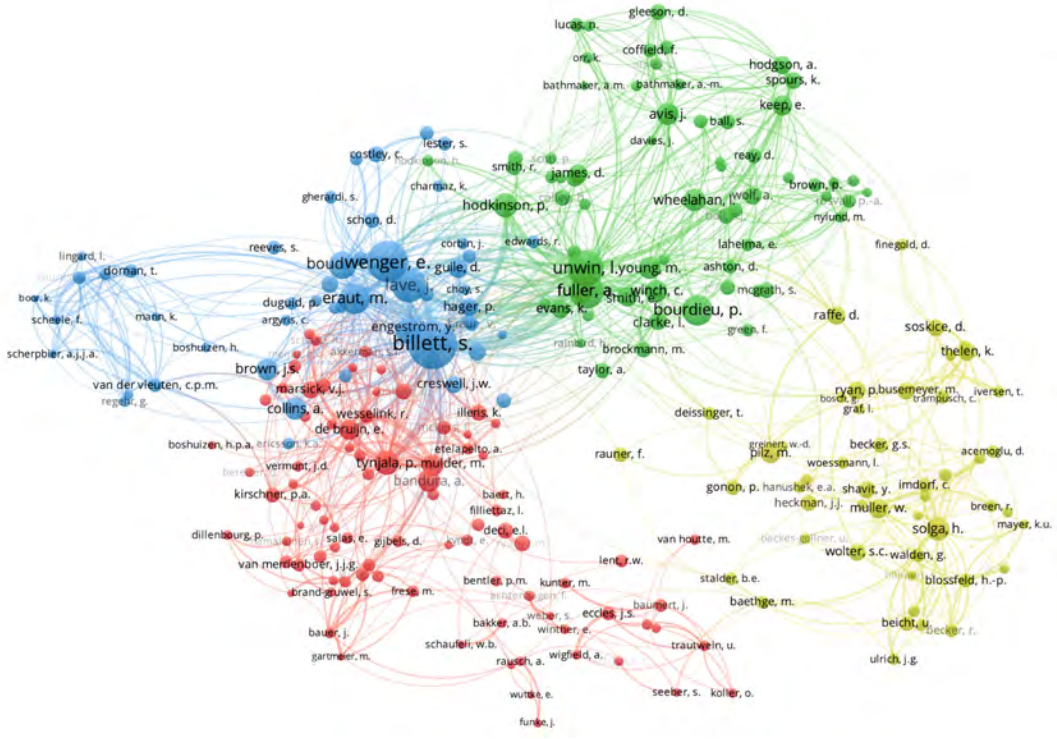

Figure 6: Co-Citation Analysis of the 250 Most Influential Authors (Weights: TCCLS)

Brief summary of the method – the key parameters used to calculate and visualise the cited author network and clusters (Figure 6): The type of analysis is a co-citation analysis, and the unit of analysis is cited authors. Threshold: An author must be cited at least 20 times. We selected the 250 cited authors with the highest total co-citation link strengths in the data corpus. Relatedness was calculated using the fractional counting method, an attraction coefficient of four and a repulsion coefficient of one. Normalisation of relatedness values was performed using the association strength technique. Cluster resolution was set to 1.0.

Of the 250 authors, we selected the 30 most cited authors within our data sample (Table 6).

Table 6: The 30 Most Cited Authors

Author	Cou.	Cit.	TCCLS	Author	Cou.	Cit.	TCCLS
Billett, S.	AU	1121	21855	Engeström, Y.	FI	359	5989
Unwin, L.	UK	660	15011	Keep, E.	UK	255	5483
Fuller, A.	UK	592	13371	Solga, H.	DE	307	5271
Wenger, E.	US	827	11943	Wheelahan, L.	CA	298	5090
Eraut, M.	UK	502	9859	Clarke, L.	UK	216	5006
Tynjala, P.	FI	350	9354	James, D.	UK	233	4856
Lave, J.	US	618	9007	Bourdieu, P.	FR	502	4551
Hodkinson, P.	UK	349	8290	Evans, K.	UK	201	4324
De Bruijn, E.	NL	250	7292	Hager, P.	AU	213	4295
Winch, C.	UK	294	6640	Muller, W.	DE	221	4172
Mulder, M.	NL	265	6324	Brockmann, M.	UK	172	4145
Avis, J.	UK	284	6229	Hodgson, S.	UK	201	4055
Young, M.	UK	291	6105	Wesselink, R.	NL	140	3910
Guile, D.	UK	228	6060	Kirschner, P.A.	NL	144	3886
Boud, D.	AU	414	6015	Thelen, K.	US	210	3868

Cou. = Country, Cit. = Citations, TCCLS = Total Co-Citation Link Strengths; analysis and calculation by VOSViewer.

Interestingly, 14 of the 30 most influential authors were from the UK. Of these 14, six (Unwin, Fuller, Young, Guile, Clarke, Evans) were associated with the University College London (UCL). When researchers from the United States (3), Australia (3) and Canada (1) were included, a total of 21 researchers came from the context of liberal skill formation systems, which "combine low levels of public investment in VET with little firm involvement. In these educational systems, VET is subordinated to academic education" (Busemeyer and Iversen, 2012, p. 218). It is likely that the research strength of researchers from the aforementioned countries significantly influence the discourse on research at the boundary between learning and working.

3.5 Analysis of References

In this step, using SciMAT, we performed a co-occurrence analysis of the references, clustered the references, and developed a strategic map based on the centrality and density measures of the reference networks and clusters. For normalisation, we used the association strength method. For mapping, we employed the union mapper method, and for clustering, we used the simple center algorithm and limited the network size to four references with a limit of three references. The strategic map is shown in Figure 7.

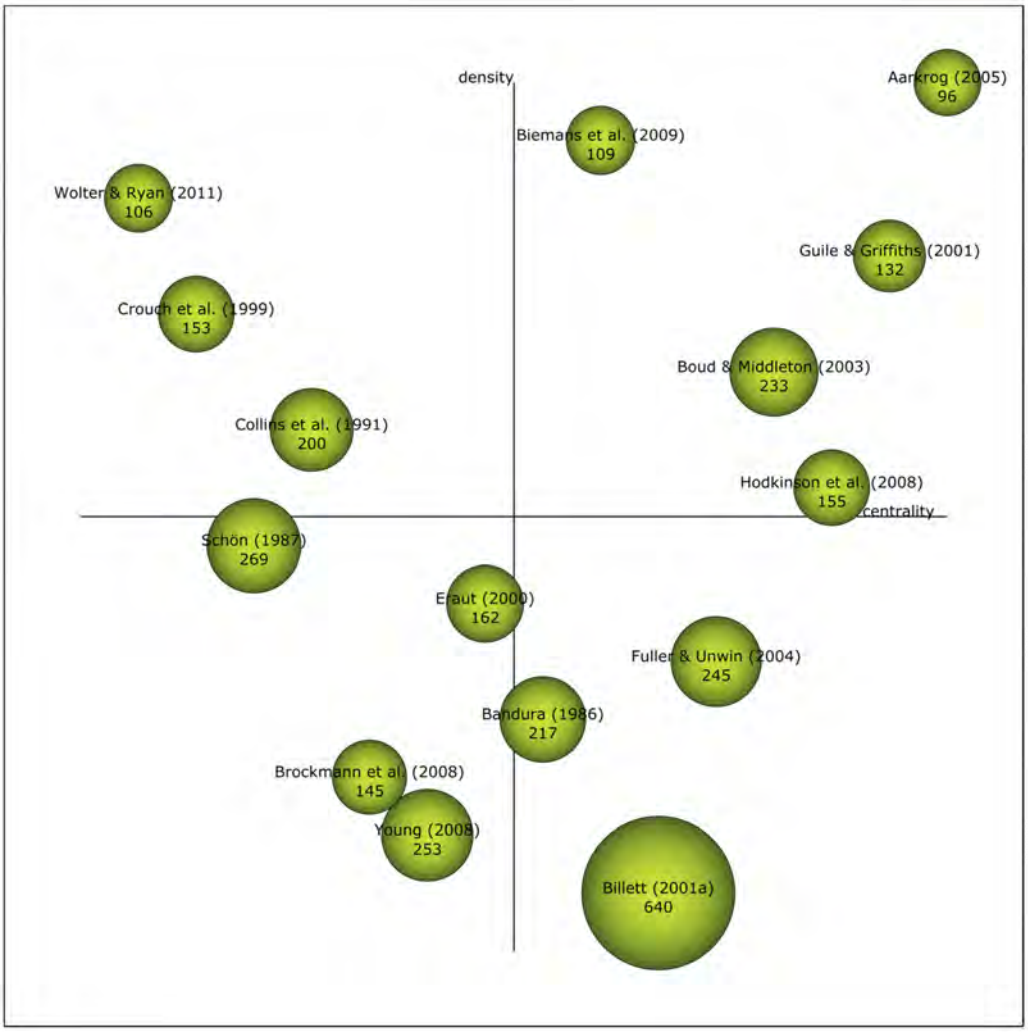

Figure 7: Strategic Map of Clustered References (Weight: Documents)

A major cluster or theme in the *motor clusters* (top right) quadrant is the Boud and Middleton (2003) cluster with its focus on workplace and informal learning. Another large cluster is Hodkinson et al. (2008) with its focus on apprenticeship training considering, for example, principles of individual and social learning. The largest cluster, Billett (2001a), in the *basic and transversal clusters* (bottom right) quadrant, which is also the largest cluster in the entire field, provides the foundations for specific additional research applications (e.g., informal learning, learning from others in the workplace) with a focus on situated learning and communities of practice. The second largest cluster in this quadrant, Fuller and Unwin (2004), represents the learning opportunities and learning constraints in the context of work and work systems. In the *highly developed and isolated clusters* (top left) quadrant, two clusters are prominent – the Crouch et al. (1999) cluster, which considers the system level and the political economy of skill creation (macro system level), and the Collins et al. (1991) cluster, which analyses the level of teaching and learning based on the cognitive apprenticeship (micro system level) approach. Within the *emerging or declining clusters* (bottom left) quadrant, the Young (2008) cluster focuses on relationships between educational policy and practice, between vocational (upper-secondary) education and employment and between learning culture and identity. In this cluster, perspectives on sociology of education are addressed. The Schön (1987) cluster also focuses on a relationship but, here, it is that between higher education and work-based learning. The other clusters and their topics should only be briefly addressed. The Aarkrog (2005) cluster focuses on the connection between work-based and school-based learning and the objects at the boundary. The Biemans et al. (2009) cluster represents the discourse on competence-based vocational education and its dilemmas and practical tensions, and the Guile and Griffiths (2001) cluster covers learning through work experiences and workplace learning. The Wolter and Ryan (2011) cluster concentrates on the economics of vocational education and training, such as costs of training and unemployment in relation to labour market conditions and/or willingness of companies to train. The focus of the Eraut (2000) cluster is the relation between professional education and learning in the workplace with slightly deep insights on adaptive and developmental learning as well as emotional and practical learning. The Brockmann et al. (2008) cluster focuses on comparative research of educational systems and their similarities and differences in the context of liberal and coordinated economies, unifying processes, such as the creation of political frameworks (e.g., European Qualifications Framework), and system reforms. The clusters briefly characterized above and shown in Figure 7 are presented in Table 7 along with other related references.

Table 7: Centrality and Density of Clustered References

Cluster Name	C	CR	D	DR	DOC	Further References Within the Cluster
Aarkrog (2005)	2.76	1	1.26	1	96	Akkerman & Bakker (2012), Griffiths & Guile (2003), Schaap et al. (2012)
Biemans et al. (2009)	1.43	0.6	1.09	0.93	109	Biemans et al. (2004), De Bruijn & Leeman (2011), Clarke & Winch (2007)
Guile & Griffiths (2001)	2.39	0.93	0.7	0.8	132	Akkerman & Bakker (2011), Billett (2002), Tynjälä (2013)
Wolter & Ryan (2011)	0.41	0.07	1.04	0.87	106	Acemoglu & Pischke (1998), Acemoglu & Pischke (1999), Ryan (2001)
Crouch et al. (1999)	0.73	0.13	0.65	0.73	153	Allmendinger (1989), Busemeyer & Trampusch (2012), Finegold & Soskice (1988)
Hodkinson et al. (2008)	1.97	0.87	0.37	0.53	155	Billett (2011), Fuller & Unwin (2003), Sfard (1998)
Boud & Middleton (2003)	1.69	0.8	0.47	0.67	233	Billett (2004), Eraut (2004), Fuller et al. (2005)
Eraut (2000)	1.25	0.47	0.34	0.4	162	Dornan et al. (2007), Ellström (2001), Eraut (2007)
Fuller & Unwin (2004)	1.62	0.73	0.32	0.33	245	Billett (2001b), Engeström (2001), Malloch et al. (2011)
Collins et al. (1991)	0.83	0.27	0.42	0.6	200	Brown et al. (1989), Collins et al. (1989), Hattie (2008)
Schön (1987)	0.83	0.2	0.37	0.47	269	Boud & Solomon (2001), Lester & Costley (2010), Schön (1983)
Brockmann et al. (2008)	0.9	0.33	0.17	0.2	145	Bathmaker & Avis (2005), Bosch & Charest (2008), Eichhorst et al. (2012)
Bandura (1986)	1.34	0.53	0.22	0.27	217	Bandura (1997), Hattie & Timperley (2007), Tynjälä (2008)
Young (2008)	1.01	0.4	0.15	0.13	253	Colley et al. (2003), Iannelli & Raffe (2007), Wolf (2011)
Billett (2001a)	1.44	0.67	0.14	0.07	640	Engeström (1987), Lave & Wenger (1991), Wenger (1998)

C = Centrality, CR = Centrality Range, D = Density, DR = Density Range, DOC = Number of Documents

In our next and final step, we analyse the keywords.

3.6 Analysis of Keywords

We used SciMAT and the co-occurrence analysis to identify the most used and most important keywords in our data corpus. We included keywords with a minimum frequency of 20 in our analysis. For the normalisation of the data, we employed the association strength method as in all other analyses. We mapped the documents using the union mapper technique and clustered the keywords and labelled the clusters using the simple center algorithm and a maximum network size of four. The measurement of the density and centrality of the clusters relative to the other clusters resulted in a strategic map of used keywords as shown in Figure 8.

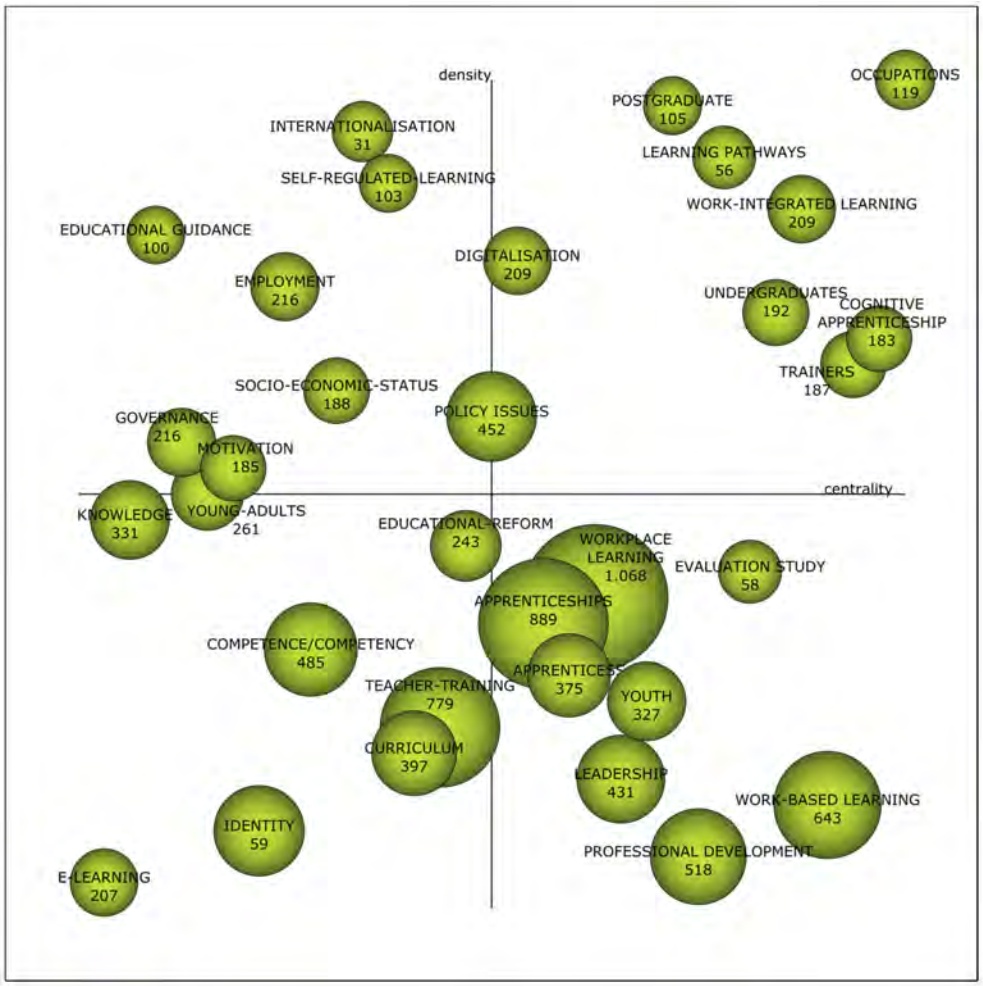

Figure 8: Strategic Map of Clustered References (Weight: Documents)

Major clusters or themes in the motor clusters (top right) quadrant are the keyword clusters *occupations, postgraduates, learning pathways, employability, digitalisation, undergraduates, cognitive apprenticeships, trainers* and close to the sector *highly developed and isolated clusters* (top left) finally the cluster *policy issues*. Major clusters in the *basic and transversal clusters* (bottom right) quadrant are the *workplace learning, evaluation study, apprenticeships, apprentices, youth, leadership, work-based learning and professional development* keyword clusters. The following keyword clusters are prominent in the *highly developed and isolated clusters* (top left) quadrant: *internationalisation, self-regulated learning, educational guidance, employment, socio-economic-status, governance, motivation* and close to the quadrant *emerging or declining clusters* (bottom left) the cluster *young adults*. Finally, the emerging or declining clusters (bottom left) quadrant

includes the *knowledge, educational reform, competence/competency, teacher training, curriculum, identity and e-learning* clusters.

The keyword clusters and their parameters (centrality range coefficient, centrality coefficient, density range coefficient, density coefficient, number of mapped documents per cluster) are shown in Table 8.

Table 8: Most Used Keywords

Name	CR	C	DR	D	MD
Occupations, Traineeships, Qualifications, Trades	1.00	0.97	1.00	0.27	119
Cognitive Apprenticeship, Problem-Based Learning, Experiential Learning, Clinical Education	0.97	0.95	0.69	0.18	183
Trainers, Continuing VET, Lifelong Learning, Ethnography	0.94	0.94	0.66	0.18	187
Work-Based Learning, Higher Education, University, Equality/Inequality	0.91	0.92	0.12	0.05	643
Work-Integrated Learning, Workplace, Employability, Graduates	0.88	0.92	0.84	0.21	209
Undergraduates, Mentoring, Inter-Professional Aspects, Qualitative Research	0.84	0.90	0.72	0.19	192
Evaluation Study, Learning Outcomes, Learning Environments, Internships	0.81	0.88	0.41	0.10	158
Learning Pathways, Career and Technical Education, High School, Communication	0.78	0.88	0.91	0.22	156
Professional Development, Adult Education, Crafts, Career	0.75	0.87	0.06	0.03	518
Postgraduate, Medical Education, Doctoral Education, Situated Learning	0.72	0.87	0.97	0.26	105
Youth, Transitions, Gender, Inclusion	0.69	0.86	0.25	0.08	327
Leadership, Organisational Aspects, Cultural Aspects, Collaborative Practice	0.66	0.82	0.16	0.05	431
Workplace Learning, Informal Learning, Communities of Practice, Learning	0.62	0.82	0.38	0.10	1,068
Apprentices, Training, Simulations, Nursing	0.59	0.82	0.28	0.08	375
Apprenticeships, Skills, Employers, Higher VET and Degree Apprenticeships	0.56	0.82	0.34	0.09	889
Digitalisation, Technology, Engineering, Information Technology	0.53	0.80	0.78	0.19	209
Policy Issues, Comparative Study, Labour Market, Skill-Formation-Systems	0.50	0.78	0.59	0.14	452
Educational Reform, Educational Quality, Dual Apprenticeship, Neo-Liberalism	0.47	0.77	0.44	0.10	243
Teacher Training, Teaching, Further Education, Teachers	0.44	0.77	0.22	0.07	779
Curriculum, Professional Education, Technical Education, Emotions	0.41	0.76	0.19	0.06	397
Self-Regulated Learning, Self-Efficacy, Educational Technology, Ethics	0.38	0.76	0.88	0.22	103
Internationalisation, Migration, Diversity, International Students	0.34	0.76	0.94	0.22	131
Socio-Economic Status, Secondary Education, Adolescence, Case Study	0.31	0.75	0.62	0.15	188
Competence/Competency, Assessment, Competence-Based Approach, Professionalism	0.28	0.74	0.31	0.09	485
Employment, Unemployment, Wages, Capitalism	0.25	0.73	0.75	0.19	216
Students, Academics, Identity, Upper-Secondary School	0.22	0.72	0.09	0.05	459
Motivation, Attitudes, Values, Classroom	0.19	0.72	0.53	0.13	185
Young-Adults, School-to-Work-Transition, Social Capital, Dropouts	0.16	0.70	0.50	0.13	261
Governance, VET-Markets, Partnerships, Colleges	0.12	0.69	0.56	0.14	216
Educational Guidance, Philosophy of VET, Beliefs, Adults	0.09	0.67	0.81	0.2	100
Innovations, Knowledge, Entrepreneurship-Education, SMEs	0.06	0.63	0.47	0.11	331
E-Learning, Blended Learning, Online Learning, Disabilities	0.03	0.41	0.03	0.01	207

CR = Centrality Range, C = Centrality, DR = Density Range, D = Density, MD = Mapped Documents

When the identified keywords are compared with a comprehensive keyword systematization, such as the guide to VOCEDplus subjects and keywords (NCVER, 2021), it can be determined that the 52 subjects mentioned in VOCEDplus are covered. Nevertheless, subjects such as *equity, demographics, disability, disadvantaged, innovation* and specific keywords such as *informal apprenticeships, informal economy, green skills* seem to be underrepresented.

4 Limitations and Further Research

At the outset, we noted that VET structures and practices are very nationally oriented, which is why the field of VET is parcelled internationally. This distribution has implications for research: international VET research is equally parcelled. In our analysis, we identified these intellectual parcels as country networks and clusters, as journal networks and clusters and as author networks and clusters. This scientific parcelling represents a disadvantage for the exchange of ideas and the accumulation of knowledge. In addition to the formation of parcels, there is also a dividing line that runs among the positions of centre, periphery and exclusion. Especially scientists from developing countries and nations, economies in transition and those from post-conflict situations are excluded from the international discourse. This situation is more than just a disadvantage for the exchange of ideas and the accumulation of knowledge. Rather, there is a systematic bias in the research landscape here. Against this background, the parcelling of the discourse and the structuring of the discourse into dominance-periphery-absence, it becomes clear that the presented conceptual structure cannot capture an international perspective but only the perspective of a dominant discourse. The analysis is therefore not wrong, but incomplete and biased.

Bibliometric analysis is a powerful tool for examining large datasets. Techniques such as bibliometric coupling and co-citation analysis visualise latent structures (relations and clusters). However, identifying latent structures does not mean that the detected structures can be explained. For example, our analysis identified a new system for clustering countries, but sufficient interpretation and explanation is not yet available. In this regard, the SciMAT tool performs better than VOSViewer as it orders the identified clusters based on their centrality and density values in a strategic map whereby meaning is created. However, VOSViewer is more efficient than SciMAT, since it parses the examined units (e.g., authors) in advance, whereas in SciMAT, the majority of the data preprocessing and structuring has to be manually performed. VOSViewer is also substantially better than SciMAT at displaying the network itself. In addition to the strategic concept analysis that we have conducted, SciMAT allows, in turn, the comparison of groups of years to identify trends between two time periods. This analysis technique was not employed here. Indeed, this technique would enable an examination of the dataset not only in one cross-section, as we have achieved, but also in several cross-sections based on the number of time periods chosen, which collectively,

would enable a longitudinal perspective. Feasible bibliometric analysis always relies on the capabilities of the software in question and the targeted control of the analyses. We employed therefore Bibliometrix only for the basic analysis of the dataset as we considered the possibility of data cleaning or data preprocessing for an analysis of references (cited authors and articles) limited. However, Bibliometrix is suited for a comprehensive analysis if the source dataset is well structured.

In a comparative analysis of nine bibliometric software tools, the developers of SciMAT determined that "not all the software tools are able to extract all the bibliometric networks, and so, different tools have to be used to analsze a field from different perspectives" (Cobo et al., 2011a, p. 1400). We can confirm this conclusion. Various software can perform basic techniques, such as bibliography coupling and co-citation, to create a bibliometric network. The differences are shown in the details: Certain analyses (e.g., bibliographic coupling of journals) and specific measures (e.g., association strengths, instead of the, e.g., Jaccard's index) are not available. The combination used here (Bibliometrix, VOSViewer and SciMAT) has been proven viable.

As described in section 2.1 *Data Selection*, using only Scopus for the collection of articles had advantages. However, this choice also had disadvantages: A developmental analysis of the research field over time was not possible with our desired tool, CitNetExplorer, as it could only analyse data from the Web of Science Core Collection. Therefore, a temporal analysis is still an open and interesting perspective in the research field presented here. Other disadvantages include the limited coverage of non-English literature in Scopus (Aksnes & Sivertsen, 2019), and the origins keywords. As a rule, authors assign keywords to their articles. Scopus (similar to the Web of Science Core Collection) supplements the authors' keywords. These supplemental keywords have different names: Index keywords, keywords plus, or in SciMAT, a source´s keywords. These keywords extend the author´s keywords to help readers find articles. For example, if an author uses the keyword *workplace learning*, Scopus splits this keyword into two index keywords: *Workplace* and *learning*. The original designation becomes more non-specific, which is a disadvantage for bibliometric analysis. Hence, we only applied the authors' keywords.

The scoping review with the mapping focus is utilised for aggregation, which is both a strength and drawback. Aggregation enables researchers to capture the research field regarding its breadth but only slightly regarding its depth. A critical review, which is performed for interpretation, has opposite strengths and weaknesses. A critical review can only cover the field to a very limited extent but can cover a particular depth. This review paradox cannot be resolved but requires a choice between breadth and depth. Hopefully, these contradictory target perspectives will be better connected in the future using, for example, machine learning methods (López Belmonte et al., 2020). A review that combines the methods applied here with machine learning methods will certainly achieve greater depth. Instead of key-

words, data mining of the whole article could be conducted to enrich the dataset to be analysed. At the interface of data mining and bibliometrics, a new analysis technique is currently being established: bibliomining (Fernández & Bonilla, 2020).

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