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Trends in teacher training in research skills based on data analytics

Tendencias de la formación docente en competencias investigativas desde la analítica de datos

DBA. Yolanda González Castro [1], DBA. Omaira Manzano Durán [1]
PhD. Carlos Alberto Vera Romero [2]

*[1]**Universidad Nacional Abierta y a Distancia – UNAD**, Escuela de Ciencias Administrativas, contables económicas y de negocios. Grupo de investigación GRINDES. UNAD Pamplona (N. de S), Colombia*
*[2]**Universidad Nacional Abierta y a Distancia – UNAD**, Escuela de Ciencias Básicas, Tecnologías e Ingenierías. Grupo de investigación GRINDES. UNAD Pamplona (N. de S.), Colombia*

***Correspondence:** omaira.manzano@unad.edu.co*

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Abstract: The research allows us to understand the scientific advances in teacher training in investigative skills that guide plans, programs and knowledge transfer in the area of study. Aim. Review the trends of existing scientific production in the Scopus database, on the need to train teachers in research skills with the purpose of strengthening the impact in said area. Methodology. Quantitative research with bibliometric techniques and uses of the Scopus database and application of data analysis using technological tools such as R Studio, Bibliometrix and Vos Viewer. Results and conclusions. Trends in teacher training in research since the review of the Scopus database and the application of bibliometric analysis demonstrated that it is an incipient area that requires further development. It allowed us to identify the number of publications, years, countries, authors, sources and institutions involved, as well as their impact, and to investigate the importance of implementing the development of research competencies in teachers and the elements to consider in the process. The trends found determine processes of support for teachers from four specific areas: New competencies in accordance with advances in educational innovation, transfer of knowledge to the environment and the curriculum, technologies applied to research processes and methods for the development of investigative competencies.

Keywords: bibliometrics, teacher competencies, information technologies, research trend.

Resumen: La investigación permite comprender los avances científicos sobre formación docente en competencias investigativas que orienten planes, programas y transferencia de conocimiento en el área de estudio. Objetivo. Revisar las tendencias de la producción científica existente en la base de datos Scopus, sobre la necesidad de formar a los docentes en competencias investigativas con el propósito de fortalecer el impacto en dicha área. Metodología. Investigación cuantitativa con técnicas bibliométricas y uso de la base de

datos Scopus y aplicación de analítica de datos mediante herramientas tecnológicas como R Studio, Bibliometrix y VOSviewer. Resultados y Conclusiones. Las tendencias en la formación docente en investigación desde la revisión de la base de datos Scopus y la aplicación de análisis bibliométricos demostró que es un área incipiente que requiere mayores desarrollos. Permitió identificar el número de publicaciones, años, países, autores, fuentes e instituciones involucradas, así como el impacto de estas, e indagar sobre la importancia de implementar el desarrollo de competencias investigativas en los docentes y los elementos a considerar en el proceso. Las tendencias encontradas determinan procesos de acompañamiento a docentes desde cuatro áreas específicas: nuevas competencias de acuerdo con los avances en innovación educativa, transferencia de conocimiento al entorno y al currículo, tecnologías aplicadas a los procesos de investigación y métodos para el desarrollo de competencias investigativas.

Palabras clave: bibliometría, competencias del docente, tecnologías de la información, tendencia de la investigación.

1. INTRODUCTION

Research is a fundamental activity in the academic and scientific field, which has become an essential tool for decision making and the advancement of knowledge in various areas of knowledge. In this context, the definition and development of research competencies have become an imperative need for professionals and students who wish to enter the field of research..

Research competencies are skills, abilities, attitudes and knowledge. These competencies include the ability to pose research problems, design studies, collect and analyze data, and communicate results clearly and effectively. In addition, they also include interpersonal skills, such as the ability to work in teams and collaborate with other researchers.

Carroll and Durkin state that adequate research competencies are available when it is possible to conduct a theoretical review with reliable sources, carry out a methodological design with all its phases, analyze qualitative or quantitative data, and socialize the results in an adequate manner [1]. Other authors add that research competencies also involve the interpretation and discussion of the results obtained [2].

Currently, there are many definitions and models of research competencies that reflect the diversity of approaches and theoretical perspectives in this field. Some definitions focus on the technical skills needed to conduct research, while others emphasize the importance of interpersonal skills and research ethics.

In general, it is recognized that research competencies are a combination of cognitive, technical and interpersonal skills, which must be developed through specific training and constant practice in research. Therefore, the importance of a comprehensive training that allows researchers to develop all the necessary competencies to carry out rigorous and quality research should be emphasized.

In order to understand the advances and trends in the area of study, it is important to understand their evolution, to adopt criteria to strengthen them in the teachers of the institutions and in teacher training. In this sense, a research with a quantitative approach was proposed to determine these advances, to know the topics of the object of study involved in scientific productivity and to recommend new studies in this regard.

2. METHODOLOGY

The research was quantitative, implementing the methodology that characterizes bibliometric studies, seeking to quantify scientific production and calculating bibliometric indicators. A bibliometric study consists of a review of publication indicators according to the researcher's area of interest, to determine scientific advances and analyze the lines or currents of research in which these advances can be classified [3].

Therefore, this research was carried out in the following phases:

Phase 1. Documentary review in the Scopus database, considering its quality and prestige in the academic world, as well as the visual tools it has

incorporated. The search equation was constructed with the strategic words of the research: "research competencies" AND "teacher".

Phase 2. Search Debugging. A total of 308 publications related to the object of study were found and filtered to obtain a total of 77.

Phase 3. Bibliometric analysis to identify productivity level, most representative authors, country, journal and institutional affiliation.

Phase 4. The set of metadata extracted from the Scopus database was analyzed with the VOSViewer software, which allows the visualization of bibliometric networks, and data analysis applications were also used with technological tools such as R Studio and Bibliometrix. 4 clusters were found that constitute the trends or lines of research in teacher training in research competencies.

3. RESULTS AND DISCUSSION

A total of 308 publications related to the area of study were found in Scopus and were refined by relating their keywords and reviewing abstracts, until 77 final documents were obtained with the following information (See Table 1)

Table 1: *General search information*

INFORMACIÓN PRINCIPAL SOBRE LOS DATOS	
Intervalo de tiempo	1979:2023
Fuentes (revistas, libros, etc.)	64
Documentos	77
Tasa de crecimiento anual %	3.73
Edad promedio del documento	5.08
Promedio de citas por documento	5.727
Referencias	1
CONTENIDO DEL DOCUMENTO	
Palabras clave Plus (ID)	254
Palabras clave del autor (DE)	274
AUTORES	
Autores	233
Autores de documentos de un solo autor	15
COLABORACIÓN DE AUTORES	
Documentos de un solo autor	16
Coautores por documento	3.17
Coautorías internacionales %	10.39
TIPOS DE DOCUMENTOS	
artículo	60
Capítulo del libro	2
Documento de conferencia	11
Revisión de la conferencia	1
revisión	3

Source: *Scopus database and R Studio*

In terms of publications per year, there is evidence of a permanent scientific productivity in the subject, from 2007 onwards the subject strengthens and expands between 2016 and 2023, as can be seen in Figure 1.

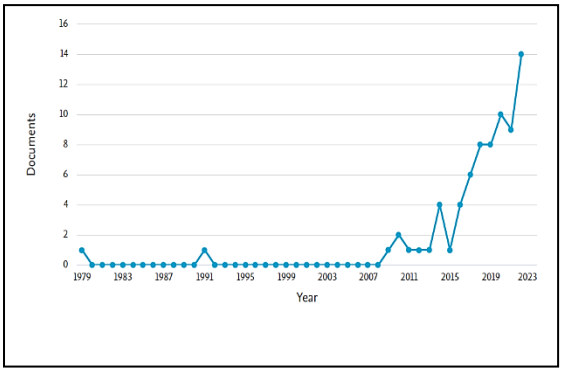

Fig. 1. *Documents by year*
Source: *Scopus database*

The journal with the highest productivity in the study area is ACM International Conference Proceeding Series and Teoriya Praktika Fizicheskoy Kultury, as shown in Figure 2.

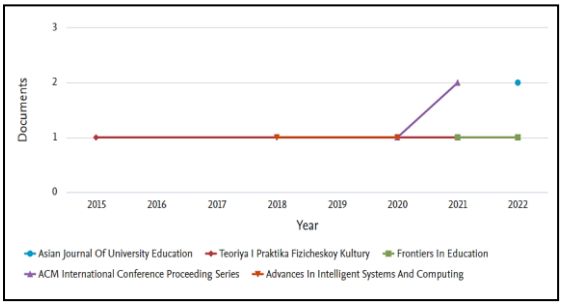

Fig. 2. *Most representative authors in the study area.*
Source: Scopus database

As for the featured authors, two authors share the highest number of publications: Shukshina, Tatiana Ivanovna and Zamkin, Petr Vasilevich, both from Mordovia State Pedagogical Institute in the Russian Federation, as seen in Figure 3.

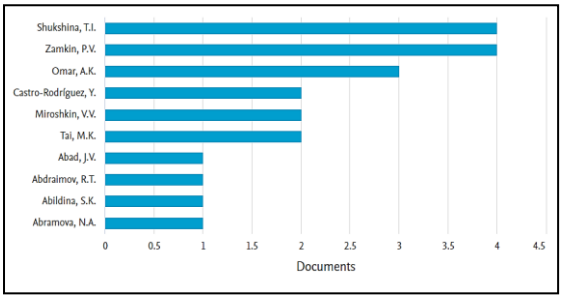

Fig. 3. *Representative authors*
Source: *Scopus database*

The countries that stand out for publications in the area of study are: Russia with 19 papers, Peru with 9 papers and Spain with 9 papers. Colombia has 3 documents in the area of study and research collaboration with Spain as shown in Figure 4.

However, the most cited countries are Mexico and Costa Rica.

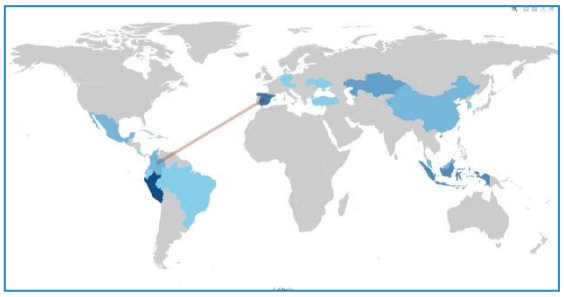

Fig. 4. *Countries with the highest number of publications*
Source: *Scopus and Bibliometrix database*

In terms of impact, two papers are observed as the most cited. The one with the highest impact with 70 citations from Albareda in 2018 called: *Holistic approach to developing sustainability and research competencies in pre-service teacher education.* It is followed by *Selvi's* article called *teachers' competencies with 69 citations.*

3.1 Ley de Lotka

In terms of impact, two documents are observed as the most cited. The one with the highest impact with 70 citations by Albareda in 2018 called: Holistic approach to develop sustainability and research competencies in pre-service teacher education. It is followed by Selvi's paper called teacher competencies with 69 citations.

Table 2: *Lotka's Law*

Documents	Authors	Ratio
1	227	0,974
2	3	0,013
3	1	0,004
4	2	0,009

Source: *Scopus with R Studio analytics*

3.2 Bradford's Law

This indicates that, if the scientific journals are arranged in decreasing order of productivity of articles on a given topic, a nucleus of journals more specifically devoted to that topic can be distinguished. In this sense, the main journals that appear in zone 1 as the most important are shown in Table 3.

Table 3: *Top Impact Journals*

SO	Rank	Freq	cumFreq	Zone
ACM INTERNATIONAL CONFERENCE PROCEEDING	1	3	3	Zone 1
TEORIYA I PRAKTIKA FIZCHESKOY KULTURY	2	3	6	Zone 1
ADVANCES IN INTELLIGENT SISTEMS AND COMPUTING	3	2	8	Zone 1
ASIAN JOURNAL OF UNIVERSITY EDUCATION	4	2	10	Zone 1
FRONTIERS IN EDUCATION	5	2	12	Zone 1
JOURNAL OF PHYSICS: CONFERENCE SERIES	6	2	14	Zone 1
OPCION	7	2	16	Zone 1
PROFESORADO	8	2	18	Zone 1
PSYCHOLOGICAL SCIENCE AND EDUCATION	9	2	20	Zone 1
SUSTAINABILITY (SWITZERLAND)	10	2	22	Zone 1

Source: *Scopus with R Studio analytics*

3.3 Lines of research related to productivity.

With the use of the VOS Viewer application it was possible to relate the lines of research grouped in clusters or categories (See Figure 8), which constitute the lines of research as follows:

Cluster 1. In mustard and red color: Research on New competencies according to advances in educational innovation.
Cluster 2. In green: Research on ways of transferring knowledge to the environment and the curriculum.
In turquoise color: Research on technologies applied to research processes.
Cluster 4. In blue: Research on methods for the development of research competencies in teachers

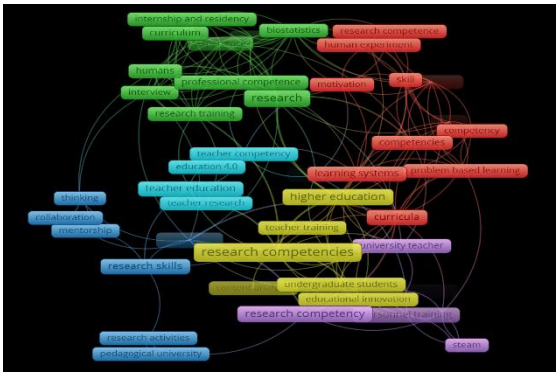

Fig. 5. *Lines of research*
Source: *Scopus with VOS Viewer analytics.*

3.3.1 Research on new competencies according to advances in educational innovation.

There are several academic and scientific sources that highlight research competencies as the set of skills, knowledge and attitudes necessary to conduct rigorous and scientifically valid research in different areas, especially in the field of education and other disciplines [4], [5]. According to Bennett, research competencies involve skills, knowledge and attitudes necessary to carry out scientifically valid

research [6]. In his research Charmaz adds that these skills include the ability to identify and define a research problem, collect and analyze data, communicate the results, and apply them in practical contexts [7].

These competencies include skills in formulating research questions, identifying and defining problems, designing and conducting empirical studies, collecting and analyzing data, interpreting and communicating results, and applying them in practical contexts [8], [9]. In addition to the aforementioned skills, it is required to design ethical and reliable empirical studies and perform appropriate statistical analyses to answer the research questions [10], [11]. This involves developing a sound theoretical framework, collecting reliable data, analyzing the data, and presenting the results clearly and coherently [12].

Research competencies should focus from the formulation of a problem to the presentation of results [13]. They enable researchers to plan, execute, and communicate research in a rigorous, ethical, and effective manner [14], [15]. These skills include cognitive and metacognitive aspects, as well as attitudes and values [16], [17].

Other authors point out that it is also necessary to identify relevant problems, to know how to choose the methodology and to synthesize and present the results clearly [18]. Authors such as García speak of the importance of developing research competencies in the training of education professionals, and mention some of these competencies, such as the ability to design and execute research projects and the ability to analyze and discuss results [9]. On the other hand, there is research that proposes a theory of teacher education for social justice, where teachers can conduct critical and reflective research on their practice [19].

3.3.2 Research on ways of transferring knowledge to the environment and the curriculum.

Another important research competency that a teacher must have is the ability to communicate the results of his or her research effectively [20]. This includes presenting and discussing their findings in conferences and publications, and conveying their knowledge and experience to their students. In fact, good communication is a cross-cutting competency that applies in all areas of teaching, whether in the classroom or in research.

It is important to note that these competencies are not exhaustive and that the skills and knowledge required may vary according to the discipline and the research context. Nevertheless, these competencies can serve as a starting point for the development of research skills in teachers [21].

According to Echazarreta, the curriculum is the set of learning experiences necessary to obtain sustainable personal and social development; it also entails the selection of the competencies to be cultivated and how to do it [22]. This implies the roles and interactions of the different actors involved, as well as the methodologies and strategies to be used.

Research has provided promising results on the influence of educational curriculum on teachers' learning and instruction [23]. The investigative attitude is not only about a research skill or technique, but it is a way of knowing oneself, the investigative approach is not only about searching for information and interpreting results, but it also involves self-critical reflection and understanding the internal processes that lead us to make decisions or act in certain ways [24]. The investigative attitude can be considered a tool for building self-knowledge, essential for the personal and professional development of learners.

Reflection and the devices used in the research process can serve as a means to this end, as they allow us to examine and understand our thoughts, emotions and actions, and how they relate to the world around us.

3.3.3 Research on technologies applied to research processes.

According to Teo and other authors, the development of 4.0 technologies is advancing rapidly, providing new opportunities to develop the 21st century skills of teachers in training and is a transcendental tool to prepare future teachers and develop the required research competencies [25].

In addition, the importance of attitudes in the development of research competencies is highlighted. Commitment to rigorous and scientifically valid research, willingness to learn, and willingness to collaborate with other researchers are attitudes that can facilitate the development of skills and knowledge necessary to conduct high quality research [9]. Research competencies also require skills in the use of advanced technologies for proper data analysis and presentation of results [26].

Technologies applied to research processes have undergone significant advances in recent decades, transforming the way research is conducted in various disciplines. In this sense, Big Data makes it possible to manage extremely large and complex data sets, facilitating the analysis of patterns, trends and correlations. On the other hand, tools such as Python, R and specific software for statistics enable researchers to analyze data more efficiently.

Studies such as those by Abd-El-Khalick and Lederman highlight the importance of research skills in the field of science education. Researchers in this area must have skills to design and conduct empirical studies to understand science and its teaching, and communicate the results effectively to different audiences always supported by technologies [27].

3.3.4 Research on methods for the development of research competencies in teachers.

In general, research competencies could be said to include skills such as the ability to design and execute research projects, analyze and discuss results, use quantitative and qualitative methods, and conduct critical and reflective research on professional practice. However, these skills may vary according to the discipline and the specific research context [28].
To be competent in research, it is necessary to know the steps, methods and ways to develop research competencies and follow them systematically, step by step, until the teacher transforms innate abilities and skills into competencies, or in other words, becomes a master in the art of research [29].

Competent researchers can design rigorous studies based on the questions posed, apply appropriate approaches and techniques, collect and analyze data, and socialize results, but to do so, they have undergone an apprenticeship involving expert mentors, who teach them through their practices how to overcome eventualities and succeed in the research process and use appropriate tools and techniques to collect data. In addition, they must be able to analyze the data using statistical tools and other analytical methods to draw meaningful conclusions [30].

Competent researchers must be able to clearly communicate the results of their research in formats appropriate to the discipline, such as research reports, presentations, and journal publications [31]. They must be able to reflect on their own research and evaluate its strengths and weaknesses. They must also be able to analyze and critically evaluate the research of others and synthesize information to inform their own research.

Research competencies involve a wide range of skills and knowledge, from formulating research questions to collecting and analyzing data, and communicating results. Researchers must be able to critically reflect on the methods employed and those of other researchers to continuously improve their research practice [32].

4. CONCLUSIONS

The bibliometric study revealed an area of knowledge to be explored related to the research competencies that teachers should develop in order to achieve a superior impact. Based on the definition of competence as the art of developing an activity that integrates competencies and skills, it is necessary to continue research on this topic of study. The trends of progress found from 1979 to 2023 indicate that scientific productivity has increased increasingly since 2007, as well as the number of journals interested in publishing on the area of study.

Although Russia, Peru and Spain are the countries with the highest productivity and the authorship of Russia stands out, this can be easily surpassed because the publications of each of these countries do not exceed 20 documents. Similarly, there is interest in Colombia on the subject.

In terms of impact, a good number of citations was achieved, taking into account the amount of existing productivity. Likewise, it was observed that Colombia and Spain are performing productivity in co-authorship. The productivity found complies with Lodka and Bradford's Law, since there are few authors and journals with exclusive dedication. In relation to the topics dealt with in the publications, they could be grouped into four categories or clusters: new competencies according to the advances in educational innovation, transfer of knowledge to the environment and the curriculum, technologies applied to research processes and methods for the development of research competencies.

The knowledge of research competencies is related to understanding their classification and the development of skills to make it an impact routine. Research and application to the curriculum comprises the transfer of knowledge from studies as

a basis for teaching, and in the case of teachers' competencies, it is fully related to programs focused on teacher training. Now, the technologies applied in research have to do with programs and applications that have been developed in recent years to be able, from analytics and artificial intelligence, to handle large volumes of data and draw conclusions or make quick decisions based on data.

Finally, the methods and forms for the development of research competencies in teachers are related to the way of approaching learning and transmitting from the accompaniment and mentoring a greater approach and motivation to the teacher to get involved in research processes and their productivity. It is recommended to strengthen research on the object of study with lines related to the impact of methodologies in the development of these competencies, case studies to identify advantages and disadvantages, strengthen existing categories and the creation of new lines of research in the area.

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