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## HOW IMPORTANT TEACHER'S DIGITAL COMPETENCY IN FACING DIGITALIZATION: BIBLIOMETRIC ANALYSIS

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### ABSTRACT

The rapid development of technology required the education to digitize by integrating ICT into learning process. However, there was a gap between the use of ICT and teacher's digital competency, despite teacher's digital ability was determinant of how well technology was adopted in education, especially in learning process. This study used bibliometric analysis method. This study aimed to analyzed the development of publications related to teachers' digital competency from 2012-2022; articles, journals, authors, and countries that eligible for consideration in future research; reviewing how important teacher's digital competency and further research opportunities. The study results showed that trend of publications regarding "teacher's digital competency" was fluctuating increase. Then co-authorship analysis indicated a relationship between scientific concepts in six domain clusters. Furthermore, from the results of content analysis, it was found that teachers' digital competency was essential for educators in the digitalization era because education in digitalization era will use Educational for Sustainable Development (ESD) concept, where teachers' digital competence was needed not only to support students to be able in utilize digital resources more effectively but it should also help them understand and develop an awareness of the broader considerations around technology use and its impact.

**KEYWORDS:** Teacher's Digital Competency, Digitalization, Bibliometric Analysis, ICT

### 1. INTRODUCTION

Continuous technological updates require digitizing all of sector, including in education. Digitalization in education is marked by the massive integration of information, communication, and technology (ICT). The implementation of ICT in education has become a "highlight" for all stakeholders, especially its use in the learning process (Basilotta-Gómez-Pablos et al., 2022). Access to digital technology in schools is widespread across the nation. It is in line with PISA 2018 that there is almost one computer for every 15 y.o student for educational purposes and computer-student ratio has increased substantially since 2009 (Reimers & Schleicher, 2020). This shows that almost all schools worldwide can access digital technology, although it is not evenly distributed, especially in remote areas.

Several studies have shown that adequately ICT using in learning process can enhance education qualities and relate learning to social situations (Ramírez-Rueda et al., 2021). The use of ICT in education positively impacts students, teachers, curricula, and educational institutions (Nguyen et al., 2022). For students, technology provides an opportunity for them to learn according to their interests and the best way to learn; students become more active, get the best learning experiences, become better prepared for future careers, and help find new and innovative ways of solving problems (OECD, 2022). For teachers, technology provides an opportunity to innovate in designing learning methods; teachers can make timely and targeted interventions and provide feedback to students personally. The technological advances encourage the curriculum to include aspects of digital technology in learning to meet the needs of students and the labor market. As for educational institutions, technology adoption promises to improve learning process and the effectiveness of campus operational costs (Latwal et al., 2020).

Even so, the use of ICT in education will not produce optimal output if educators, as the main actors, do not have adequate digital skills (Basilotta-Gómez-Pablos et al., 2022). Cantabrana et al. (2019) indicate that teachers must link their digital-age skills or competencies to their professional practice, as Kuzminska et al. (2019) found that there is a gap between policies on ICT using in education and the fundamental abilities of educators. The low level of teacher confidence in the ability to adopt technology from both a technical and pedagogic perspective also inhibits the integration of ICT in education (Kasperski et al., 2022; Mueller et al., 2008).

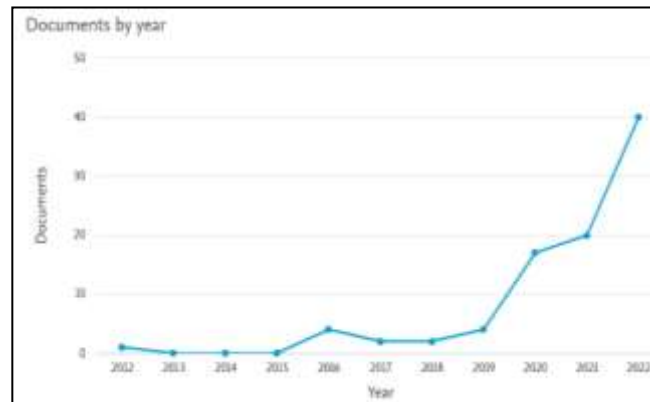
This gap indicates that digital capital is needed for digitalization in education. Digital capital consists of two dimensions, namely material and non-material. The material dimension is related to the availability of technology and digital resources in a school to implement educational activities (Ruiu & Addeo, 2019; Pandolfini, 2016). Meanwhile, the non-material dimension is related to investment in strengthen the digital competence of school staff with educational projects or didactic experiments. However, as time goes by, digital capital is reduced to human capital. It refers to individuals' cultural characteristics and knowledge when using digital technologies and contributes to define new types and levels of digital competence (Cortoni & Perovic, 2020).

In the last few decades, teacher digital competence has become very prominent in the educational context (Tejada Fernández & Pozos Pérez, 2018). Teacher digital competence is a set of knowledge, skills, and attitudes required by teacher so that they can use ICT more effective from its various aspects (technology, information, multimedia, communicative, collaborative, and ethical), assuming pedagogical-didactic criteria for the effective integration of ICT in their educational practice both in formal or non-formal settings (Duran, 2019). Teacher's digital competency must be holistic, conditioned, systemic, trainable, and continuously evolving. It tends to teacher for combine the skills, attitudes, and knowledge so they can support their students' learning as active participants in the digital era (Castañeda et al., 2018). In response, UNESCO developed the " UNESCO ICT Competency

Framework for Teachers" program in 2008. This program has three key elements: digital competency, knowledge deepening, and knowledge creation.

Furthermore, teachers must possess 24 standards related to digital competence. The 24 standards are divided into three levels, namely: 1) Technology literacy level, comprehending technology and incorporating technical competencies into the curriculum, which consists of aspects of technology literacy, basic knowledge, integrated technology, essential tools, standard classroom, digital literacy; 2) Knowledge deepening, utilization of these skills to provide value to society and the economy, and applying of this knowledge to solve complex and fundamental problems, consisting of aspects of knowledge deepening, knowledge application, complex problem solving, complex tools, collaborations groups, manage and guide, and 3) Knowledge creation, production and subsequent leverage of new knowledge consisting of aspects of 21st-century skills, self-management, pervasive tools, learning organization, and teacher as a model learner. The aim of establishing 24 aspects of teacher digital competence is to improve teacher practice in all areas of their professional work, combining ICT competence with innovation in teaching, curriculum, and teaching institution organization. Besides that, it improves the quality of education.

Teacher's digital competency has recently become a fascinating topic for research. This is evidenced by the trend of research on digital competence, which has increased significantly from year to year. Based on the search results for Scopus articles related to the trend of Educator *Digital Competency research* during the period 2012 to 2022, there have been fluctuations. Research articles related to Educator's Digital Competency from 2012 to 2015 tended to be stable, then in 2016, the number of publications increased but decreased again until 2019. Research related to this topic began to increase significantly from 2019 to its peak in 2022. There are 40 articles in 2022, the highest over the past 11 years. The increase in publications was due to the Covid-19 outbreak, which prompted teachers to change their learning practices to distance learning quickly and urgently to ensure student learning continuity. During the pandemic, many teachers replicated face-to-face lessons so that the possibility of imparting technology-related insights was almost non-existent (Bacus et al., 2022; Cabero-Almenara et al., 2020; Casado-Aranda et al., 2021; Usher et al., 2021). This forces educators to be *aware* of technology using for distance learning so that educators are forced to improve their digital abilities (Petrila et al., 2022).



**Figure 1. Distribution of Teacher' Digital Competency Research**

Source: Scopus Analysis

Based on this background, the authors are interested in researching how important teachers' digital competency in facing digitalization with bibliometric analysis. Similar studies have been carried out by Basilotta-Gómez-Pablos et al. (2022) but it just focuses in digital competence of educators in higher education and that article use a systematic literature review that only explains one specific research topic. This research aims to fill the gaps by using the bibliometric method to review research trends related to digital educator competence every year. More specifically, this article aims to develop a systematic objective to answer the following research questions about how important teacher's digital competency:

RQ1: How research trend of Scopus-indexed publications about teacher's digital competency between 2012 to 2022?

RQ2: Which articles, journals, authors, and countries are most worthy of consideration for further research on this topic?

RQ3: How important teacher's digital competency viewed from keywords analysis and content analysis of the clusters formed?

## 2. METHODOLOGY

This research used descriptive bibliometric analysis method related to teachers' digital competencies in an international scope. Descriptive bibliometric analysis was chosen because it can describe the characteristics of the research topic (Supinah & Soebagyo, 2022). In addition, bibliometric analysis can reveal trends that appear in articles to be used to predict future research directions (Donthu et al., 2021). Data collection was carried out through the *Scopus.com database* on May 11, 2023, with the keywords "teacher's," "digital," and "competency" with the year of publication of the article 2012 – 2022. The search results from data in the Scopus database then analyzed through four processes: the search stage, filtration stage, checking bibliometric attributes, and bibliometric analysis (Julia et al., 2020). The initial data search found 1,314 articles which were the population of this study. Then, from

1,314 articles, 90 were obtained as research samples because they matched the research criteria: articles published in journal form, related to Teacher digital competence, and in English. Furthermore, the data was saved in CSV format then processed by using *the VOSviewer software*. VOS viewer serves as an analytical tool in mapping the trends of international scientific publications.

### 3. RESULT AND DISCUSSION

The bibliometric analysis results of this study are guided by the research of Donthu et al. (2021). There are two categories of analysis, namely, performance analysis and mapping. Performance analysis includes the development of publications every year, articles with the highest number of citations, the most influential authors, the most influential countries, and future research opportunities. In contrast, the mapping analysis is in the form of clustering research themes, which are then carried out a content analysis to determine how essential educators' digital competencies are in dealing with digitalization.

#### 3.1 The Development of Teacher's Digital Competency Research Publication

The development of publications related to digital competency research for the last 11 years between 2012 to 2022 shows fluctuating developments. Found 1,314 documents with the keyword teacher's digital competency. However, only 90 documents are relevant to the research topic. Publications related to teacher's digital competency from 2013 to 2015 experienced a vacuum seen from the absence of documents related to this topic and have resurfaced in the following years. The development of publication growth regarding teacher digital competence is the highest in 2022, reaching 40 publications (44%). The increase in publications on educators' digital competence, which has increased yearly, shows that this research is still interesting.

**Table 1. Development of Research Publications on Teacher's Digital Competency**

Year	Documents	Percentages
2012	1	1
2013	0	0
2014	0	0
2015	0	0
2016	5	6
2017	2	2
2018	2	2
2019	4	4
2020	16	18
2021	20	22
2022	40	44
Total Publications	90	

Source: Scopus Analysis and Processed by Researchers in 2023

**3.2 Most Influential Articles, Journals, Authors, and Countries**

Articles in Scopus-indexed journals are often used as references or references in research. More citations of an article mean that the research results are used as references in other studies and have a more significant impact. The search results through the Excel database show the number of citations to be 1,680 from 90 articles from 2012 to 2022. The following are the ten articles with the highest citations.

**Table 2. 10 Articles with the Most Citations**

No	Article Title	First Author	Year	Journal Name	Journal Ranking	Publishers	Citation
1	Generation z's teachers and their digital skills	Fernández-Díaz M. -J.	2016	Community, Media Education Research Journal	Q1	Grupo Comunicar Edicions	178
2	From digital literacy to digital competence: the digital teacher competency (TDC) Framework	Falloon G.	(2020).	Educational Technology Research and Development	Q1	Springer	155
No	Article Title	First Author	Year	Journal Name	Journal Ranking	Publishers	Citation
3	Development of computational thinking, digital competence, and 21st-century skills when learning programming in K-9	Nouri J.	(2020).	Education Inquiry	Q1	Routledge Taylor and Francis Ltd.	107

4	A review of research exploring teacher preparation for the digital age	Starkey L.	2020	Cambridge Journal of Education	Q1	Routledge Taylor and Francis Ltd.	99
5	Teacher digital literacy: The indisputable challenge after covid-19	Sánchez-Cruzado C	2021	Sustainability (Switzerland)	Q2	MDPI AG	70
6	Understanding social and cultural aspects of teachers' digital competencies	Engen BK	2019	Communicar	Q1	Grupo Comunicar Editions	69
7	Evaluation of teacher digital competence frameworks through expert judgment: The use of the expert competence coefficient	Cabero-Almenara J	(2020).	Journal of New Approaches in Educational Research	Q1	University of Alicante	57
8	Engaging pre-service primary and preprimary school teachers in digital storytelling	Starčić AI	(2016).	British Journal of Education Technology	Q1	Blackwell Publishing Ltd	56

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No	Article Title	First Author	Year	Journal Name	Journal Ranking	Publishers	Citation
9	Pre-service teachers' perceptions of the competence dimensions of digital literacy and psychological and educational measures	García-Martín J	(2017).	Computer and Education	Q1	Elsevier Ltd	55
10	The smart classroom as a means to the development of ESD methodologies	Cebrián G.	2020	Sustainability (Switzerland)	Q2	MDPI	48

Source: Excel Database and Processed in 2023

The data in Table 2 shows that the article entitled " *Generation z's Teachers and their digital skills,*" written by Fernández-Díaz M.-J and published by Grupo Comunicar Ediciones in 2016 is the article with the highest citations, namely 178 citations. In second place is an article entitled " *From digital literacy to digital competence: the digital teacher competency (TDC) framework,*" written by Falloon G. and published by Springer in 2020, obtaining 155 citations. In contrast, the third place is in an article entitled " *Development of computational thinking, digital competence, and 21st-century skills when learning programming in K-9*" by Nouri, J. and published by Routledge Francis and Taylor Ltd in 2020 with 107 citations. Table 2 describes the number of citations obtained by the author in the *Scopus database*. The ten authors with the most citations contributed significantly to teacher's digital competency research. However, one thing that needs to be noted is that not all academic papers related



to educators' digital competence can be identified because this research only searched the *Scopus database*.

Beside analyzed the authors with the most citations, the researcher also analyzed the journals that provide the most references related to teacher's digital competency. The five journals with the highest number of articles are presented in the table below:

**Table 3. Journals with the Most Articles about Teacher's Digital Competency**

No	Journal Name	Documents	Citation	Ranking Journals
1	Sustainability (Switzerland)	11	169	Q2
2	Community	6	114	Q1
3	Education science	4	276	Q1
4	Technology, Knowledge, and Learning	4	23	Q1
5	European Journal of Teacher Education	3	39	Q1

Source: Excel Database and Processed in 2023

Table 3 shows the development of Scopus-indexed journals with the highest articles on teacher's digital competency. "Jurnal Sustainability" is a platform that provides the most articles about educators' digital competence, with 11 articles and 169 citations. In second place is "Communicator Journal" with six documents and 114 citations; in third is "Education Science Journal" with four articles and 276 citations. These five journals can be the best references when researching educators' digital competence because they are highly reputable international journals with over 50 years of quartile (> 50<sup>years</sup>).

Co-authorship analysis examines the interaction between various authors in a research field and is a formal way to discover the intellectual collaboration process between researchers (Cisneros et al., 2018). The more often the authors collaborate, it will have implications for increasing the number of research documents. As Tahamtan et al. (2016) that, new contributions and explorations in certain studies will further enrich and deepen a particular field of study.

The results of the co-authorship analysis showed that 314 article authors participated and contributed to the research on teachers' digital competency. This study used at least two documents for each author so that five authors were found who met the threshold criteria. The following are the five authors with

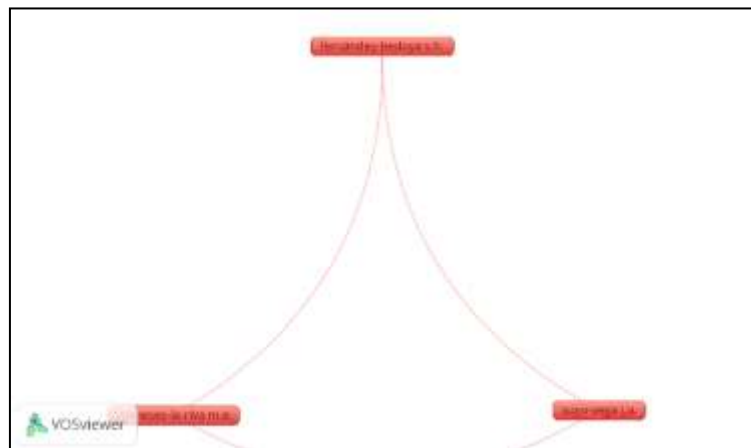
the most published and Scopus-indexed documents. Tomczyk became the author with the most articles, namely four documents. While other writers, on average, have the same number of documents, namely two.

**Table 4. Authors with the Most Articles**

No	Author	Documents	Citation
1	Tomczyk, L.	4	18
2	Cabero-Almenara, J.	2	100
3	Fernandez Bedoya VH	2	4
4	Meneses-La-Riva, ME	2	4
5	Suyo-Vega, JA	2	4

Source: Scopus Analysis and VOS viewer Processed in 2023

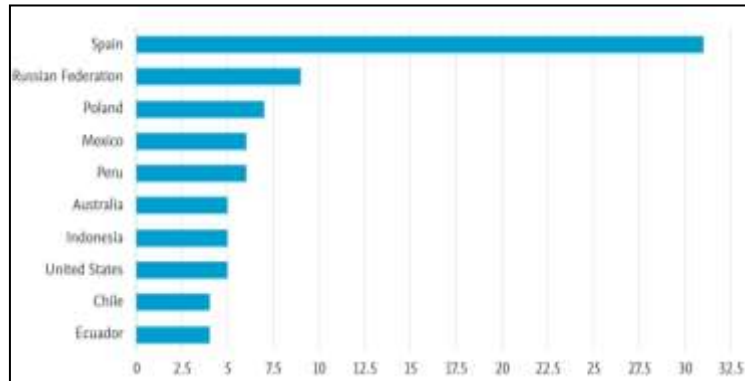
Furthermore, the authors found that of the 314 authors, there are three authors collaborate each other, namely Fernandez-Bedoya VH with Meneses-la-riva ME and Suyo-Vega.JA The two authors collaborated in writing an article entitled "University teachers' self-perception of digital research competencies. A qualitative study conducted in Peru". The five authors are the most influential in Teacher digital competence research.



**Figure 3. Author Collaboration**

Source: VOS viewer and processed in 2023

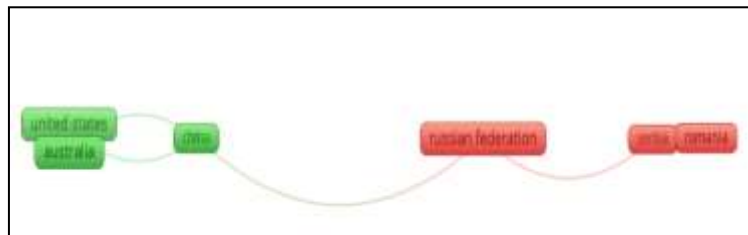
The results mapping of the countries distribution with the highest Scopus-indexed articles show that Spain is the country that produces the most articles on teacher’s digital competency, with 31 documents. The second position is the Russian Federation, with nine documents, and Poland occupies the third position. The top 10 countries producing Scopus-indexed articles regarding teacher’s digital competency are the following.



**Figure 4. Distribution of Countries with the Most Article Documents**

Source: Scopus Analysis

Bibliometric analysis was also carried out to see which countries dominate and significantly influence research related to educator competence. Researchers use a maximum score of 25 on the "maximum number of countries per document" and a minimum of 2 on the "minimum number of documents of a country." Forty-nine countries emerged, but only 23 met the thresholds, and six were interrelated.



**Figure 5. Most Influential Countries and Author Collaborations Between Countries**

Source: VOSViewer and Processed in 2023

Apart from a country of origin, the database can also analyze the distribution of documents based on affiliation. This distribution can come from universities or research and development organizations in a country. Figure 6 shows the distribution dominated by the University of De Salamanca, located in Spain, and it is one of the countries that produce the most articles about teacher’s digital competency.

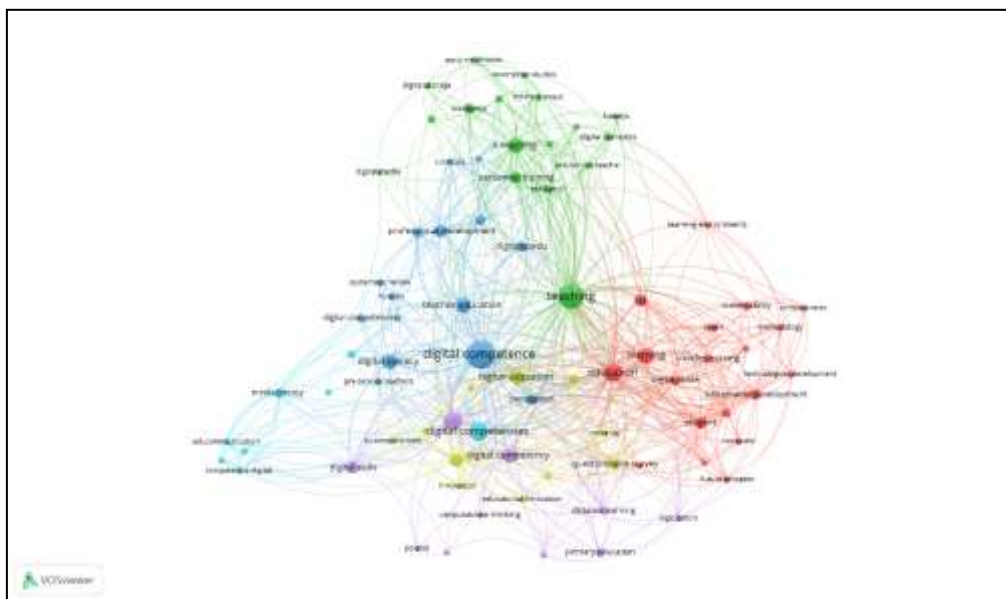


**Figure 6. Distribution of Documents Based on Affiliation**

Source: Scopus Analysis

**3.3 Clustering of Teacher’s Digital Competency Research Topics (Co-Occurrence)**

Clustering is done by analyzing keywords. The author uses the keyword teacher's digital competency to find articles on the Scopus page. 1.314 journal articles appeared, but after the authors made limitations, namely only in the period 2012 to 2022, the subject area was in the field of social sciences, the document type was journal articles, and the language used was English, only 113 articles appeared. Then, the author conducts a screening by reading the abstracts of the articles one by one to get articles relevant to the research needs. Found 90 articles that are relevant to this research. Furthermore, the keywords used by journal article authors and appearing more than two times in the Scopus core database are 498. Out of a total of 498 keywords, 80 articles met the threshold.



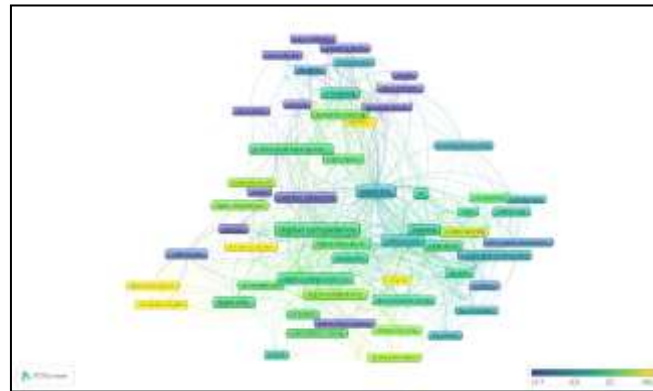
**Figure 7. Circles Network Visualization**

Source: VOSviewer and Processed in 2023

Data visualization images with keywords (*Co-Occurance*) *Teacher's Digital Competency* shows the emergence of various keywords. The node size shows the frequency of using these keywords in an article review. The larger nodes size in *the Circles Network Visualization*, the more frequent studies in that regard. The curves between nodes represent their shared occurrences in the same publication. The shorter distance between the two nodes, the greater number of expected occurrences of the two keywords, and vice versa. The farther distance between two nodes can be assumed that the less frequently the two things are examined simultaneously. In addition, the network map above shows that there are 6 clusters consists of 80 terms related to teachers' digital competency, namely:

1. ICT Environment cluster (in red) consists of the terms blended learning, competencies, computer, digital device, education, prospects, ICT, information and communication, learning, learning environments, methodology, Spain, student, sustainability, sustainable development, sustainable development goals, Teacher professional development, technological development, university sector.
2. Pre-service Training cluster (in green) consists of the terms descriptive studies, digital literacy, digital media, digital storage, e-learning, early childhood, engineering education, learning system, online surveys, personal training, pre-service teachers, students, surveys, teachers, teaching, technology, virtual reality.
3. Teacher Digital Competency Framework cluster (in blue) consists of Chinese terms, curricula, digcompedu, digital competencies, digital literacy, digital technologies, human, perception, pre-service teachers, professional aspects, professional development, systematic review, and Teacher and teacher education.
4. Educational Innovation Cluster (in yellow) consists of the terms covid-19, education 4.0., educational development, educational innovation, emergency remote teaching, higher education, ICT competencies, innovation, questionnaire survey, Romania, and training.
5. Teacher in the Digitization cluster (colored purple) consists of computational thinking, digital competency, digital skills, digitization, distance learning, Poland, pre-service teachers, primary education, teacher training, and teaching skills.
6. Digital Capital cluster (in light blue) consists of digital competence, competence mediatic, digital capital, communication, media literacy, and teachers.

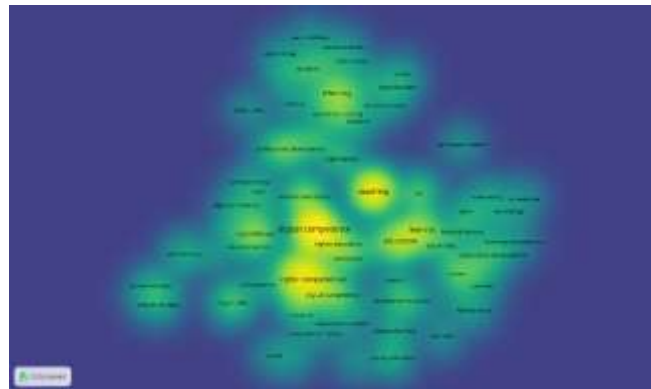
After clustering using "network visualization," then mapping the trend of "teacher's digital competency" publications based on historical traces or years of research publication using "overlay visualization." The results interpretation of the "overlay visualization" can be used as a guide in identifying and detecting "state of the art" from research on "teacher's digital competency" conducted during 2012 – 2022. In the "overlay visualization," the colors on the nodes represent keywords that indicate the year rise. Trends in the theme of writing articles related to teacher's digital competency from the oldest year to the latest year are symbolized with purple, blue, tosca, dark green, light green, and yellow themes. It means that the themes "blended learning," "communication," and "pre-service teachers" in yellow are the newest themes related to educators' digital competence. All that theme can be a reference for the next research.



**Figure 8. Overlay Visualization**

Source: VOSviewer and Processed in 2023

Next step is used *Density Visualization* to identify dense areas or those with high density at one node with other nodes. A bright yellow color indicates the density of the research theme. The lighter the color of a theme, the more research is done. Conversely, the dimmer the color means that the theme is rarely studied. Dimly colored themes such as "communication," "pre-service teacher," and "digital technologies." There are any connection themes between the mapping results of Frames Overlay Visualization and Density Visualization, they are "communication" and "pre-service teacher." These themes should be studied more in teacher's digital competency research.



**Figure 8. Density Visualization**

Source: VOSviewer and Processed in 2023

### 3.4 The Important of Teacher's Digital Competency

After conducting a bibliometric analysis of research related to digital teacher's digital competency, the authors conducted content analysis of the clusters formed to identify how important teacher's digital competency, especially in the digitalization era. Education in the digitalization era will use the concept of Educational for Sustainable Development (ESD) (Cebrián et al., 2020; Gómez-ruiz et al., 2021). ESD considers the concepts of virtual and physical learning spaces by transforming classrooms

towards student engagement, formative assessment, and active methodologies (Brudermann et al., 2019; Gavinolla et al., 2022). An intelligent, flexible, sustainable learning environment must support ESD (Sebastián-López & de Miguel González, 2020). The innovative learning environment is an educational space equipped with technology, incorporating both digital devices and learning software to include network of sensors that will help track the all learning processes (Tammets et al., 2022). The learning environment is essential because it will affect students' progress, emotion, comfort, and concentration (Cebrián et al., 2020). This means that the learning environment must allow for the efficient use of resources, the production of optimal environmental circumstances, and the innovative use of ICT. The use of ICT should be adapted to pedagogical aspects, not just providing innovative solutions but not connected. Using ICT effectively during learning can encourage pedagogical transformation while strengthening student competence (Morales Capilla et al., 2014).

Implementing ICT in education, especially during the learning process, requires the critical role of a teacher (Rangel-Pérez et al., 2021). Teachers must not only help their students use digital resources more successfully, but they must also help them grasp and acquire an understanding of the broader issues surrounding technology use and its effects (Falloon, 2020; Isoda et al., 2021). Therefore, teachers must have significant digital competence for mastering ICT and integrating it into the teaching and learning process. Digital competence is a set of abilities, knowledge, or skills teachers have to solve educational problems by integrating ICT. Cabero-Almenara et al. (2020) state that several factors drive teacher digital competence: 1) Training of the Teacher. Teacher work experience and knowledge of ICT tools become fundamental factors for developing TDC (ElSayary et al., 2022); 2) Resources. Infrastructure quality and technology availability influence how ICT integrates into the learning process (Miralles-martínez et al., 2019); 3) Usage time. Dedicated use of ICT both inside and outside the classroom is supporting element in building teacher digital competence (A. Shibankova et al., 2019); 4) Attitudes towards technology are related to the Teacher's belief in his ability to operate ICT devices (Hatzigianni & Kalaitzidis, 2018).

The rapid advancement of technology provides both an opportunity and a problem for teacher to constantly reflect on current educational capacities and demands (Mynaříková & Novotný, 2020), as well as to access professional learning if necessary. Digital competence for teacher actually started since the prospective teachers were still studying through pre-service training (García-Martín & García-Sánchez, 2017; Yang & Alicia, 2022). Pre-service training, namely the provision of knowledge and skills for teachers and prospective teachers in educational institutions in terms of technical mastery. So far, training on educational technology has yet to be carried out. Therefore, many educational institutions integrate pre-service training in the use of technology in their curricula (Howard et al., 2021). This is based on the fact that teachers who have just graduated from teacher education institutions are considered to have more knowledge of technology integration, so they are better prepared to implement it in learning. Furthermore, this research found a significant demand among teachers in primary and secondary schools regarding digital training that can be accessed free. However, there is still a digital divide between generations and gender (Rodríguez-García et al., 2022).

Female teachers are more interested in participating in training than male teachers. Meanwhile, teachers aged 56 and over were the least interested in digital training. Even though teacher training was identified as the main factor motivating teachers to use technology in the classroom and enhance digital education (Cortoni & Perovic, 2020; Gisbert-Cervera et al., 2022).

In response to pre-service training, several frameworks are the most consolidated for the formation of teacher's digital competency, namely: the European Digital Competence Framework for Educators, DigCompEdu; ISTE standards for Educators; the UNESCO ICT Competency Framework for Teachers; the Spanish Common Framework of Teacher's Digital Competence; the British Digital Teaching Professional Framework; the Colombian ICT Competencies for the professional development of teachers; the Chilean ICT Competencies and Standards for the teaching profession (Cabero-Almenara et al., 2020). However, an evaluation study on the TDC framework highlights that the DigCompEdu model is adequate for reviewing teacher digital competence (Cabero-Almenara et al., 2020; Reisoğlu, 2022).

The DigCompEdu model is a model of the results of meetings, workshops, debates, and professional considerations with experts and professionals published at the end of 2017 (Hurtado-Mazeyra et al., 2022). The DigCompEdu model develops five dimensions for reviewing teacher's digital competency: 1) Professional engagement: focusing on the teacher's work environment. Teachers' digital competency is exposed their skill when using digital technology in learning and interact professionally with peers, students, families, and other educational communities (Starkey, 2020); 2) Digital resources: This concerns the source, creation, and distribution of digital power. The main competency that every teacher must develop is identifying educational resources. In addition, teachers must capable to use and manage digital content responsibly, respect copyright guidelines and protect personal data (Romanova & Petrenko, 2022); 3) Teaching and learning, namely a teacher must know how to design, plan, and apply the digital technology in various stages of the teaching and learning process (Tabieh et al., 2021). As well as always trying to focus on student learning; 4) Assessment related to use digital tools in evaluating the learning process, including how to increase student achievement. Digital technologies can improve the existing of assessment strategies and provide better evaluation methods (Jorge-Vázquez et al., 2021); 5) Empowering learners; one of the keys that reinforces the reasons for the need for ICT in education is to encourage the active participation of students in the learning process and their autonomy in it. In addition, digital technology can offer learning activities tailored to each student's competency level, interests, and needs (Pérez-Navío et al., 2021); 6) Facilitating learners' digital competence; teachers with high digital competence will be very helpful in developing and facilitating their students' digital competence (Starkey, 2020)

It advises that a university teacher training plan be established in three major areas, out of the five dimensions. First, as part of the teacher's professional commitment, teachers learn how to use technology to connect professionally with peers, students, and other members of the educational community. Second, having sound training to drive technology in the learning process suggests that



teachers' identification of teaching technology demands must be modified to student characteristics. And the third is to have adequate training to know how to empower students by strengthening digital technology and to implement training actions so that students gain digital competences that meet their needs.

#### 4. CONCLUSION

The rapid development of technology requires the education sector to digitize by integrating ICT into the learning process because it will positively impact students, teachers, curricula, and educational institutions. The use of ICT will only produce optimal output if educators, as the main actors, have adequate digital skills. Educators must link their digital-age skills or competencies to their professional practice. However, there needs to be more policies on the use of ICT in education and the actual abilities of educators, namely the low self-confidence of teachers in adopting technology from both a technical and pedagogic perspective. This gap indicates that digital capital is needed in the form of educator digital competencies to deal with digitalization. This study uses bibliometric analysis in which the results show that the development of publications related to digital competency research over the last 11 years between 2012 - 2022 shows fluctuating developments. An article entitled "*Generation z's Teachers and their digital skills*" by Fernández-Díaz M.-J, published in 2016, has received many citations for reference for similar research. Journal of Sustainability (Switzerland) is a journal that publishes many articles related to "teacher's digital competency," but education science journal gets more citations.

Furthermore, the results of the co-authorship analysis show that of the 314 authors involved in research on "teacher's digital competency," three authors collaborate. Spain has the highest publications on "teacher's digital competency." Teachers' digital competency is essential for educators in the digitalization era because education in the digitalization era will use the concept of Educational for Sustainable Development (ESD). ESD must be supported by an intelligent learning environment that is flexible and sustainable, the implementation of which requires ICT integration. Educators' digital competence is urgently needed to support their students to use digital resources more effectively and to help them understand and develop an awareness of broader considerations around the use of technology and its impact. Given the critical role of the Teacher's Digital Teacher, a pre-service training program is needed. This is based on the fact that teachers who have just graduated from teacher education institutions are considered to have more knowledge of technology integration, so they are better prepared to implement it in learning.

#### 5. RECOMMENDATION

This research is still limited to using one keyword when searching for articles in the Scopus database. Subsequent research can use several keywords to make the research results more comprehensive. In addition, based on the results of the bibliometric analysis and content analysis that has been carried out, the authors found that subsequent research can explore related pre-service training programs for prospective educators in tertiary institutions because it is identified as the main factor that can later

motivate teachers to use technology in the classroom. Topics related to the pre-service training program are still relatively new and need much exploration.

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