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# The evolution of scientific publications on Practicum and Information and Communication Technologies

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## Abstract

The purpose of this study is to evaluate the scientific production and performance of the concepts “Practicum” and “Information and Communication Technologies” (ICT) from 2000 to today through a bibliometric analysis. The study resorted to different processes to quantify, analyse, evaluate, and estimate the scientific output by means of specific software such as *SciMAT*, *Analyze Results* and *Creation Citation Report*. The concepts were run through 55 scientific publications dating from 2000 to 2022, extracted from the Web of Science (WoS) citation database. The findings suggest that the evolution of the study about Practicum and ICT is constant and continuous and has followed a stable trend. The results also highlight the research themes that are of greatest scientific interest throughout each of the decades, *new methodologies* being relevant in each of the timeframes analysed. Future works could build from this review to strengthen links between Practicum and ICT in enhancing quality teacher training.

## Keywords

practicum, ICT, scientific production, bibliometric analysis, scientific mapping

## Introduction

The search for effective teaching Practicum by applying Information and Communication Technologies (ICT) has been a constant in the field of teacher training at both national and international scales. The most compelling research on this subject has been developed by Cebrián de la Serna (2011), Donlon (2019), McGarr and Gavaldon (2018), Olivares and Castillo (2018), Raposo-Rivas and Martínez-Figueira (2019), Rogers (2004), Vidergor, Magen-Nagar and Ilaiyan (2018), Yamamoto, Tagami and Nakazawa (2012), and Zabalza (2011).

The research by Habibi et al. (2022) focuses on beliefs and Knowledge for pre-service teachers’ technology integration during teaching practice. Hu and Yelland (2017) explore the adoption of ICT in a teaching Practicum context. Mabunda (2013) and Mathisen and Bjørndal (2016) inquire into the use of ICT strategies or digital tools for teaching practicum supervision, as do Martínez-Romera, Cebrián-Robles and Pérez-Galán (2020), who focus their study on tutoring and assessment using ICT during the practical training. The study by Davids (2017) also addresses an ICT-based e-assessment application for the teaching Practicum. These studies on pre-professional practice point to the need for further use of ICT in

Practicum management, supervision, and tutoring, especially when it has been shown that ICT are effective tools for reducing anxiety in these practical experiences (Trotsenko, Bilyk, Pyliachyk 2020).

On the other hand, improving ICT competency during preservice teachers' practicum appears to be a common research topic in recent years (Wang and Ko 2022). Teacher education courses training and participating in school-based field practice are important processes for equipping preservice teachers with technology integration ability. However, preservice teachers still lack the ability and knowledge needed to teach successfully with technology. Liu (2012) investigates this topic. His study focuses on Practicum and technology competency, and the results reveal that teacher education courses fail to facilitate preservice teachers' technology integration in the Practicum context. However, preservice teachers' experiences with mentors can help preservice teachers use technology while practicing teaching.

Other studies focus on what are known as ICT innovation linked to the Practicum. These articles address the use of the technology of digital video and video and e-portfolio annotations in teacher preparation programmes (Martínez-Romera and Cebrián-Robles 2019; Martínez-Romera et al. 2020).

Although much research has been done on the relationship between ICT and Practicum, it is still important to study it. ICT have become a tool of application and development of/for the Practicum. This implies the need to reflect on their suitability and applicability, the obstacles encountered, or the benefits of applying them to the Practicum. The current bibliometric analysis of this subject was thus carried out to identify its thematic evolution, its themes of greatest impact, its most relevant and visible thematic areas, and those areas devoid of thorough examination that are open to future academic research. Specifically, this study aims to identify the state of scientific productivity on Practicum and ICT by referencing works on the subject through the platform Web of Science, currently one the most prestigious online databases. The research questions guiding the study are the following:

1. What is the performance of Practicum and ICT publications in Web of Science?
2. How can one characterise the scientific evolution of Practicum and ICT through the Web of Science?
3. What are the most common research themes related to Practicum and ICT in the Web of Science?

### The present study

For decades, the process of initial teacher training has been –and continues to be– a recurring theme of constant concern in the field of educational research. Numerous studies have focused on the field of professional teacher training, giving priority attention to one of the core components of practical university training, the Practicum. Some of these studies have outlined the key indicators and/or conditions for providing a quality Practicum period (Blanco and Latorre 2008). Other studies have documented successful innovative practices linked to the use of ICT during the Practicum (Raposo et al. 2020).

Although the scientific literature reveals that the search for effective teaching practicum by applying ICT has been a constant in the field of teacher training, it has been found that, to date, no bibliometric analysis has been carried out on it, based on academic publications indexed in the Web of Science database. Herein lies the significance of the current study. Additionally, it will made a significant contribution to the understanding of the evolution of research on Practicum and ICT. What other ICT-related constructs can contribute to inno-

vation and improvement in the Practicum? This is a crucial question because it will allow researchers to identify and focus their attention on those other concomitant constructs that are key to increasing the quality of the practical teaching experiences of future teachers. Deepening the study and analysis of these themes, topics or areas will take on a fundamental role in guiding initial teacher education programmes, both nationally and internationally.

This study therefore explored the concepts of “Practicum” and “ICT” (henceforth PRACTICT) by means of a bibliometric analysis of articles pinpointed through the Web of Science (WoS) database. This database, most often applied to social sciences, offers a series of tools facilitating concrete searches. It contains the means to carry out scientific mapping (Cobo et al. 2011a) based on different bibliometric indicators which can shed light on the dynamics and structural evolution of the topic of PRACTICT.

This study specifically focused on evaluating the trajectory and evolution of PRACTICT through the main WoS collection. The first step was to undertake a search to determine the status of the term and identify similar research. It must be noted that this initial phase yielded no publication or scientific mapping, which reveals the dearth of research on the theme. The current analysis therefore intends to delve deeper into the subject so as to increase the research of PRACTICT in the specialised literature. The study’s findings thus acquire relevance as they contribute both to advance the subject matter as well as to serve as a foundation for successive research.

The general objective of this study is to carry out a survey of the scientific literature on the subject of PRACTICT indexed in the WoS database. Deriving from this general objective are the following specific aims:

- a. To determine the frequency of publications linked to PRACTICT in the WoS.
- b. To identify the scientific evolution of PRACTICT in this database.
- c. To identify the most researched themes related to PRACTICT in the WoS.

## Methodology

### Bibliometric analysis

This study undertook a bibliometric analysis of secondary sources, a type of analysis that allows researchers to identify the general or specific concepts of specific areas of a field, and subsequently visualise its evolution (López-Robles et al. 2019). These analyses offer academics valuable information (Rey-Martí et al. 2016) and are currently highly valued as a means to assess scientific quality, productivity and evolution (Rodríguez-Bolívar et al. 2018).

The current study specifically resorted to co-word analyses (Hirsch 2005) as well as other bibliometric indicators of scholarly output such as the *h*-index as well as the *g*, *hg* and *q2* indices (Cobo et al. 2011a) yielding node maps serving to interpret the output and position of the conceptual subdomains related to PRACTICT. The current study used the WoS to define the thematic development of the concept over time (López-Robles et al. 2019). The records extracted from the database therefore served to obtain the greatest amount of relevant information to carry out the co-word analysis.

### Selecting the database

The most prominent databases for this type of study are WoS, Scopus and Google Scholar (Martínez et al. 2015). WoS with its greater access to academic literature is nonetheless the most widely accepted and commonly used platform to survey publications from the disciplines of science, social science, arts, and humanities (Norris and Oppenheim 2007). Thus,

the data on PRACTICT of the current study were collected through WoS, focusing on the timeframe of 2000 to 2022 to determine its recent evolution.

### Procedure and data analysis

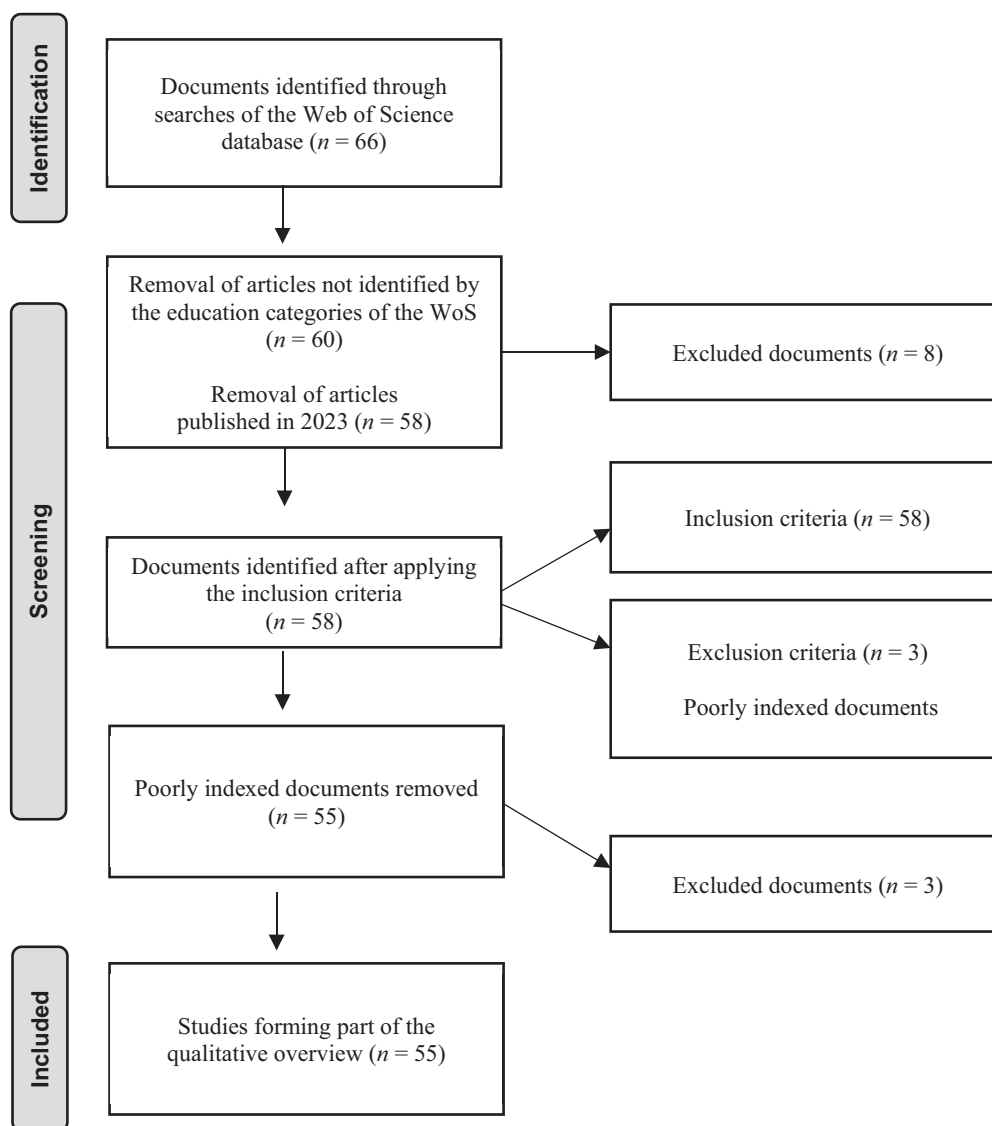
The research on this issue, subsequent to selecting the database, adhered to the following procedures: (a) determining the keywords (this was undertaken after consulting specialised thesauri, ERIC), and (b) constructing a precise search equation to obtain significant results (“Practicum” AND “ICT”) [TOPIC]) and report the documents containing these terms from the different metadata (title, abstract and keywords).

The first search identified 66 scientific publications, a volume that was reduced to 60 by exploring exclusively through the education categories of the Web of Science (*Education Educational Research* and *Education Scientific Disciplines*). In addition, the entire report was analyzed to eliminate repeated documents, those belonging to the year 2023, those published before 2000 and the poorly indexed ones. After this, an analysis unit of 55 publications remained, as a result of the configuration inclusion and exclusion criteria (Alexander 2020) (Table 1).

**Table 1** The inclusion/exclusion criteria chose to assemble the corpus of articles.

Inclusion criteria	Exclusion criteria
Studies identified by the search equations	Studies that do not meet the inclusion criteria
Studies identified by the education categories of the Web of Science (WoS)	Studies that do not line up with the theme under study
Studies published between 2000 and 2022	Poorly indexed studies in the WoS
Studies published in different formats (articles, book chapters...)	Repetition of documents in the WoS

The following flow chart (Figure 1) was drafted following the protocols of the PRISMA-P matrix to improve the understanding and visualisation of the different actions.



**Figure 1** Flowchart according to the PRISMA Declaration.

### The analytical tools

First of all, two tools served to carry out the analysis. The applications *Analyze Results* and *Creation Citation Report* that form part of by WoS served to analyse the performance and scientific production of the documents. These rendered it possible to qualitatively and quantitatively measure the contribution of the themes and thematic areas to the entire academic field thus identifying the most outstanding, productive and impactful subfields (Muñoz-Leiva et al. 2012). Specifically, each of these tools served to obtain data as to year of publication, authorship, country, type of document, language, institution, source of publication, and determine those most often cited.

Secondly, the study resorted to the SciMAT software to delve into the structural and dynamic development of the results gleaned from the assemblage of publications. This consisted of a co-word analysis of the topics according to the following processes advanced by experts (Montero-Díaz et al. 2018):

- a. Recognition. Various actions were carried out in this process. The first was an analysis of the keywords garnered through the literature (n = 238). This generated a map consisting of co-occurrence nodes and a standardised network of co-words yielding the most significant (n = 51). Moreover, the more predominant themes and concepts were represented by means of a clustering algorithm.
- b. Reproduction. This process consists of designing a strategic diagram and a thematic network based on the principles of centrality and density according to the guidelines established by Cobo et al. (2011b). Four quadrants appear in the figures: (1) top right (motor themes and highlights), (2) upper left (highly developed and isolated themes); (3) lower left (emerging or declining themes), and (4) lower right (underdeveloped and transversal themes).
- c. Determination. This process consists of analysing the evolution of the nodes in specific moments or intervals of time. Here two periods were defined (P1 = 2000-2011; P2 = 2012-2022). The number of matching keywords determine the strength of the associations between the periods.
- d. Performance. This process delimits the set of production indicators associated with the inclusion criteria serving to pinpoint the scientific publications that align with the themes of the study (Table 2).

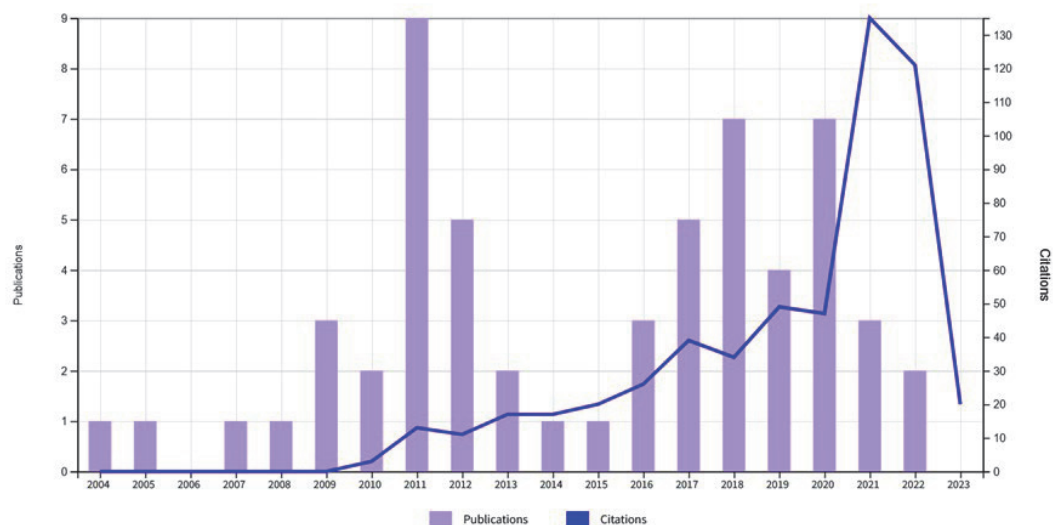
**Table 2** Production indicators and inclusion criteria.

Configuration	Values
Analysis unit	Keywords authors, keywords WoS
Threshold frequency	Keywords: P1 = (1), P2 = (1)
Network type	Co-occurrence
Co-occurrence union value threshold	Keywords: P1 = (1), P2 = (1)
Normalisation measure	Equivalence index
Clustering algorithm	Maximum value: 9; minimum value 3
Evolutionary measure	Jaccard index
Overlapping measure	Inclusion rate

## Results

### Performance and scientific production

The evolution of the scientific publications on the theme of PRACTICT is constant and continuous over time, marked by an exponential growth from its beginnings until 2022. A chart (Figure 2) depicting the frequency of these publications by year reveals a gradual growth with a peak in 2011 and others peaks in 2018 and 2020. These data coincide with the state of technological revolution experienced worldwide, highlighted in many studies. Productivity from then to the present is stable. A compelling investigation would be to determine the causes behind these peaks. One hypothesis motivating this surge in recent publications in the field of education as well as in other scientific disciplines relates to the penetration of what is known as academic capitalism (Saura and Caballero 2021) imposing a *publish or perish* scenario (Fernandez-Cano 2021) among the teaching staff of universities.



**Figure 2** Number of documents per year gathered from the Web of Science (WoS).

Most of the documents identified in this study were articles (46 documents, 79.31%) penned in English (40 documents, 68.96%) and Spanish (17 documents, 29.31%). Less than half of these documents analyzed are Open Access (20 documents, 34.48%).

On the other hand, the country contributing the greatest number of publications (22) is Spain (37.93%) followed by Australia with 5 (8.62%) and China with 4 (6.89%). Of the total 26 countries, this study selected only those with or greater than two (Table 3).

**Table 3** Ranking of the number of documents by country.

Countries	Number of documents
Spain	22
Australia	5
China	4
Chile	3
Indonesia	3
South Africa	3
Canada	2
Finland	2
Ireland	2
Malaysia	2
Portugal	2
Singapore	2
Ukraine	2
USA	2



The 55 documents linked to research on PRACTICT are authored by a total of 100 authors. A. Bautista García-Vera is the most productive with two publications (3.44%). This is a Spanish author. In the rest of the scientific output (it has carried out by M. A. Zabalza Beraza, A. D. Colvin, A. N. Bullock, D. Cebrián Robles, H. Lau, M. Cebrián de La Serna, M. Raposo Rivas, N. Maakdiani, for example) the authors appear with a single contribution (1.72%).

Furthermore, the main source of research on PRACTICT is the journal *Revista de Educación*, with four articles (6.89%), followed by *Educar* with three (5.17%). The reviews *Asia Pacific Journal of Education*, *Australasian Journal of Educational Technology*, *European Journal of Teacher Education*, *Information Technologies and Learning Tools*, *Teaching Education* and *Turkish Online Journal of Distance Education* each have two (3.44%). Of the total 54 sources, 37 are scientific journals. It should be noted that of these, nine are Spanish journals (Table 4).

**Table 4** Ranking of the number of publications per source.

Source	Number of articles
Revista de Educación	4
Educar	3
Asia Pacific Journal of Education	2
Australasian Journal of Educational Technology	2
European Journal of Teacher Education	2
Information Technologies and Learning Tools	2
Teaching Education	2
Turkish Online Journal of Distance Education	2
Africa Education Review	1
Bordon. Revista de Pedagogía	1
Campus Virtuales	1
Computers in the Schools	1
Early Years	1
Educatio Siglo XXI	1
Education and Information Technologies	1
Education in the Asia Pacific Region Issues Concerns and Prospects	1
Education and the Knowledge Society	1
Educational Technology Society	1
Electronic Journal of E-Learning	1
Estudios sobre Educación	1
Information and Communication Technologies and Real Life Learning	1
Interactive Learning Environments	1
International Journal of Early Childhood	1
International Journal of Information and Communication Technology Education	1
Journal of Early Childhood Teacher Education	1
Journal of Physics Conference Series	1
Journal of Teaching in Social Work	1
Nordic Journal of Digital Literacy	1

Source	Number of articles
Procedia Social and Behavioral Sciences	1
Profesorado. Revista de Curriculum y Formación del Profesorado	1
RED. Revista de Educación a Distancia	1
REDU. Revista de Docencia Universitaria	1
Revista Latinoamericana de Investigación en Matemática Educativa RELIME	1
Revista Latinoamericana de Tecnología Educativa RELATEC	1
RIED. Revista Iberoamericana de Educación a Distancia	1
Technology Knowledge and Learning	1
Turkish Online Journal of Educational Technology	1

The following institutions are the leaders of PRACTICT research: *University of Málaga* (Spain), *Complutense University of Madrid* (Spain) and *Education University of Hong Kong* (*EdUHK*). Only those with or a number greater than one were retained (Table 5).

**Table 5** Ranking of institutions by number of publications.

Institutions	Number of documents
University of Málaga	4
Complutense University of Madrid	3
Education University of Hong Kong (EdUHK)	3
Nanyang Technological University	2
National Institute of Education Nie Singapore	2
University of Cádiz	2
University of Vigo	2
University of Hong Kong	2
University of South Africa	2

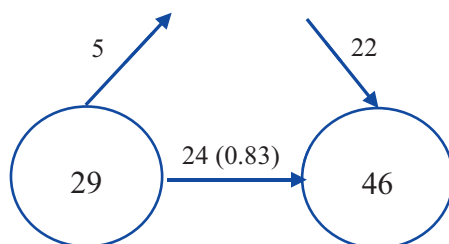
Finally, the authors with the greatest number of citations related PRACTICT are Kim (2020) and Zabalza (2011), followed by Gao, Choy, Wong and Wu (2009), Liu (2012) and Guillén-Gámez, Mayorga-Fernández and Álvarez-García (2020) (Table 6).

**Table 6** Author/s, number of citations and main research theme on the subject of study.

Article	Citations	Main research theme
Kim (2020)	114	Practicum and online communication tools
Zabalza (2011)	102	State of the art of Practicum. It is highlight the need for further use of ICT in Practicum management, supervision and tutoring
Gao, Choy, Wong and Wu (2009)	36	Process of learning to teach with ICT across the teacher preparation programme
Liu (2012)	34	Practicum and technology competency
Guillén-Gámez, Mayorga-Fernández and Álvarez-García (2020)	28	Use of 2.0 applications in the teacher training (level of digital competence, and level of motivation to use ICT)

### Structural and thematic development

The 55 documents extracted from the WoS database yielded a total of 238 keywords, *a priori*, through the SciMAT software. These were subsequently refined reducing their number to 51 for the two timeframes of the study. The evolution of the keywords reveals information as to their number in each of the time intervals, the number of matching keywords between periods and the number of keywords exiting and appearing in a certain period in comparison to another. Based on the evolution of keywords among the scientific production, the studies on the topic of PRACTICT represent a cultivated and robust line of research given that the values of the periods coincide more often than 50% (Figure 3).



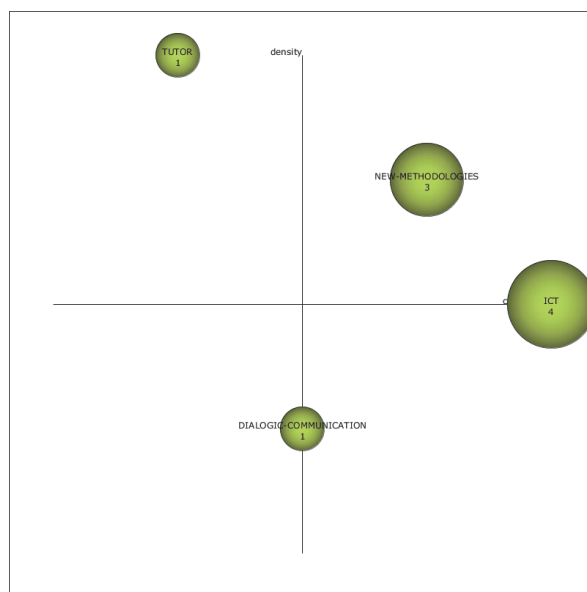
**Figure 3** Continuity of the keywords between contiguous time intervals.

The performance of the themes by time interval yields evidence as to the subjects with the greatest number of bibliometric indicators. This information is determined through the *h*-index as the main reference and completed data gleaned from the *g*, *hg* and *q<sup>2</sup>*-indices as well as by the number of citations. On the theme of PRACTICT, the subject/s with the highest bibliometric indicators varied between periods. ‘ICT’ was the topic with the greater bibliometric indicator in the initial timeframe [2000–2011] whereas ‘new-methodologies’ was that of the second period [2012–2022]. These data are key, as they reveal changes in the interests of researchers in this field. It is likewise possible to observe changes between periods of the themes of greatest interest to researchers, values that reveal the main lines of research in each of the two time intervals (Table 7).

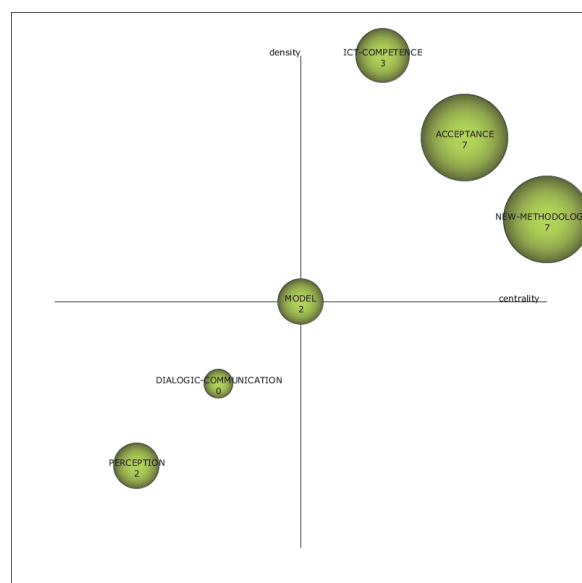
**Table 7** Thematic performance for the two periods of the study.

Period 2000–2011						
Denomination	Works	<i>h</i> -index	<i>g</i> -index	<i>hg</i> -index	<i>q2</i> -index	Citations
New-methodologies	7	3	4	3.46	6.48	124
ICT	7	4	5	4.47	5.29	34
Tutor	1	1	1	1	1.41	2
Dialogic-communication	2	1	1	1	3.74	14
Period 2012–2022						
Denomination	Works	<i>h</i> -index	<i>g</i> -index	<i>hg</i> -index	<i>q2</i> -index	Citations
ICT-competence	5	3	4	3.46	6.93	54
Acceptance	11	7	9	7.94	11.22	239
New-methodologies	21	7	15	10.25	13.75	267
Model	3	2	2	2	2.83	7
Perception	2	2	2	2	15.1	125
Dialogic-communication	2	0	0	0	0	0

The next phase of the study was to examine the diagrams generated for each of the two study periods (Figures 4-5) that point to the importance of each of the themes by period. This entailed grouping them according to Callon's indicators which serve to assess the degree of interaction of a network with respect to others from the standpoint of two axes. The first, centrality, analyses the strength of the relationship of external links with other topics revealing the degree of development of a topic in a field of research. The second, density, assesses the internal strength of the network, analysing the internal links between the keywords that are grouped around a specific topic, yielding information on the degree of development of a field of study.



**Figure 4** Strategic diagram of PRACTICT according to the  $h$ -index for the 2000–2011 timeframe.



**Figure 5** Strategic diagram of PRACTICT according to the  $h$ -index for the 2011–2022 timeframe.

### The first decade of research [2000-2011]

The strategic diagram corresponding to the first period (Figure 4) highlights four research themes: *new-methodologies*, *ICT*, *tutor*, and *dialogic-communication*. The measurements of performance point to *ICT* with total of 34 citations and an *h*-index of 4 as the motor theme for the period (Table 7). Certainly, it is the theme with the highest centrality that ceased to be a basic and transversal theme and became a motor theme when analysed from the perspectives of Practicum, new methodologies and student teachers; attitudes; model; teacher training; mentoring preservice teachers; teacher professional knowledge; professional competency; practical tasks; higher education and new methodologies; preparation; trends; tutor; professional profile and tutor; duties and tutor; qualitative evaluation; and collaboration and new methodologies.

Likewise, *new-methodologies* appears as another motor theme, with a larger number of citations but with an *h*-index lower than the previous topic (124 citations and an *h*-index = 3). This theme is linked to studies focusing on Practicum; teachers; higher education; curricular integration; collaboration; professional development; reflection on practice, and innovative education.

The findings also indicate that *tutor* is a highly developed and isolated theme comprising topics such as professional profile and duties. Although extremely specialised and closely related, this research theme is no longer relevant in PRACTICT research. On the other hand, *dialogic-communication* ceased to be a basic and transversal theme and became an emerging or declining theme when analysed from two perspectives: supervisors and campus virtual. Its evolution towards other quadrants of the diagram it is an issue that will be confirmed in the next decade.

### The second decade of research [2012–2022]

The strategic diagram obtained from this second period highlights six research themes (Figure 5): *ICT-competence*, *acceptance*, *new-methodologies*, *model*, *perception*, and *dialogic-communication*. Compared to the previous period, this second timeframe offers more research themes, a difference which influence the performance indicators (Table 7). When comparing the number of works, *h*-index, *g*-index, *hg*-index, *q*<sup>2</sup>-index and the sum of the citations of the six highlighted themes, the following three themes form the backbone of PRACTICT research: *ICT-competence*, *acceptance*, and *new-methodologies*. They are the motor themes of this decade. *New-methodologies* is the motor theme with the greatest *h*-index (7), greater number of works (21) and a highest sum of citations (267). Its position in the diagram with the highest centrality reveals it to be a highly relevant topic in the field of research linked to studies focusing on ICT and practicum; professional development; inclusive education; school; innovative education; tutor; and needs. *Acceptance* as new motor theme (239 citations and an *h*-index = 7) is addressed in publications related to student teachers; ICT in schools; strategies; context; pedagogical beliefs; teacher training; higher education; and gap. *ICT-competence* also appear as motor theme with the highest density studied in relation with gender; faculty; teachers; anxiety; attitudes; integration; intention; and distance education.

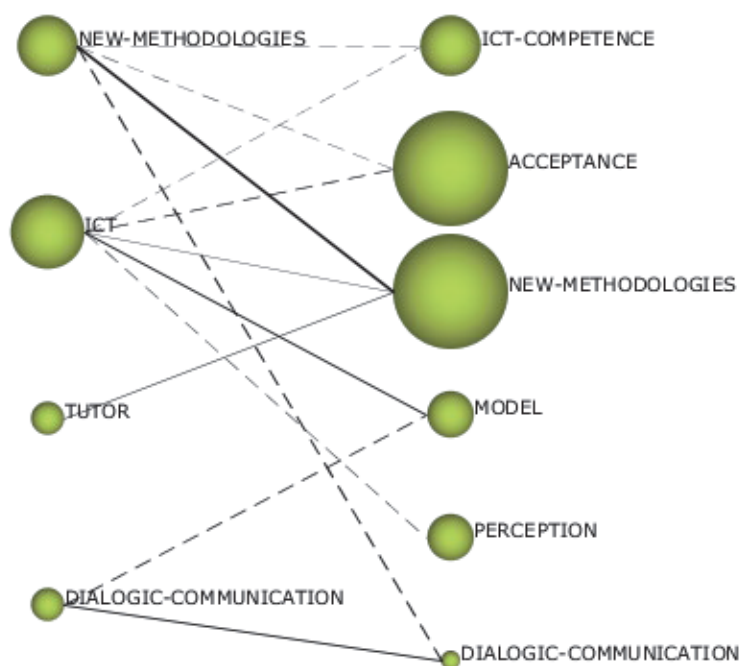
Furthermore, the study detected two emerging or declining themes marked by a weak and marginal development in the field of PRACTICT in the second period. The first, *perception*, relates to teacher professional knowledge, early childhood education, and research. The second, *dialogic-communication* (without evolution since the first decade), appears in analyses in the fields of reflection on practice, collaboration, and empathy. It is important to highlight them given that their position in the diagram places them among an unknown group that in this field of study in the next few years could transition into either a reference or simply disappear.

Finally, *model* follows a different trajectory, not well defined by its location in the diagram. There are two options: (a) cease to be an emerging or declining theme and become a motor theme through a focus on the study of supervisors, mentoring preservice teachers, impact, and feelings, gaining importance for this field of study; (b) cease to be a basic and transversal theme and become a highly developed and isolated theme, linked to study of same topics. In the latter case, it would lose importance for this research field.

#### Thematic evolution of the terms

This study also carried out an analysis of the themes detected in each period taking into account keywords and their evolution over time. In general terms, the research themes that emerged during the second decade doubled in quantity compared to those of the first. This translates into a surge of interest and bolsters the lines of research on PRACTICT.

The scientific map generated by the SciMAT software identified the conceptual evolution and the thematic areas related to the research on PRACTICT over the last two decades (Figure 6). Specifically, it reveals more connections between keywords than themes. Following the recommendations of experts as to the configuration of the thematic areas (Cascón-Katchadourian 2020), this study identified two cases: *new-methodologies* and *dialogic-communication*.



**Figure 6** Thematic areas and evolution of research on PRACTICT identified by the *h*-index throughout the two decades study timeframe [2000–2022].

*New-methodologies* is the hardest thematic area in the research field on PRACTICT, gaining importance through the time period. Attending to the performance indicators (Table 7), the number of documents, *h*-index, and the sum of the citations are doubled in the second timeframe studied. This thematic area touches on issues related to ICT and Practicum; tutor; teacher professional development; inclusive education; higher education; collabora-

tion; reflection on practice; and innovative education. This last topic encompasses the most recent studies on the use of emerging multimedia annotation technologies, including video annotation, which attracts the interest of many researchers. All these themes are revealed as the founding bases of the research thematic area.

The other thematic area, *dialogic-communication*, appears as less relevant to the field of study. In fact, it loses strength from the first to the second decade analysed. It is possible to see an advance in its disappearance in the coming years when observing the connections between the two periods within this thematic area. Research in this sense will certainly not be devoid of interest in the coming years.

## Discussion and conclusions

The data gathered in this study indicates it to be the first bibliometric analysis of PRACTICT based on academic publications ranging from 2000 to 2022. There is in fact no bibliometric study on this subject among all the documents gathered through the WoS and analysed by *Analyze Results* and *Creation Citation Report*. In this sense, the current investigation sheds new light on the matter.

Specifically, the intent of this study is to define the general state of productivity and scientific performance related to the subject of PRACTICT by attempting to contribute compelling notions as to its evolution and referencing of its most frequent aspects developed by researchers. After collecting and analysing 55 publications (practically all of the known publications on PRACTICT in the WoS) by means of WoS Analyze Results, Creation Citation Report and SciMAT software, it was possible to identify the subject's main themes and areas of study.

In the following, a series of key aspects are highlighted that answer the research questions guiding the study, as well as future lines of research.

### 1. What is the performance of Practicum and ICT publications in Web of Science?

The scientific performance analysis of the subject reveals stability of the line of research on PRACTICT, which has been progressively cultivated over the years. In fact, there is an increase in research in the last time period, evidenced by the number of documents published. This indicates that PRACTICT is a theme that has gained greater relevance over time, especially in the last years, and is currently in a stable phase.

### 2. How can one characterise the scientific evolution of Practicum and ICT through the Web of Science?

Spain produced the greatest number of publications. In fact, two Spanish institutions are the leaders of PRACTICT research: *University of Málaga* and *Complutense University of Madrid*. The data also reveals the great diversity of scientific journals publishing PRACTICT related articles. Worth highlighting in this sense are *Revista de Educación* and *Educación*; both are Spanish journals. Furthermore, Spanish author A. Bautista García-Vera is the most prolific author of these types of articles. His research focus is on dialogical communication between teacher student and supervisor during the Practicum through a virtual campus. However Kim (2020), Zabalza (2011), Gao, Choy, Wong and Wu (2009), Liu (2012) and Guillén-Gámez, Mayorga-Fernández and Álvarez-García (2020) stand out in terms of the number of citations.

Gao, Choy, Wong and Wu (2009) and Zabalza (2011) can be highlighted for their work in the first decade [2000-2011]. They focus on Practicum and the process of learning to teach with ICT across the teacher preparation programme. Liu (2012), Kim (2020), and Guillén-Gámez, Mayorga-Fernández and Álvarez-García (2020), in turn, pertain to the second decade [2012-2022], and delve into the Practicum and technology competency. The last three authors also focus on the crucial role of digital competence for classroom teaching and learning. They come to the conclusion that future teachers have a low level of attitude of use towards ICT in the classroom.

In sum, this first analysis suggests that PRACTICT is the object of study by numerous researchers from different institutions in different parts of the world.

### 3. What are the most common research themes related to Practicum and ICT in the Web of Science?

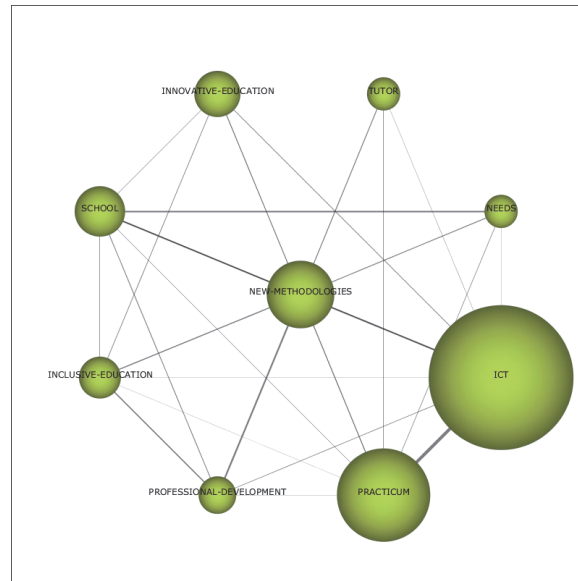
The structural and thematic development analysis carried out with SciMAT identified the research topics of greatest interest related to PRACTICT in each of the two timeframes. The first, 2000–2011 (*the initial stage of the analysis*), comprised four predominant research topics: new-methodologies, ICT, tutor, and dialogic-communication. The first two were found to be motor themes leading that decade's field of study. PRACTICT in the initial decade also began to concern experts from the field of teacher training.

Six research themes emerged during the second study period between 2012–2022 (*development stage analysis*): ICT-competence, acceptance, new-methodologies, model, perception, and dialogic-communication. The first three were motor research themes. They are the backbone of the field of study in this second decade analysed.

This study analysed the evolution of the concept of PRACTICT over two timeframes. The scientific map generated through specialised software makes it possible to state that (a) there are conceptual and keyword connections between the topics identified and analysed in each timeframe, and that (b) PRACTICT research is concentrated over time in two thematic areas. The first relates to *new-methodologies*, the most potent research area. The second is *dialogic-communication*, a thematic area that endured throughout the two periods, but has yielded a smaller number of publications in recent times.

Thus, the evolution of keywords linked to scientific production reveals a level of coincidence throughout each of the two decades greater than 50% (Figure 3), indicating the stability of the line of research on PRACTICT, which has been progressively cultivated over the years. Taking stock of the data presented above, the interests of researchers now focus on aspects related to emerging and innovative methodologies in the field of PRACTICT as these are the foundations of recent studies (Figure 7).





**Figure 7** Strategic diagram of the *new-methodologies* theme for the 2012–2022 timeframe.

The study by Martínez-Romera and Cebrián-Robles (2019) is a clear example of this current and innovative line of research on PRACTICT, one that emphasizes the use of an emerging methodology: technology of digital video and video and e-portfolio annotations. The authors focus on videographic analysis for assessment of external work placements in the initial stages of secondary school teacher training. In a similar line, the work by Martínez-Romera et al. (2020) emphasizes the triad of new-methodologies, Practicum and ICT, by studying tutoring and assessment using ICT in the practical training of secondary school teachers. For its part, the research by Davids (2017) addresses an ICT based e-assessment application for the teaching Practicum.

The above data reveal the changes in PRACTICT research themes over the two decades, as well as the current relevance of those topics that require further study and analysis to promote improvement in the field of practical university education of future teachers, which is one of the decisive triggers for learning to teach.

### Recommendations for future research

The present study concludes with an analysis of its limitations as a proposal for different research options to extend the increasingly consolidated line of research on PRACTICT.

The first limitation that must be considered is that it only resorted to the WoS database to determine the current state of research on PRACTICT. Therefore, a potential future line of research is to replicate the analysis resorting to other databases of impact such as Scopus. A second limitation concerns the debugging of the data gleaned from WoS which was hampered by unrelated documents. The same can be said as to the way the time intervals were selected as an attempt was made to maintain an equal density (10 years) for each.

The practical training incorporating ICT has received special attention in recent times. Are ICT and digital skills considering an essential element for development of the Practicum? In what sense? Do they make up a complementary, substitute element? The studies carried out in this regard point out as an implication for teacher education that technology should be integrated into core method courses, not limited to isolated courses. If higher

education institutions are likely to increase the use of ICT in the future, this requires that teachers and student teachers have the necessary digital skills (Hermansen 2023). In this respect, partnerships between university and schools are crucial for enhancing professional digital competence among student teachers and teacher educators (Andreasen et al. 2022). Hopefully, this study will contribute to the research focused on these topics, Practicum and ICT. For example, this study may encourage other researchers or academics to analyse the impact of the use of new methodologies on the development and/or improvement of digital competences of student teachers during the Practicum (Cebrián de la Serna & Cebrián Robles 2023). Future researchers should apply for international research projects in order to continue generating knowledge in this area. Future works could build from this review to strengthen links between Practicum and ICT in enhancing quality teacher training, in line with the recent study by Latorre and García (2023).

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Note: Scientific output extracted from the Web of Science database is marked with \*.