

Teacher Vocational Education Competence in Digital Age: A Bibliometric Analysis

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ABSTRACT

Over the years technology has transformed the way people live and behave. Teaching clearly cannot be an exception. Teachers at all levels of education undergo a process of adaptation to develop the digital skills necessary for this transformation. Moreover, vocational education teachers are required to adapt the skills taught to the needs of the industry. The purpose of this paper is to provide an extensive bibliometric literature review on the competence of vocational education teachers in the digitalization era. Articles are found via publish or perish software and the Google Scholar database. Scanning by scimagojr.com (Q1, Q2, Q3, and Q4), we analyzed 42 articles from 26 leading journals from January 1, 2010 to June 30, 2022. Mendeley software is used to manage and resume references. We have reviewed this database and tried to classify articles using the VOSviewer software. Three groups were reviewed; The words that appear most often in each group are 'vocational education', 'apprentices', 'teaching', 'e-learning', 'professional competence', dan 'competence based education' This cluster represents the flow of teacher digital competence (TDC) research.

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Introduction

Teachers have an important role in vocational schools (Antonietti et al., 2022; Sulaiman et al., 2019), especially since vocational schools were established to train students to have job skills. They

are trained in situations like real workspaces so that the graduates are young people who have field skills and are ready to work in the field as interpreters (Batz et al., 2021; Nissilä et al., 2015). However, economic and industrial markets often change, which demands the adaptation of new skills. The industrial revolution 4.0 was marked by the rapid development of technology and automation into a disruptive era that created massive changes in all aspects of life (Ahmad et al., 2020; Morrar et al., 2017). Vocational schools are no exception because this educational model is the closest to the world of education and the industrial world.

Teacher competency development is the answer to dealing with the transition and the need for new skills that integrate digital technology (Andres & Svoboda, 2019; Tacconi et al., 2021), but there has not yet been a reflection of the extent to which competency development has been carried out, this study aims to fill the gap by provided an extensive bibliometric analysis of the literature related to this term in order to answer the following questions:

1. How are vocational teacher competency articles classified?
2. What are the trends in vocational teacher competency research? Which research topics are more published?

Method

Literature reviews should be carried out using systematic, explicit and reproducible methods (Fink, 2005; Reyes & Arturo, 2015), or mind-mapping methods that emphasize knowledge boundaries (Tranfield et al., 2003). Bibliometric review is commonly used in scientific disciplines and focuses on the quantitative study of journal papers, books or other types of written communication (Heersmink et al., 2010). For this work, the five-step method of bibliometric analysis introduced by Fahimnia et al., (2015) was adopted. These five steps include determining search keywords, initial search results, refinement of search results, compiling statistics on the initial data, and data analysis which will be explained in detail in the following subsections:

Defining search keywords

A literature search was conducted in June 2022 using the keyword 'Teacher Vocational Competence'. PoP software with Scopus database is used to collect data. Initially, we entered a query into the PoP software, using the keyword 'Teacher Vocational Competence', and set special conditions for 'title words only', and the year '2010–2022'. From the Scopus database, we obtained 42 articles in our initial search for the period 2010 to 2022.

Initial search results

In the initial search the search year range is not specified, this aims to identify and study the latest developments in vocational teacher competency studies. The top ten articles that appeared are shown in Table 1.

Table 1. The top ten articles are identified from PoP

Author/s	Title	Year of Publication
Wesselink, Dekker-Groen, Biemans, & Mulder	Using an instrument to analyse competence-based study programmes: Experiences of teachers in dutch vocational education and training	2010
Misbah, Gulikers, Maulana, & Mulder	Teacher interpersonal behaviour and student motivation in competence-based vocational education: Evidence from Indonesia	2015
Andersson & Köpsén	Maintaining Competence in the Initial Occupation: Activities among Vocational Teachers	2018
Seezink & Poell	Continuing professional development needs of teachers in schools for competence-based vocational education: A case study from The Netherlands	2010
Nissilä, Karjalainen, Koukkari, & Kepanen	Towards competence-based practices in vocational education – What will the process require from teacher education and teacher identities?	2015
Cattaneo, Antonietti, & Rauseo	How digitalised are vocational teachers? Assessing digital competence in vocational education and looking at its underlying factors	2022
Brauer & Siklander	Competence-based assessment and digital badging as guidance in vocational teacher education	2019
Nurhabibah, Setiawan, Yanti, Miraj, & Yannuar	Analysis of ICT Literacy Competence among Vocational High School Teachers	2018
Otero, Cerqueiras, Fernández, & Antelo	Digital teaching competence of Galician vocational training teachers	2021
Sutarto & Jaedun	Authentic assessment competence of building construction teachers in Indonesian vocational schools	2018

Refinement of the search results

We excluded articles that were not suitable for the screening criteria, Table 2 and Table 3 shows the inclusion and exclusion criteria of this study.

Table 2. Research inclusion criteria

Inclusion criteria
Research work related to the competence of vocational teachers
This publication covers the state of vocational teacher competence
Research papers published between 2010-2022
Research paper written in English
Research papers have been published after being submitted to a peer review process
Full versions of publications are available through subscriptions to our institutions or by associations of which we are members
The research follows a research structure that is in accordance with the research method

Table 3. Research inclusion and exclusion criteria

Exclusion Criteria
Research work is not related to the competence of vocational teachers
This publication does not cover the state of vocational teacher competence
Research papers not published between 2010-2022
Research papers are not written in English
Research papers have been published without a peer review process
The full version of this publication is not available through our institutional subscriptions or by associations of which we are members
The publication does not follow a research structure in accordance with the research method

We pulled 42 papers from leading journals (Q1 and Q4) based on the Scimagojr website. Table 4 shows the metric data from article searches.

Table 4. Comparison metrics

Metrics data	Initial search
Query	'teacher vocational competence'
Source	Google Scholar
Papers	42
Citations	143
Years	10
Cites_Year	11,92
Cites_Paper	3,40
Cites_Author	1.00
AWCR	32,47
h_index	5
g_index	11
hI_norm	5
hI_annual	0,42
hA_Index	3
Year_First	2010
Year_Last	2022
Query Date	07/06/2022

Compiling the initial data statistics

The search generated after the fix is downloaded, saved in Mendeley software, and exported to RIS format to include all important information related to the paper, including title, author name, abstract, keywords and journal specifications (published journal, year of publication). publication, volume, issue, and pages). The data is analyzed so that articles can be classified according to year and source of publication and publisher. From the query using the maximum timeframe, PoP obtained 42 journal articles from 2010 until 2022. After verifying whether various journal publications (sorted by Schimagojr) are reputable, and filtering them with the criteria shown in Table 4. The number of published articles is increasing year by year. Figure 2 presents the number and distribution of publications per year.

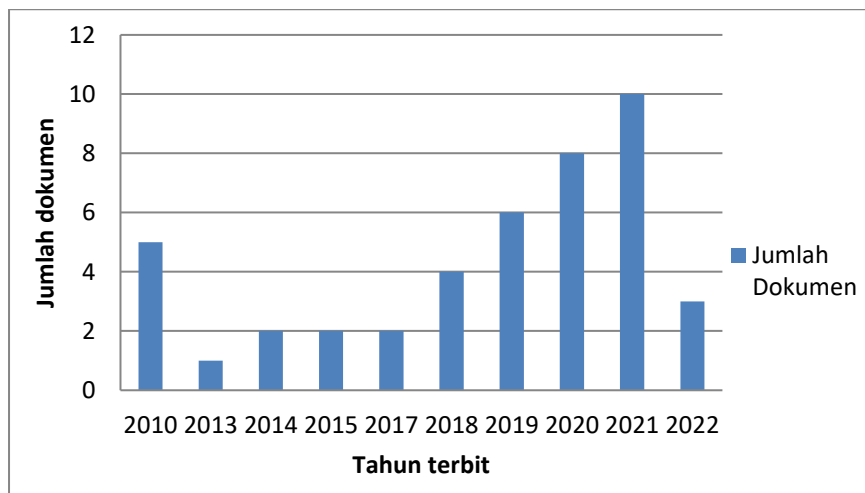


Fig 1: Year-over-year publication trend

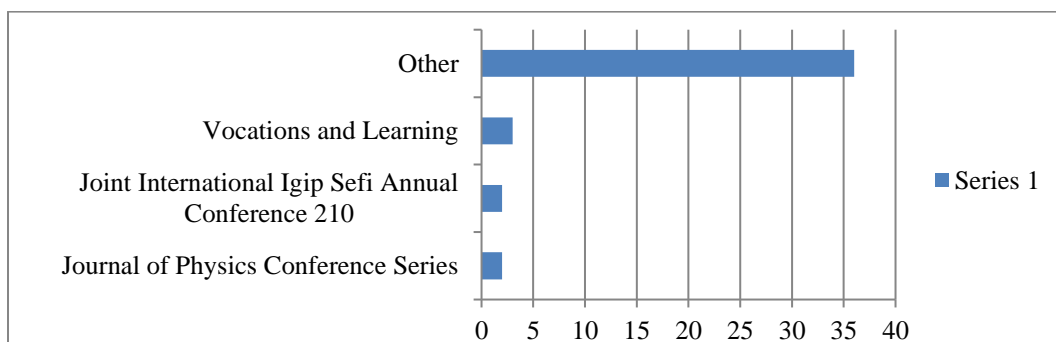


Fig 2: Journals in which articles in analysis appeared

Data analysis

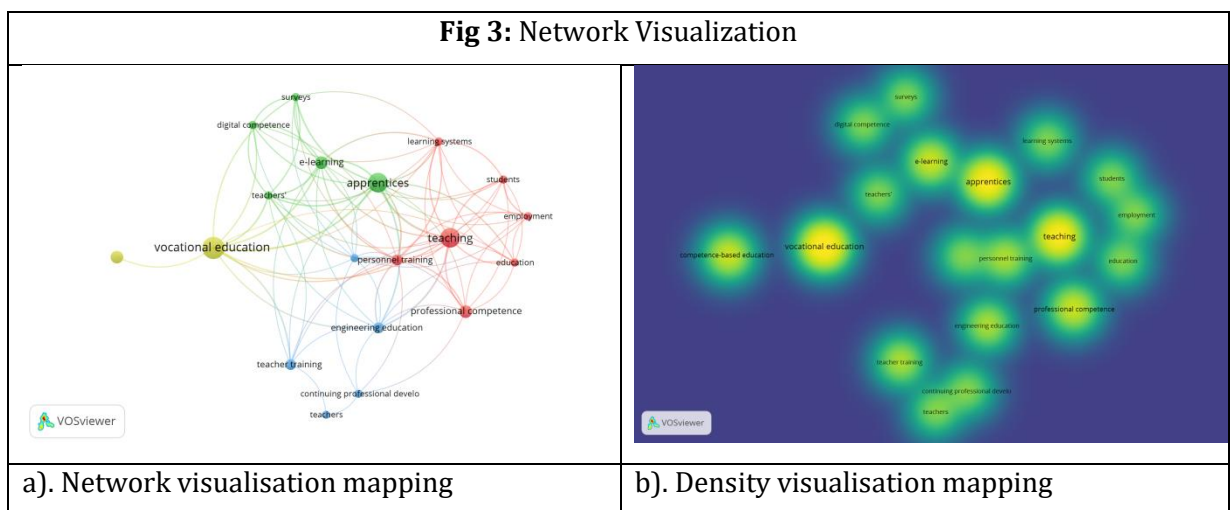
This paper presents a bibliometric analysis of the terms 'citical pedagogy' and '21st century

skills', from the Scopus database. The bibliometric review in this paper uses PoP software developed and launched in 2006 by Professor Anne Wil Harzing of Tarma Research Software Pty Ltd-Melbourne (Bensman, 2011). For this analysis, we use version 8.2.3944.8118. We executed this software in June 2022, obtained 42 papers with 143 citations (11.92 citations/article).

Result and Discussion

Our study shows that Q1, Q2, Q3 and Q4 journals have a large impact on the metrics related to citations. Table 5 shows the most cited articles and authors. The article by Wesselink et al., has been cited by 37 authors, being the most frequently cited article in this field. Article written in 2010 and published in the International Journal of Curriculum Studies. The second most cited article is the paper Misbah et al., (2015) published in Teaching and Teacher Education and later cited by 34 authors; it was followed sequentially by an article by Andersson & Köpsén, (2018) Wrahatnolo, (2018) entitled Maintaining Competence in the Initial Occupation: Activities among Vocational Teachers All articles cited at least once attended (with complete citation information) in Table 6

Figure 3 Network visualization mapping After taking into account the quote frequency and other metrics, we analyze the output from PoP software to VOSviewer software to determine what keywords occur frequently. Keyword frequency can be set by 1, 5, 10, 20, or any other occurrence. The VOSviewer tool was developed by van Eck and Waltman in 2010 (see at <http://www.vosviewer.com>) and is used to visualize bibliometric maps. This software demonstrates bibliometric mapping on three different visualizations, network visualization (Fig. 3), overlay visualization, and density visualization (Fig. 4). VOSviewer can classify keywords into different groups. Bullets show incident weights. This explanation answers the first research question.



Extracting from title and abstract fields, full count with minimum number of occurrences set to 3, we get 254 terms and 39 items meet the threshold. Six clusters are identified here. The keywords that have the highest frequency of occurrence are 'vocational education', 'apprentices', 'teaching', 'e-learning', 'professional competence', and 'competence based education'. The keywords in each cluster represent the research flow of vocational teacher competence. Detailed information is presented in Table 7. Each cluster shows trends in studies related to vocational teacher competence which can be represented through the occurrence of certain terms. This data allows this paper to answer the second question, what are the trends in vocational teacher competency research, namely the use of e-learning and the most common and widely studied words of teacher professional competence.

Table 5. Articles with their most frequently occurring keywords

Cluster	Elemen
Cluster 1	Professional competence (5), students (3), professional aspects (3), information technology (2), employment 9), education (3), curricula(2), vocational colleges (2)
Cluster 2	Apprentices (8), digital technologies (2), engineering education (4), high school teachers(2), participation(2), teaching (8)
Cluster 3	Continuing profesional (3), teacher competency (2), teacher training (4), teachers(3), teacher experience (2), vocational education (9), vocational training (2)
Cluster 4	Competence (2), competence based education (5), digital competence (3), teacher education(2),vocational college (),vocational education and training (2), vocational teachers (2)
Cluster 5	Computer aided instruction (2), e-learning (5), educational tecnology (2), learning systems (3), professional development (2), teaching and learning (2)
Cluster 6	Digital devices (2), personnel training (4), teachers' (3)

Digital technology curriculum integration is an important issue, reflected in many teacher education programs around the world (for example, (Buabeng-Andoh, 2012; Russell et al., 2007). In Europe, teacher competencies related to digital technology challenges have been described in the European Digital Competence Framework for Educators (DigComEdu, Caena & Redecker, 2019).In Germany, national teacher education standards from 2004 were updated in 2019 (KMK [Standing Conference of Ministers of Education and Culture] 2019) as appropriate.In the state of North Rhine-Teacher Vocational Education Competence... (Santi, K., et al)

Westphalia (NRW), Germany, where this research was conducted, the so-called NRW Media Competency Framework was developed based on DigComEdu (Medienberatung, 2019). Schools as well as teachers and universities are expected to adopt this framework for the integration of digital technology into the curriculum. However, this competency framework (i.e., transformation into learning opportunities) has begun to develop, its systematic implementation is still at an early stage. In addition, few empirical studies have specifically examined the use of learning opportunities and provide insight into the status quo of the implementation process (see, for example, for Norway, Gudmundsdottir & Hatlevik, 2018). In Germany, a study conducted by König, Jäger-Biela, & Glutsch, (2020) in 2019, used a standardized scale inventory to survey pre-service teachers' use of opportunities to develop their digital competencies during teacher education. The inventory relates to the NRW Media Competency Framework and defines six content areas (see, for further detail, Table 6),

Table 6. The scale inventory measures opportunities to learn digital competencies during teacher education (König et al., 2020).

Subscale	Item Example
Operate and apply	Organizing, structuring, and securing digital information and data (teaching materials, teaching results, and project data)
Informasikan dan riset	Conduct targeted information research on the Internet and digital databases (documents, information, literature)
Communicate and cooperate	Rules for appropriate digital communication and cooperation and strategies for dealing with media-related behavioral problems (Internet bullying, Internet addiction)
Production and presentation	Plan, design and present media products in a way that suits the recipient (students) and the appropriate conditions
Analyze and ponder	Reflecting on media actors and their respective positions and their influence on media education (business companies, interest groups, parties, governments, private individuals, mass media)
Problem solving and modeling	Knowledge of algorithmic patterns and structures for different usage contexts (e.g. search engines, switching systems, human-machine interfaces)

Proposed by the International Society for Technology in Education (ISTE), the National Educational Technology Standard for Teachers (NETS-T), is internationally one of the most influential models; The standard consists of five dimensions generated depending on teacher performance (figure 4), similarly focused on ways teachers can make student learning easier

through digital technologies, covering all aspects (digital citizenship and materials management), including professional development educator. This model has been focused, through the latest update in 2017, unlike its previous version in 2008, in relation to the importance of self-taught students and managing their own learning.

According to ISTE (2018), the main purpose of the NETS-T standard is to establish guidelines for educators to design, implement, and evaluate educational experiences to engage students and enhance learning, enrich professional practice, and provide positive role models in educational contexts (ISTE, 2018); in this sense, the indicators shown in Figure 4 are explained; 1) Facilitate and inspire student learning and creativity: the use of subject knowledge, teaching processes, and technology is promoted to facilitate student learning, creativity and innovation in virtual environments; 2) Designing and developing learning experiences and consulting in the new digital era: design, development, and evaluation of learning experiences defined through the amalgamation of contemporary tools and resources; 3) Models of work and learning in the new digital era: teachers must demonstrate the knowledge, skills and work processes that characterize an innovative professional in a global and digital society; 4) Promote and model digital citizenship and responsibility: an understanding of local and global community resources is sought, as well as the responsibility to incorporate digital culture through ethical and legal behavior in their professional practice;

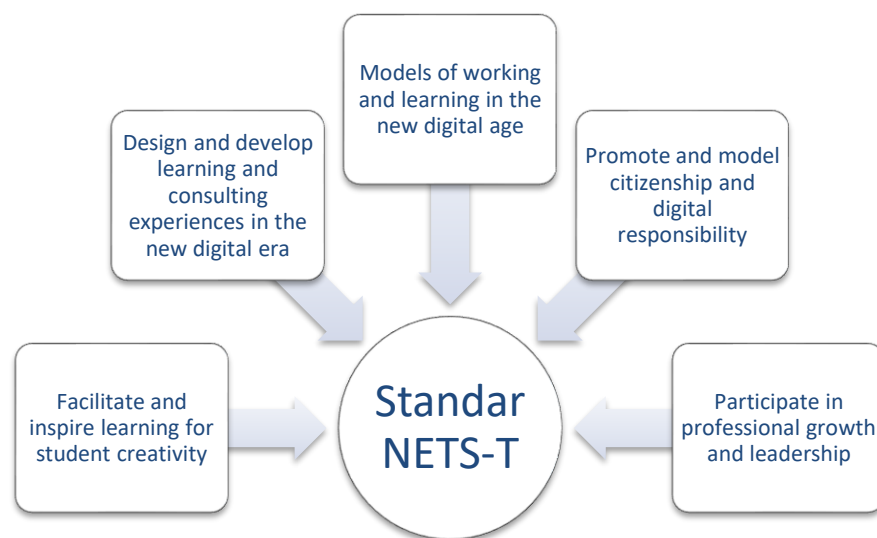


Fig 4: NETS-T Educator Performance Indicators. (Adapted from ISTE, 2018)

The other model establishes a standard set of competencies in digital technologies for teachers in training and for those pursuing careers, this model is among the most internationally recognized group of models by UNESCO. A model with a strict organizational vision, which in

addition to considering didactic excellence, also takes into account issues such as the inclusion of digital technology in the study plan or in the professional training of teachers. The structure of the model is presented in Figure 2, and is based on establishing pedagogical practices that support the construction of significant student knowledge through the integration of digital technology; in such a way as to bring together the skills required for design, As can be seen, the UNESCO model is based on developing levels of use of digital technologies which, in turn, are broken down into three elements to promote appropriate use of information technologies, what it seeks is to get teachers to set their levels. skills according to established standards, to set training plans and professional growth in relation to the subject concerned (Pontificia Universidad Javeriana - UNESCO, 2018).

On the other hand, in Europe, the Joint Research Center (JRC) of the European Commission proposed the European Framework for Digital Competence of Teachers (DigCompEdu), represented in figure 5, which is based on elements related to environment and professional commitment. from educators, As can be seen in Figure 5, the model considers various types of competencies related to its application, such as the following: professional commitment, digital resources, digital pedagogy, evaluation and feedback, empowerment, and facilitating learning. student; in turn, these aspects can be developed according to different levels of progress, such as: awareness, exploration, integration, mastery, leadership, and finally innovation. According to the proposed guidelines, the establishment of educational programs that can adapt to different learning environments is sought to achieve an adequate allocation of technological resources (European Commission, 2018).

As a consequence of the different models, different changes have emerged from time to time. For example, in the US, based on the ISTE 2008 NETS-T model, several states have made changes and established their own standards, publishing manuals and books to guide and facilitate their implementation in schools (Morphew, 2012). For the design of strategic education plans of various countries or institutions, guidelines such as UNESCO (2011) have been taken as a basis. The ISTE model has been used in several investigations regarding the digital skill levels of active teachers and trainees (Banister and Reinhart, 2012).

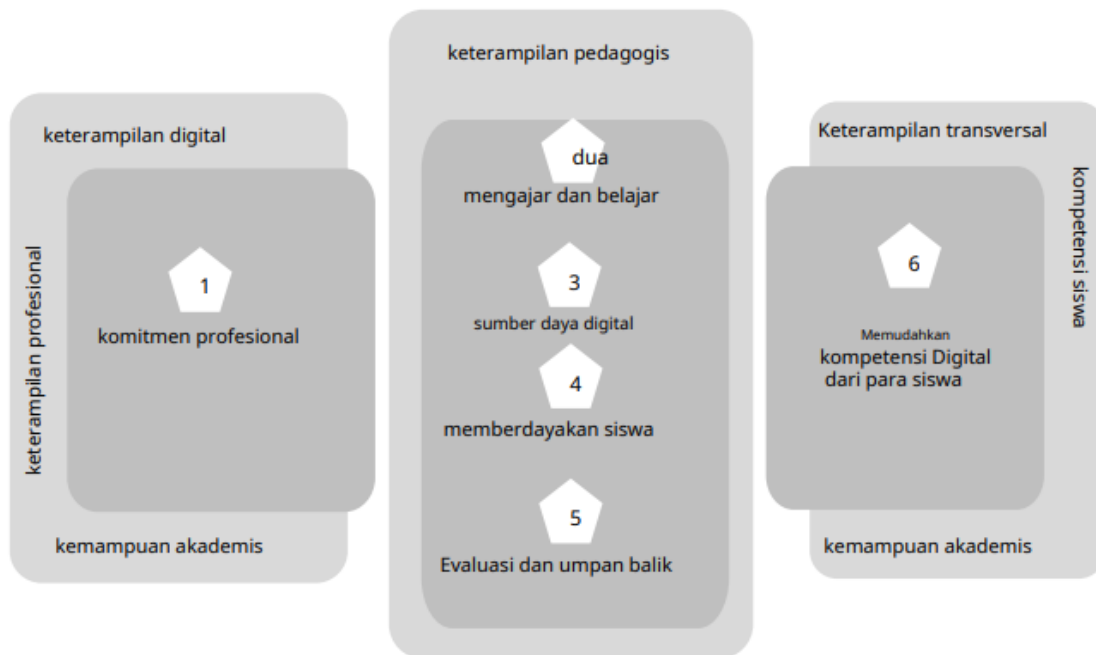


Fig 5: *The concept of digital competence evaluation in teachers proposed by JRC (Adapted from European Commission, 2018)*

There is no doubt about the importance of teachers' digital knowledge today, as the application of new technologies in teaching leads to a teaching model in which communication makes teaching more flexible, collaborative, relocating, individual and dynamic. For digital technologies to be truly effective in teaching, teachers must have instrumental and pedagogical digital training, and for this, they need to have access to training programs that make available technological resources truly useful. This will be achieved with quality training in digital skills in both initial teacher training and lifelong learning. In Dual Vocational Training, digital teaching skills become very prominent because, in this model, collaboration between school and workplace is very important and increases significantly with teachers' utilization of digital technology in both fields. In addition, the use of digital knowledge is critical in dual education to maintain students' optimal pathways as there is less face-to-face presence in the classroom than in other models.

Table 7. Articles with 1 or more citations

No	Citation	Per Year	Author	Title	Year	Publication
1.	32	10.67	Radkevych, Kravets, Herliand, Radkevych, &	Modern technologies in the development of professional competence in teachers from professional (vocational) education schools	2019	<i>International Journal of STEM Education</i>
2.	31	7.75	Karabaevna, Musurmanova, & Xamruevich	Improving the competence of future vocational education teachers based on modular-rating education	2018	<i>International Journal of Instruction</i>
3.	28	7.00	Zhao, Zhang, & Rauner	KOMET-based professional competence assessments for vocational education and training (VET) teachers in China	2018	<i>IOP Conference Series: Materials Science and Engineering</i>
4.	26	6.50	Andres & Svoboda	Development of Digital Competences of Teachers of Social Sciences at Secondary Vocational Schools	2018	<i>Physical Education and Sport Pedagogy</i>
5.	20	6.67	Mardi, Wijaya, & Sumiati	Teacher' s Competences in Technology-Based Education in Indonesia: The Case of a Vocational Accounting Teaching School	2019	<i>Journal of Curriculum Studies</i>
6.	17	4.25	Sánchez-Prieto, Trujillo-Torres	Incident factors in the sustainable development of digital teaching competence in dual vocational education and training teachers	2018	<i>Sport, Education and Society</i>
7.	16	4.00	Tacconi, Tütlys, Perini, & Gerdivilienė	Development of pedagogical competencies of the vocational teachers in Italy and Lithuania: implications of competence-based VET curriculum reforms	2018	<i>Active Learning in Higher Education</i>
8.	14	4.67	Antonietti, Cattaneo, & Amenduni	Can teachers' digital competence influence technology acceptance in vocational education?	2019	<i>Theory and Research in Social Education</i>

Conclusion

This study reviews 42 articles with themes related to teacher competence in the digital era. Articles are collected from the Scopus database using PoP software. Six clusters are identified here. The keywords with the highest occurrence frequency were 'vocational education', 'apprenticeship', 'teaching', 'e-learning', 'professional competence', and 'competence-based education'. The keywords in each cluster represent the flow of research on vocational teacher competence. The trend of vocational teacher competency research is the use of e-learning and teacher professional competence

The transformation of digital technology has led to major transformations in various sectors of society, including education. In the teaching and learning process, the inclusion of technological devices has facilitated communication and understanding of various content taught in academic training. However, despite these advantages, the inclusion of these tools poses a challenge for teachers, who must acquire the necessary skills and abilities to be able to apply them successfully and for them to be a true source of progress. After reviewing the literature and based on the findings, some conclusive ideas can be drawn: a) It is relevant to use proven and recognized models for the management of digital teaching skills, as this cannot happen by chance; b) Training in this field must be articulated with the education policies of the state and higher education institutions; c) There are difficulties in ethical, legal and safe use of digital technology in training rooms, therefore, training in this area should be significantly strengthened; d) Teachers need significant support in information management and design of digital technology activities because, in some cases, they lack the necessary elements to carry out these processes smoothly. As the most important element, preparing teachers is a challenge and potential to transform Indonesian education in a better direction, including challenges for higher education and educators who prepare teachers for the future. Further development requires the introduction and integration of digital technology in the teaching process. This process must be permanent because there is still a major deficiency in teachers' digital technology knowledge and resistance to its application.

The current study has at least two limitations. First, this research is primarily based on a limited set of keywords and also potentially limited by publish or perish (PoP) used for article submission. Second, even though this study used the right tools (PoP software, VOSviewer, Mendeley, Microsoft Excel), subjective judgment by the authors persists and can still lead to errors. Future studies should use a larger sample size by expanding the keywords and databases accessed. In addition, it is advisable to compare the analysis results using different bibliometric analysis software (such as BibExcel and HistCite).

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