Current Distance Education Research Landscape: A Bibliometric Study

Panorama actual de la investigación en educación a distancia: un estudio bibliométrico

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Abstract
In this article, we analyse the thematic evolution of the distance education research field, the production of its researchers, and their impact. Bibliometrics techniques, such as performance analysis and science mapping, were applied to 40 journals selected as most relevant in the Scopus database from 2018 to 2022, which resulted in 12,947 articles analysed with the science mapping analysis tool (SciMAT). The performance analysis identified a significant increase in the number of publications, from 1,943 in 2018 to 3,512 in 2022 (80,75%), with a notable concentration of journals in Europe (55%) and North America (35%); on the other hand, the affiliation of the top 10 most impact authors (citations, h-index and FWCI) is predominantly located in Asia. The science mapping procedures identify two hot topics: the COVID-19 pandemic, which emerged in this study in 2020, and virtual reality, appearing in 2022. Student-related themes emerged as central, underscoring its pivotal role in structuring the field. The stability of keywords was identified, showing that the terminology is consolidated. The interconnections among themes grew, indicating a multidisciplinary approach in the study of distance education.
Keywords: SciMAT; Distance education, e-learning, Bibliometrics; Science mapping

Resume
En este artículo se analiza la evolución de la educación a distancia, la producción de sus investigadores y su impacto. Para ello, se han aplicado técnicas bibliométricas, como el análisis de rendimiento y el mapeo científico, a 40 revistas seleccionadas como las más relevantes en la base de datos de Scopus con un filtro temporal de 2018 a 2022. El resultado de la búsqueda fue 12,947 artículos analizados con la herramienta de análisis de mapeo científico (SciMAT). Por un lado, el análisis de rendimiento identificó un aumento significativo en el número de publicaciones, de 1,943 en 2018 a 3,512 en 2022 (80,75%), con una notable concentración de revistas en Europa (55%) y América del Norte (35%); por otro lado, la afiliación de los 10 autores más impactantes (citas, índice h y FWCI) se encuentra predominantemente en Asia. Mediante el mapeo científico identifica dos temas candentes: la pandemia de COVID-19, de la que se intensificó la publicación en 2020, y la realidad virtual,

que apareció en 2022. Los temas relacionados con los estudiantes son de gran interés pora la comunidad y tienen un papel fundamental en las publicaciones. Finalmente, se detectó que existe una consolidación de las palabras clave y que hay una interconexión entre varios temas implicando un enfoque multidisciplinario en el estudio de la educación a distancia.
Keywords: SciMAT; Educación a distancia, e-learning, Bibliometría; Mapeo científico

1. Introduction

Research in distance education has advanced considerably in recent years, mainly due to technological progress, the widespread adoption of online learning programs worldwide, and a transformation in the culture of communication and knowledge dissemination. With the COVID-19 pandemic, Emergency Remote Teaching (ERT) (Hodges et al., 2020) became a necessity, and consequently, the research on themes related to online education increased considerably during this period. Understanding distance education research's trends, actors, and evolution is important for its maturation and growth. It allows researchers to identify gaps, discover new directions, and improve the field.

Researchers have historically employed qualitative structured literature reviews and quantitative meta-analyses as primary methods for understanding prior research. However, the advent of bibliometric methods, such as science mapping, performance analysis, and other techniques, introduced a compelling third approach. These methods allow the analysis of relationships and trends across disciplines, fields, specialities, individual articles, journal performance, and collaboration patterns (Donthu, Kumar, et al., 2021; Schmidt, 2008; Zupic & Čater, 2015). This approach broadens the scope of research analysis and enhances the understanding of the intricate interconnections within the scientific landscape.

Bibliometric methods are essential in analysing the field of distance education comprehensively. Unlike qualitative reviews or meta-analyses, bibliometric methods offer a unique capability to process and analyse a vast amount of published data, enabling quantitative and qualitative evaluations (Bitzenbauer, 2021). Through methods analyses, researchers can identify emerging trends, detect knowledge gaps, and measure the cumulative impact of research.

Among the bibliometric methods, science mapping and performance analysis have been explored in several fields. Science mapping provides a unique viewpoint on a subject matter. As Cobo et al. (2012, p. 1609) noted, "science mapping aims at displaying the

structural and dynamic aspects of scientific research." as long as connections among studies exist within the analysed corpus, it can examine any study (Zupic & Čater, 2015). These techniques can support each other, provide a robust analysis, and identify and describe research patterns, trends, and evolution.

1.1 Bibliometrics

Bibliometrics refers to the collection, management, and analysis of scientific publication information, including publication year, number of citations, and author, through techniques such as descriptive statistics.

The application of bibliometrics has recently increased, particularly in business, management, accounting, economics, econometrics, finance, and social sciences (Donthu, Kumar et al., 2021). The increasing digitalisation of research processes has significantly transformed the academic landscape, facilitating access to and managing scientific databases and optimising data processing and collection. This technological advancement has been a key catalyst for the expanded use of bibliometric methods in education (Hossain et al., 2022; Khan & Gupta, 2022; Machado & Davim, 2022; Marín Suelves et al., 2021; Sherwood et al., 2023).

According to Donthu et al. (2021, p. 1), "bibliometric analysis is useful for deciphering and mapping the cumulative scientific knowledge and evolutionary nuances of well-established fields by making sense of large volumes of unstructured data in rigorous ways."

In this study, we will adopt a comprehensive approach to evaluate our dataset's quantitative and qualitative aspects, as Cobo et al. (2011a) outlined. Quantitative measures will include the number of documents, authors, journals, and countries involved, providing a broad statistical overview of the data. For qualitative or impact measures, we will analyse the number of citations received by the documents and employ bibliometric indices to assess the influence and reach of the research within the field. This dual approach allows for robust data analysis, offering insights into the volume and impact of the research contributions.

Bibliometric methods have two primary applications: performance analysis and science mapping (Donthu, Kumar et al., 2021). Performance analysis aims to assess scientific actors' activity and impact (quantitative and qualitative) based on bibliographic data.

According to Donthu, Reinartz et al. (2021), "the analysis, which is descriptive in nature, is the hallmark of bibliometric studies" (p.1).

Science mapping showcases the structural and dynamic aspects of scientific research and represents the cognitive structure of a research field (quantitative and qualitative) (Cobo et al., 2011a; Zupic & Čater, 2015). According to Donthu, Reinartz et al. (2021), "science mapping examines the relationships between research constituents" (p. 1). While performance analysis assesses the contributions of the individuals or organisations involved in research, science mapping examines their connections (Donthu, Kumar et al., 2021).

Bibliometric analysis is currently facilitated by a range of software tools, including Bibexcel, BiblioShiny, BiblioMaps, CiteSpace, CitNetExplorer, CoPalRed, IN-SPIRE, Leydesdorff's Software, Network Workbench, SciMAT, Sci2 Tool, VantagePoint, and VOSviewer (Cobo et al., 2011b; Machado & Davim, 2022; Moral-Muñoz et al., 2020). These tools provide comprehensive support for conducting sophisticated bibliometric research.

The commonly used scientific databases for bibliometric study are Scopus[1] and Web of Science[2] (WoS) (Debackere et al., 2002; Fahimnia et al., 2015; Khan & Gupta, 2022; Wu & Wu, 2017), with the Scopus database being owned by the Elsevier evaluation agency, and the WoS by Clarivate.

Scopus has systems for exporting data in formats such as Comma-Separated Values (CSV) and Research Information Systems (RIS) that are compatible with most bibliometric tools and adopt an open data policy for the metadata of indexed articles.

Bibliometric analysis is supported presently by various software tools (Machado & Davim, 2022; Moral-Muñoz et al., 2020). In a study evaluating eight main science mapping analysis tools, Bibexcel, BiblioShiny, BiblioMaps, CiteSpace, CitNetExplorer, SciMAT, Sci2 Tool, and VOSviewer,

1.2 Evaluation of Scientific Production and Impact

Commercial publishers, bibliographic databases, or funding agencies commonly use several scientific metrics to evaluate the quality, impact, and visibility of scholarly

[1] https://www.scopus.com/sources
[2] https://mjl.clarivate.com/search-results

journals, publications, and research. Some of these organisations have developed their scientific metrics. Such metrics might be restricted to subscribers or open to all, but almost all coincide with the same unit of measure, the number of citations. All leading international bibliometric service providers use normalised metrics to evaluate research outputs. For example, Clarivate's Web of Science platform uses the Journal Citation Indicator (JCI). In contrast, Elsevier uses the Source Normalized Impact per Paper (SNIP) in its Scopus database, and SCImago Journal & Country Rank (SCImago) uses the SCImago Journal Rank indicator (SJR indicator) (Guerrero-Bote & Moya-Anegón, 2012). It is worth noting that Clarivate makes the use of its metrics and metadata accessible only for subscribers, whereas Scopus and SCImago offer open access to everyone.

To measure the academic impact of authors, articles, journals, and institutions, we employ various indicators such as citations, the average of citations, SNIP, h-index, Field-Weighted Citation Impact (FWCI), and SCImago Institutions Rankings (SIR).

1.2 Objectives

This article aims to evaluate the thematic evolution of distance education research by using bibliometrics procedures, specifically performance analysis and science mapping, and applying and discussing these to create a comprehensive representation of the research publishing landscape. This will be done by identifying, classifying, visualising, and synthesising the research production and its actors.

This article is organised as follows: Section 2, methodology, details the methodological procedures employed in this study in the first part, and also provides information about 'selection of database' (2.1), 'selection of bibliometric tool' (2.2), and 'indicators' (2.3) and selection of journals'(2.4). After this sections, the 'performance analysis' (2.5) is presented and it explores the quantitative and qualitative approaches used assess the impact of the works. This is followed by the 'science mapping' (2.6) which discusses the mapping techniques used to visualise trends and interconnections in the field. Section 3, 'results and discussion', is organised into three parts: 'selection of journals' (3.1), presenting the outcomes of the journal selection; 'performance analysis' (3.2), where we discuss the insights gained from performance analysis; and 'science mapping' (3.3), analysing the data resulting from scientific mapping. finally, section 4, 'conclusion',

summarises the study's main findings and discusses their implications for distance education research.

2. Methodology

2.1 Selection of Databases

Two data sources were utilised: (i) SCImago, serving as a data source that included a list of journals and their respective metrics, downloaded in Comma-Separated Values (CSV) format, and (ii) the Scopus database, from which metadata for articles from the selected journals was obtained in Research Information Systems (RIS) format.

SCImago is a public portal encompassing indicators developed from the information in Scopus. This portal provides a comprehensive assessment of the research performance of scientific journals and countries and has systems for exporting data in Comma-Separated Values (CSV) formats.

Scopus database is compatible with most bibliometric tools, adopts an open data policy for the metadata of indexed articles, and has systems for exporting data in Research Information Systems (RIS) formats.

2.2 Selection of Bibliometric Tool

According to Moral-Muñoz et al. (2020), the Science Mapping Analysis Software Tool (SciMAT) stands out for its features and capabilities. It is an open-source science mapping software that encompasses methods, algorithms, and measures for every step in the science mapping process, from pre-processing to visualising results (Cobo et al., 2012; Moral-Muñoz et al., 2020; Zupic & Čater, 2015).

The SciMAT supports the two major scientific databases, Scopus and Web of Science; it offers powerful pre-processing options, including a deduplication process, time slicing, stop words, and data editing, and also provides six out of nine options for analysis and visualisation, including Themes and Thematic networks (strategic diagram and cluster network) and Evolution of Themes (overlapping map and conceptual evolution map), allowing researchers to focus on specific research topics (Moral-Muñoz et al., 2020). Additionally, SciMAT has been programmed in Java, making it compatible with multiple platforms such as Windows, MacOS, and Linux (Zupic & Čater, 2015).

2.3 Indicators

A range of metrics are utilised to assess the impact of authors, articles, journals, and institutions, including citation count, average citations per item, SNIP, h-index, Field-Weighted Citation Impact (FWCI), and SCImago Institutions Rankings (SIR).

2.3.1 Citation Count and Average Citations per Item

Citation is an essential component in the academic context, acting as formal recognition of another author's work that underpins or influences the research content. In our study, the counting and analysis of citations were carried out using the SciMAT tool. For the author, affiliations of the authors, and journal, the average number of citations was calculated as the ratio between the number of citations and the number of articles.

2.3.2 SNIP

The SNIP is a standardised indicator that facilitates direct comparisons of journals across different fields, considering the distinct characteristics of scientific production in each field. Is calculated as the ratio between the number of citations received by a journal over the past three years and the expected number of citations for a publication in the same scientific area during the same period (Moed, 2009; Waltman et al., 2012).

2.3.3 H-index

The h-index is a pivotal metric that gauges both the quantity and influence of the scientific outputs produced by a researcher or journal. This indicator uniquely balances the number of publications against their citation impact, reflecting an integration of quantitative reach and qualitative influence (Dorta-González & Dorta-González, 2010). Thus, the h-index emerges as a robust measure, capturing the breadth and depth of academic contributions. It is especially esteemed for its ability to discern impactful scholars and journals, highlighting those whose works are not only prolific but also resonate widely within the academic community.

2.3.4 FWCI

The FWCI is a standardised indicator calculated based on individual articles or authors. This metric offers a nuanced evaluation of each article or author, the document's citations to the average number of citations received by all similar documents or authors over a three-year window. In essence, the FWCI provides a more refined assessment by

considering the contextual impact of citations within the scientific field, contributing to a deeper understanding of the scholarly influence of individual articles or authors (Moed, 2009; Waltman et al., 2012).

2.3.5 SIR

The 'Overall Indicator', used to assess the performance of academic and research institutions in the SIR, consists of three components: 'Research Indicator', 'Innovation', and 'Societal'. The 'Research Indicator' focuses on scientific production, measuring factors such as Normalized Impact and Excellence with Leadership, which quantify the relative impact of publications compared to the global average and the prominence of the institution in conducting high-quality research. The 'Innovation' indicator evaluates the institution's capacity to generate new knowledge applicable to technologies, its technological impact, and the resulting patents, reflecting the influence of research on the development of innovations. Meanwhile, the 'Societal' indicator measures the social impact of the institution's activities, particularly its contribution to the United Nations' Sustainable Development Goals (SDGs), showing how research aligns with global sustainability targets.

These indicators are expressed in percentiles, positioning institutions on a relative comparison scale, where, for example, being in the 90th percentile indicates that the institution outperforms 90% of those evaluated in terms of performance on a specific indicator. In this article, we will adopt the 'Overall Indicator' and, more specifically, the 'Research Indicator' for a detailed analysis of the relative performance among institutions.

2.3.6 SJR Indicator

The SJR indicator is based on data from the Scopus database. In the SJR indicator, the subject field, quality, and reputation of the journal directly affect the value of a citation. It assigns relative scores to all the sources in a citation network. The Google PageRank algorithm inspires its methodology; therefore, not all citations are equal. A source transfers its prestige or status to another source by citing it. A citation from a source with a relatively high SJR indicator is worth more than one from a source with a lower SJR indicator (Guerrero-Bote & Moya-Anegón, 2012). The SJR indicators are available

individually on the journal page in SCImago[3], which includes metrics and ranks of the journals and countries and is expressed by quartiles.

2.4 Selection of Journals

SCImago is a data source that contains various basic information, such as name and ISSN, as well as classification data, like area and subject. This file also includes metrics, such as the SJR indicator and quartiles.

Two inclusion criteria are defined in this research:

- Criterion 1: Quartiles Q1 or Q2 in the e-learning category.

Criterion 1 considered journals categorised under 'e-learning' within the Q1 and Q2 quartiles. The application of the criterion began in the SCImago online system (SCImago Journal & Country Rank[4]) and was filtered and applied to their area (social sciences) and subject (education). After applying the filter, the file was downloaded. In the file downloaded were data treatment and selected journals of the category (column categories) 'e-learning' with quartiles Q1 or Q2.

- Criterion 2: Journal specialisation with the best[5] quartiles Q1 or Q2.

In the scope of this study, criterion 2 considered journals we considered specialised journals containing the expressions e-learning, online, Distance Education, Technology Learning, Communications in Information, and Information Education and their variants (e.g., plural) in the title of journals in SCImago online system. The criterion implementation commenced within the SCImago online system with the complete download of the database containing the comprehensive list of evaluated journals. The search was conducted in an exploratory manner, querying each word (in both singular and plural forms when possible) in the title field (column title) of the downloaded file.

2.5 Performance Analysis

Conducting a comprehensive performance analysis of journals allows us to perform quantitative (keywords, documents, journals, country, and affiliation of authors) and qualitative (journals and articles) assessments of their respective contributions to the field

[3] https://www.scimagojr.com/
[4] https://www.scimagojr.com/journalrank.php
[5] The best quartile technique informs the quartile in which the magazine is best positioned.

of distance education research. The primary objective of this analysis is to identify the most prominent, productive, and impactful themes, thematic areas, and subfields within the domain. By seamlessly integrating quantitative metrics and qualitative evaluations, we aim to cultivate a nuanced understanding of the influence and significance of these within the diverse distance education landscape.

This approach enables the identification of the most prolific contributors. It sheds light on high-impact themes that are pivotal in advancing knowledge within specific domains and subfields of distance education.

Using quantitative analysis, we delve into the productivity of the identified journals by examining various factors such as the number of documents, publishers, the geographic distribution of journals, authors' affiliations, and the average citations and citations. Concurrently, qualitative measures assess quality through bibliometric impact indicators, including citations, journals' SNIP, and articles' FWCI. This comprehensive approach offers a deep understanding of the scholarly influence embedded in those themes and thematic areas.

2.6 Science Mapping

Science mapping was carried out by analysing themes and thematic networks (strategic diagram and cluster network) and the evolution of themes (overlapping map and conceptual evolution map). We adopted the science mapping workflow designed by Börner et al. (2003) and Cobo et al. (2011b), comprising the following steps: a) data retrieval, b) data pre-processing, c) network extraction, d) network normalisation, e) mapping, f) analysis, g) visualisation, and h) interpretation.

This article presents the steps of network extraction, network normalisation, mapping, and analysis in the data analysis section for science mapping. In contrast, the steps of visualisation and interpretation are presented in the results and discussion section.

All stages of the science mapping were carried out using SciMAT version 1.104 (MacBook version).

2.6.1 Data Retrieval

After selected journals at SCImago were downloaded from the Scopus database on December 31st, 2022, the files in RIS format were imported to SciMAT. We considered the articles published between 2018 and 2022.

2.6.2 Data Pre-processing

For processing the data, we considered authors, affiliations, articles, keywords, and references as units of analysis. Each of them was processed separately to filter duplicated entries and misspellings. We used a de-duplicating procedure for authors and affiliations to identify cases where the same author or affiliation was named differently; for this using the native function of SciMAT 'levenshtein distance'. Duplicated articles and editorials, corrections, retractions, author corrections, and introductions to special volumes were removed. Keywords differing in their plural and singular forms were joined in the native function of SciMAT 'levenshtein distance', after a manual normalisation process was applied to the data.

2.6.3 Data Analysis for Science Mapping

Data analysis for science mapping consists of network extraction, network normalisation, mapping, and analysis steps. Data analysis was carried out after data retrieval and pre-processing based on the framework of ten SciMAT steps.

- **Step 1 – Select periods:** The documents were divided into five periods (2018, 2019, 2020, 2021, and 2022) to perform 'longitudinal analysis' and Callon's density and centrality measures.
- **Step 2 – Select unit of analysis:** The 'unit of analysis' 'words' was chosen, selecting 'author's words' and 'source's words'.
- **Step 3 – Data reduction:** The chosen data reduction method was Frequency reduction, with a minimum frequency of 40 entries. We use a 'minimum frequency of 40 entries' to focus on the most influential data and to enhance the graphical representation in the evolution map. This strategic selection minimises distortion from less relevant items and significantly improves visual clarity in the evolution map, allowing for a more effective analysis of prevailing trends and patterns in the studied field (Cobo et al., 2011b).
- **Step 4 – Select the type of matrix:** Selection of the 'matrix type' to build the network. Cooccurrence was chosen here, allowing the creation of coupling networks and the calculation of similarities between items based on the information extracted in the third step (Cobo et al., 2011a).

- **Step 5 – Network reduction:** The 'edge value reduction' was chosen with six as a minimum threshold value. The 'edge value reduction of six entries' was used, similar to the method employed in 'data reduction', to handle the extensive number of words identified.

- **Step 6 – Normalisation:** The similarity between the keywords was assessed using the 'equivalence index' (Callon et al., 1991), calculating the bond strength between clusters. Van Eck and Waltman (2009) concluded that the 'equivalence index' is the most appropriate measure for normalising co-occurrence (step 4).

- **Step 7—Clustering algorithm:** To demonstrate the strength of the link between the clusters, a 'simple center algorithm' (Coulter et al., 1998) was applied to form the clusters. The selection of the simple centres algorithm for cluster formation is supported by its widespread use in co-word analysis studies, as highlighted by Cobo et al. (2011a). Its ability to automatically return labeled clusters simplifies the post-processing stages, making it particularly suitable for efficiently delineating thematic connections within extensive datasets. For the network's construction, the maximum and minimum cluster sizes were set to 4 and 3, respectively, to enhance graphical representation.

- **Step 8 – Document mapper:** Document mapping using the 'core and secondary mappers'. Both core and secondary document mappers are chosen to ensure comprehensive coverage of thematic networks Cobo et al. (2011a, 2014). Core documents, intersecting at least two thematic networks, provide in-depth insights into central themes. Secondary documents, often linked to a single theme, reveal peripheral and less prominent connections, enriching the understanding of the field's interconnected landscape.

- **Step 9 – Quality measures:** 'Average citations' were applied to measure quality.

- **Step 10 – Longitudinal:** Longitudinal measurements of the maps. The 'inclusion index' (Cobo et al., 2011a) was used. The inclusion index is advantageous for measuring similar sets over Jaccard or cosine indices due to its lack of bias toward item numbers. It is also employed as an overlap measure for information retrieval (Eck & LudoWaltman, 2009; Sternitzke & Bergmann, 2009).

2.6.4 Themes and Thematic Networks

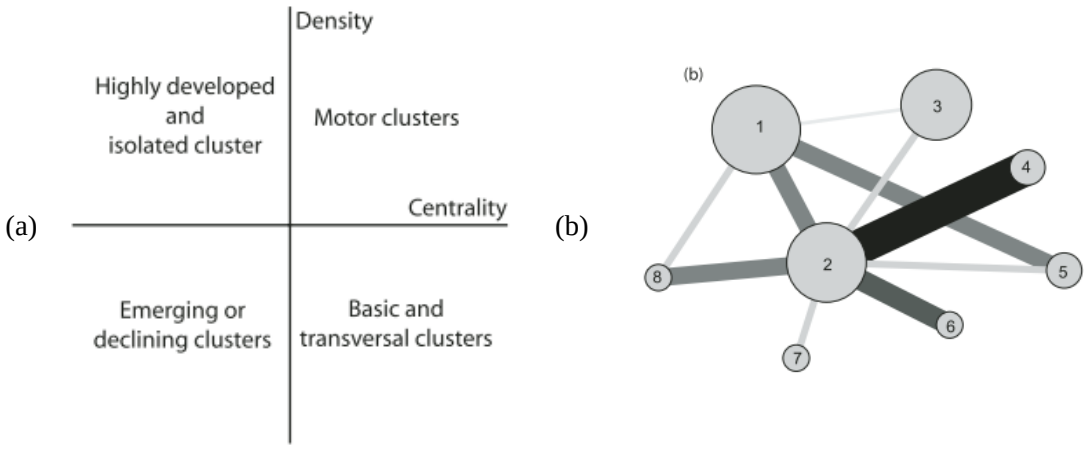
For strategic diagrams and cluster networks, the SciMAT uses Callon's density and centrality (Callon et al., 1991) as network measures for each detected cluster. The centrality (c) measures the degree of network interaction with other networks, while density (d) measures the network's internal strength (Herrera-Viedma et al., 2020).

The Callon's density and centrality (Callon et al., 1991) measures are distinguished by two parameters, 'density' and 'centrality', with the classification of themes into four groups based on either median or mean values for both density and centrality. Callon's centrality quantifies the extent of interaction within a network with keywords from distinct themes, assessing the robustness of external connections to other themes "Centrality measures for a given cluster the intensity of its links with other clusters" (p. 164). Callon's density gauges the intensity of internal connections among all keywords, delineating the research theme and providing a metric that can be interpreted as a measure of the theme's level of development "Density characterizes the strength of the links that tie the words, making up the cluster together" (p. 165).

The strategic diagram (Figure 1a) represents a two-dimensional space built by plotting themes according to their centrality and density values. The cluster network (Figure 1b) represents keywords and their interconnections, highlighting significant ones based on centrality. In both schemes, the sphere volume is proportional to each keyword's corresponding number of documents.

Figure 1

Model strategic diagram (a) and cluster network (b)



Retrieved from Cobo et al. (2011a, p. 151).

2.6.4.1 Strategic Diagram

In the strategic diagram, we can identify four types of themes (Callon et al., 1991; Cobo et al., 2011a) (Figure 1a) based on the quadrant in which they are placed:

- Themes in the upper-right quadrant (motor clusters) are well-developed and crucial for structuring a research field. Termed as motor-themes within the speciality, they exhibit robust centrality and high density. Their positioning in this quadrant indicates their external relationships to concepts applicable to other closely related themes on a conceptual level.
- Themes in the upper-left quadrant (highly developed and isolated cluster) possess well-developed internal connections but lack significant external ties, rendering them marginally crucial for the field. These themes are highly specialised and exhibit a peripheral character.
- Themes in the lower-left quadrant (emerging or declining clusters) are characterised by weak development and marginal significance, with low density and centrality. They predominantly represent either emerging or fading themes.
- Though necessary for the research field, themes in the lower-right quadrant (basic and transversal clusters) still need to be fully developed. This quadrant encompasses transversal and general basic themes.

2.6.4.2 Cluster Network

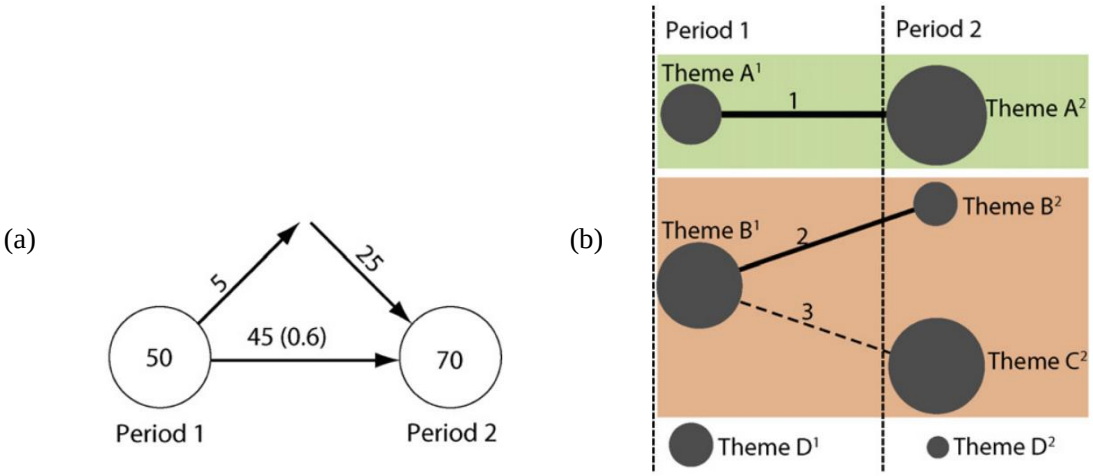
The cluster network (Figure 1b) analyses the keywords and their interconnections, highlighting the most significant keywords based on their centrality. It is represented by a sphere with volume proportional to the corresponding number of documents for each keyword, and the thickness affects the equivalence index (Callon et al., 1991), indicating the strength of association.

2.6.5 Evolution of Themes

We mapped the distance education thematic evolution for the period (2018-2022) by using longitudinal analysis conducted through the overlapping map of the stability (Figure 2a) between periods (b) and the conceptual evolution map of the themes (Figure 2b).

Figure 2

Longitudinal analysis: (a) overlapping map of the stability between periods and (b) conceptual evolution map of the theme.



Source: Cobo et al. (2011a, p. 152).

2.6.5.1 Overlapping Map of the Stability

The overlapping map of the stability (Figure 2a) quantifies the shared keywords between the periods, with the circles representing these periods and their respective counts of associated keywords. The upward-pointing arrows describe the count of new keywords in the current period. In contrast, the upward-outgoing arrow indicates the keywords present in the current period but not in the subsequent period (Cobo et al., 2012). The horizontal arrow denotes the number of shared keywords between periods, accompanied by the Stability Index (SI) in parentheses (stability measures). The SI goes from zero, where no keyword is repeated, to 1.0, where all are repeated (Small, 1977).

2.6.5.2 Conceptual Evolution Map

Evolution maps are valuable tools for unveiling the developmental patterns within a field across the analysed periods. They rely on the interaction between graphical elements. Examining themes identified in each period becomes a comprehensive endeavour by exploring their conceptual evolution. This involves revealing standard terms and closely observing how these terms transform over time (Herrera-Viedma et al., 2020).

In the conceptual evolution map, demonstrated previously in Figure 2b, solid lines mean that the interconnected themes share the same name; either both themes have identical names, or the name of one theme is a subset of the other. Conversely, a dotted line indicates that the themes share elements other than the theme name or some keywords

(Cobo et al., 2012; Herrera-Viedma et al., 2020). The thickness of the connecting lines is proportionate to the inclusion index, while the volume of the spheres corresponds to the number of published documents associated with each theme.

The inclusion index is a good measure of the overlapping between themes and periods. When keywords of a theme are wholly contained in another theme, the inclusion index will be equal to 1.0 (Cobo et al., 2011a; Sternitzke & Bergmann, 2009); for example, if all keywords contained in Theme A^1 are included in Theme A^2 (Figure 2b).

3 Results and Discussion

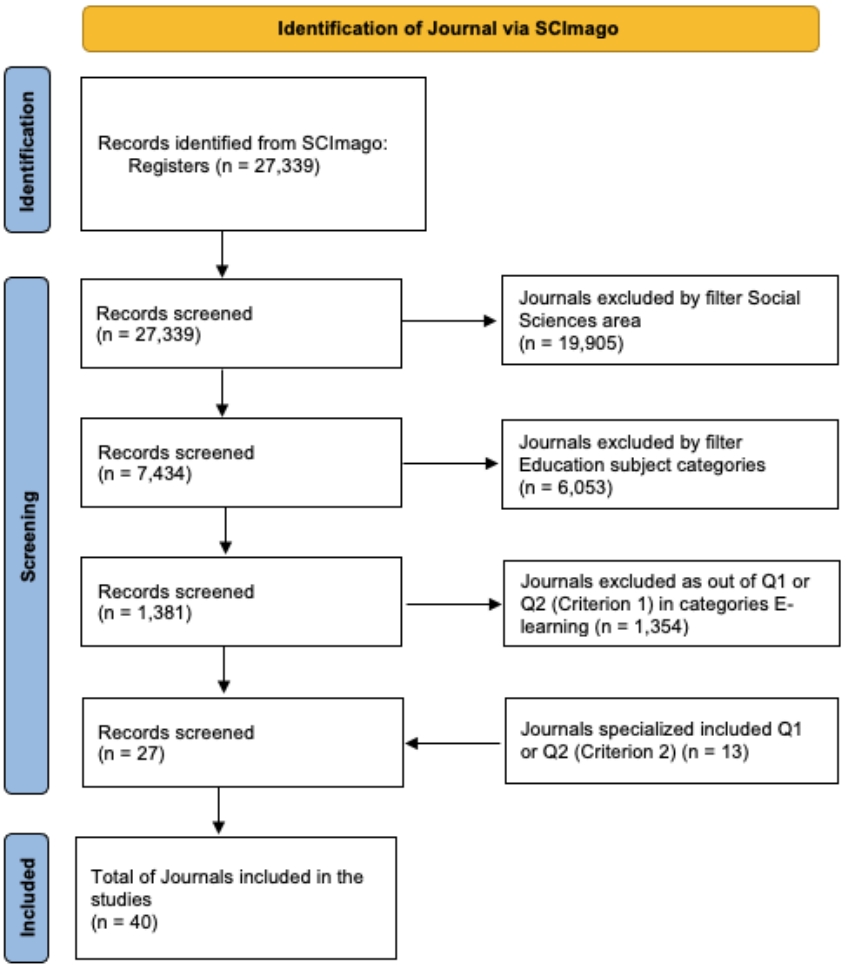
3.1 Selection of Journals

The initial dataset of 27,339 journals was first filtered based on the Social Sciences area, which reduced the number to 7,434; this number was further narrowed down by selecting only those in the education area, resulting in 1,381 journals. From them, only the journals classified as Q1 or Q2 in the e-learning category were kept, resulting in 27 journals (criterion 1). Additionally, 13 specialised journals classified as Q1 or Q2 were included (criterion 2), bringing the final count to 40. The indication of which journals were selected considering criteria 1 (n=27) and 2 (n=13) is presented in Table 1 in the criterion column.

Figure 3 summarises the workflow for selecting journals from the SCImago, and Table 1 lists the 40 journals ultimately selected for this study.

Figure 3

Workflow for the selection of journals



Source: Adapted from Page et al. (2021).

The 40 journals (Santos et al, 2024) contained (raw data)13,525 articles, 26,082 authors, 21,224 affiliations, and 32,986 keywords.

Table 1

List of selected journals

Identification				Data Citation and Documents			Indicators Data		
Title	**ISSN (print) / ISSN (online)**	**Publisher**	**Country**	**Number of articles**	**Number of citations**	**Average of citations[a]**	**SNIP[b] (Scopus)**	**Quartiles[c] (SCImago)**	**Criterion[d]**
Adult Education Quarterly	0741-7136 / 1552-3047	SAGE	United Kingdom	106	403	3.80	1.514	Q2	1
American Journal of Distance Education	0892-3647 / 1538-9286	Taylor & Francis	United States	140	914	6.53	2.130	Q1	2
Australasian Journal of Educational Technology	1449-3098 / 1449-5554	Australasian Society for Computers in Learning in Tertiary Education	Australia	317	2,973	9.38	1.948	Q1	1
British Journal of Educational Technology	0007-1013 / 1467-8535	Wiley-Blackwell	United Kingdom	714	10,904	15.27	2.634	Q1	1
Communications in Information Literacy	1933-5954	Communications in Information Literacy	United States	72	179	2.49	0.603	Q2	2
Computers and Education	0360-1315	Elsevier	United Kingdom	1016	14,079	13.86	5.207	Q1	1
Distance Education	0158- 7919 / 1475- 0198	Taylor & Francis	United Kingdom	181	2,130	11.77	2.908	Q1	1
E-Learning and Digital Media	1741-8887 / 2042-7530	SAGE	United Kingdom	169	823	4.87	1.173	Q2	2

Identification				Data Citation and Documents			Indicators Data		
Title	**ISSN (print) / ISSN (online)**	**Publisher**	**Country**	**Number of articles**	**Number of citations**	**Average of citations[a]**	**SNIP[b] (Scopus)**	**Quartiles[c] (SCImago)**	**Criterion[d]**
Education and Information Technologies	1360-2357	Springer Nature	United States	1851	15,167	8.19	1.055	Q1	1
Educational Technology and Society	1176-3647 / 1436-4522	National Taiwan Normal University and Society	Taiwan	241	2,981	12.37	2.445	Q1	1
Electronic Journal of e-Learning	1479-4403	Academic Publishing Limited	United Kingdom	160	815	5.09	1.363	Q2	2
IEEE Transactions on Learning Technologies	1939-1382	IEEE	United States	298	2,653	8.90	2.044	Q1	1
Interactive Learning Environments	1049-4820	Taylor & Francis	United Kingdom	1083	8,916	8.23	1.761	Q1	1
Interactive Technology and Smart Education	1741-5659 / 1758-8510	Emerald Publishing	United Kingdom	159	1,256	7.90	1.366	Q1	2
International Journal of Artificial Intelligence in Education	1560-4292 / 1560-4306	Springer Nature	United States	179	1,424	7.96	2.716	Q1	1
International Journal of Distance Education Technologies	1539-3100	IGI Global Publishing	United States	83	556	6.70	0.790	Q1	2
International Journal of Educational Technology in Higher Education	2365-9440	Springer Nature	Netherlands	278	5,329	19.17	4.303	Q1	1
International Journal of Emerging Technologies in Learning	1868-8799 / 1863-0383	International Association of Online Engineering	Germany	1861	10,453	5.62	1.414	Q2	1

Identification				Data Citation and Documents			Indicators Data		
Title	**ISSN (print) / ISSN (online)**	**Publisher**	**Country**	**Number of articles**	**Number of citations**	**Average of citations[a]**	**SNIP[b] (Scopus)**	**Quartiles[c] (SCImago)**	**Criterion[d]**
International Journal of Game-Based Learning	2155-6849 / 2155-6857	IGI Global Publishing	United States	71	303	4.27	1.089	Q2	1
International Journal of Lifelong Education	0260-1370 / 1464-519X	Taylor & Francis	United Kingdom	230	647	2.81	0.999	Q2	1
International Journal of Mobile Learning and Organisation	1746-725X / 1746-7268	Inderscienc e Publishers	Switzerland	112	850	7.59	1.358	Q2	1
International Journal of Technology Enhanced Learning	1753-5255 / 1753-5263	Inderscienc e Publishers	Switzerland	118	483	4.09	0.768	Q2	2
International Review of Education	0020-8566 / 1573-0638	Springer Nature	Netherlands	194	1,121	5.78	1.783	Q2	1
International Review of Research in Open and Distance Learning	1492-3831	Athabasca University	Canada	306	2,860	9.35	2.089	Q1	1
Internet and Higher Education	1096-7516	Elsevier	United Kingdom	122	3,103	25.43	5.300	Q1	1
Journal of Computer Assisted Learning	0266-4909 / 1365-2729	Wiley-Blackwell	United Kingdom	516	5,245	10.16	1.964	Q1	1
Journal of Continuing Education in the Health Professions	0894-1912 / 1554-558X	Wiley-Blackwell	United States	258	870	3.37	1.134	Q2	1
Journal of Educators Online	1547-500X	Matthew Elbeck	United States	176	550	3.13	0.899	Q2	2

Identification				Data Citation and Documents			Indicators Data		
Title	**ISSN (print) / ISSN (online)**	**Publisher**	**Country**	**Number of articles**	**Number of citations**	**Average of citations[a]**	**SNIP[b] (Scopus)**	**Quartiles[c] (SCImago)**	**Criterion[d]**
Journal of Information Literacy	1750-5968	CILIP Information Literacy Group	United Kingdom	119	231	1.94	1.070	Q2	1
Journal of Information Systems Education	1055-3096	Data Processing Management Association's Special Interest Group for Education	United States	139	523	3.76	1.275	Q2	2
Journal of Information Technology Education: Research	1547-9714 / 1539-3585	Informing Science Institute	United States	169	1,013	5.99	1.085	Q2	1
Knowledge Management and E-Learning	2073- 7904	University of Hong Kong	China	123	797	6.48	1.036	Q2	1
Learning Environments Research	1387-1579 / 1573-1855	Springer Nature	Netherlands	177	1,045	5.90	2.231	Q1	1
Nordic Journal of Digital Literacy	0809-6724 / 1891-943X	Universitets forlaget AS	Norway	69	265	3.84	0.736	Q2	1
Online Journal of Communication and Media Technologies	1986-3497	Bastas	United Kingdom	90	294	3.27	0.648	Q2	2
Online Learning Journal	2472-5730	The Online Learning Consortium	United States	379	3,925	10.36	2.478	Q1	2

Identification				Data Citation and Documents			Indicators Data		
Title	**ISSN (print) / ISSN (online)**	**Publisher**	**Country**	**Number of articles**	**Number of citations**	**Average of citations[a]**	**SNIP[b] (Scopus)**	**Quartiles[c] (SCImago)**	**Criterion[d]**
Open Learning	0268-0513 / 1469-9958	Taylor & Francis	United Kingdom	139	748	5.38	1.122	Q2	1
Revista de Educacion a Distancia	1578-7680	Universidad de Murcia	Spain	151	660	4.37	1.069	Q2	2
Revista Iberoamericana de Tecnologias del Aprendizaje	1932-8540	IEEE	United States	181	738	4.08	0.862	Q2	2
Turkish Online Journal of Distance Education	1302-6488	Anadolu University	Turkey	311	1,275	4.10	0.988	Q2	2

Source: The authors.

Note. [a] The average number of citations was calculated as the ratio between the number of citations and the number of articles. [b] Standardized indicator that facilitates direct comparisons of journals across different fields, considering the distinct characteristics of scientific production in each field. SNIP 2021 was published in 2023.[c] Quartile is a statistical measure that divides the distribution based on indicators of that journal into four equal parts. Q1 represents the best-positioned journal compared to others in the same field, while Q4 indicates the least favoured position based on the indicators considered. Best quartile SJR 2022 consulted in 2023. [d] The criteria for the selection of journals were defined in Section 2.1 of the methodology. Criterion 1 encompasses journals ranked in quartiles Q1 or Q2 in the e-learning category, while criterion 2 considers journal specialisation, also requiring a ranking in quartiles Q1 or Q2.

3.2 Performance Analysis

First, we assess the article's keywords, followed by its productivity, by examining the number of documents, publishers, the geographic distribution of publishers and journals, and author and author´s affiliations. Second, we assess quality using bibliometric impact indicators, such as citations, SNIP of the journal, and FWCI of the article. These indicators comprehensively understand the scholarly impact within the identified themes and thematic areas.

Keywords

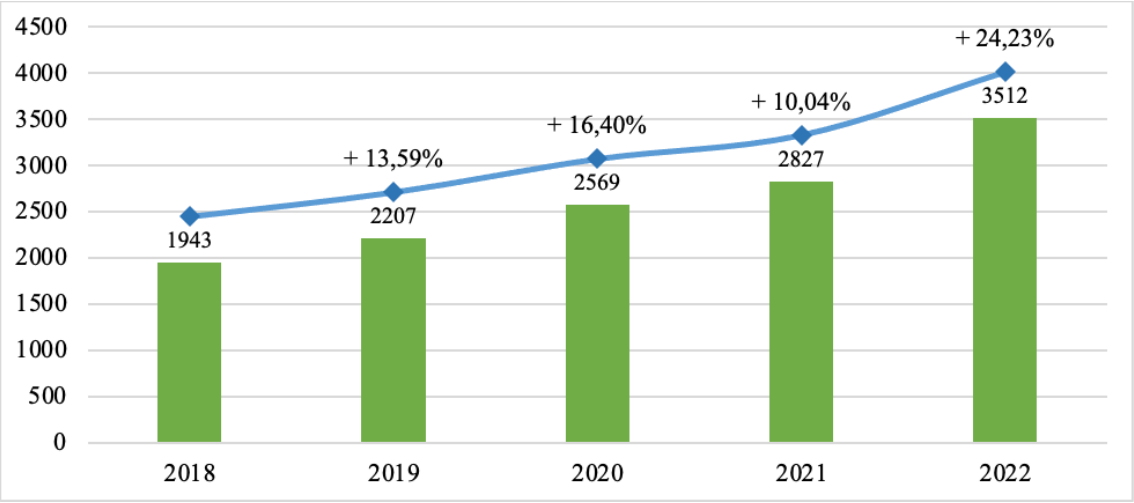
As a result of the data processing carried out in SciMAT, we selected 29,423 different keywords. The more used ones were STUDENTS (n=2564), DISTANCE-EDUCATION (n=2349), LEARNING-SYSTEMS (n=1068), DISTANCE-LEARNING (n=1016), HIGHER-EDUCATION (n=988), TEACHING (n=966), COMPUTER-AIDED-INSTRUCTION (n=751), CURRICULA (n=661), EDUCATION (n=652) and EDUCATION-COMPUTING (n=573).

Documents

Figure 4 shows that the productivity of the research area of distance education has demonstrated steady growth from 2018 to 2022, with a significant increase in the number of publications from 2021 to 2022, which shows the vitality of this area.

Figure 4

Number of selected articles published in the period in the selected journals.



Source: The authors.

Between the first year of analysis, 2018, and the last, 2022, the number of published articles increased by 80.75%. The most significant growth occurred from 2021 to 2022, with a rise of 24.23% in publication volume.

Following the SciMAT framework steps adopted in this study, the number of articles was reduced to 12,947 after filtering out the duplicated articles, editorials, corrections, retractions, author corrections, and introductions to special volumes.

Similarly, after data processing, the number of authors and affiliations decreased to 25,980 and 19,391, respectively.

Publisher, Journals, and Country

The five most prominent publishers in the academic in the Scopus database (n=28,126) are Springer (n=3,026), Elsevier (n=2,561), Taylor & Francis (n=2,369), Wiley-Blackwell (n=1,575), and SAGE (n=932). Table 1 (identification column) notes that 17 (42.5%) of the 40 selected journals were published by these five largest publishers. These publishers account for a significant portion of the global research output, and it is reasonable to expect that distance education researchers would prefer the journals they publish. It is also that most of the selected journals were published in Europe (55%), followed by North America (35%), Asia (7.5%) and Oceania (2.5%).

Among the selected journals, Taylor & Francis and Springer emerged as the most frequent publishers, each contributing five journals with SNIP values of 1.784 and 2.418, respectively. Subsequently, Wiley-Blackwell features with three journals, achieving an average SNIP of 1.910. Finally, Elsevier and SAGE, each with two journals, report average SNIPs of 5.253 and 1.343, respectively. Notably, the two journals from Elsevier, Internet and Higher Education and Computers and Education, hold the highest SNIPs at 5.3 and 5.207, respectively, thus highlighting this publisher's distinguished position in the field of distance education.

Considering the data from Table 1 regarding the five journals with the highest citation average per article (data citation and document column) and with the highest SNIP (indicators data column), we reach the same list of the five journals with the highest impact in the distance education research field: (a) Internet and Higher Education (Elsevier); (b) International Journal of Educational Technology in Higher Education

(Springer Nature); (c) British Journal of Educational Technology (Wiley-Blackwell); (d) Computers and Education (Elsevier); and (e) Educational Technology and Society (National Taiwan Normal University and Society). It is essential to highlight that these five journals have remarkable differences in publication costs and open-access statements. Specifically, while journals *b* and *e* stand out for not requiring Article Processing Charges (APC) for both publication and open access, journals *c*, and *d* require APC to enable open access. Journal *c* requires the payment of an APC for both publication and open access.

Affiliations and Authors

Contrary to the geographic distribution of publishers for the 40 journals selected in this study, when analysing the authors' affiliations, it becomes clear that the most prolific institutions in the distance education area are localised outside of Europe and the USA, as seen in Table 2. The five most productive affiliations, in terms of the number of published articles, are based in Asia. However, when considering the highest citation averages, the scenario looks different: only one of these affiliations is located in Asia, two in North America, one in Europe, and another in Oceania.

Table 2

List of affiliations with the highest number of articles

Affiliation	Articles	Citations	Citations Average[a]	Region/ Country	Overall Indicator[b]	Research Indicator[b]
The University of Hong Kong	218	3,485	15.99	Asia Hong Kong	3	2
National Taiwan University of Science and Technology	173	3,115	18.01	Asia Taiwan	19	47
National Taiwan Normal University	163	2,441	14.98	Asia Taiwan	24	30
Beijing Normal University	142	1,209	8.51	Asia China	6	3
Central China Normal University	136	1,487	10.93	Asia China	-	-
Monash University	122	1,630	13.36	Oceania Australia	1	1

University of South Africa	88	697	7.92	Africa South Africa	31	42
University of Florida	87	1,050	12.07	North America United States	2	2
Universiti Teknologi Malaysia	85	1,069	12.58	Asia Malaysia	19	9
The Open University	81	817	10.09	Europe United Kingdom	20	16
Purdue University	81	1,148	14.17	North America United States	3	2

Source: The authors.

Note. [a] The average number of citations was calculated as the ratio between the number of citations and the number of articles. [b] Indicator by SCImago Institutions Rankings (SIR) 2024.

The combined analysis of the 'Citations Average' indicator alongside the SIR indicators reveals a significant discrepancy between journals with the highest 'Citations Average', 'Overall Indicator' and 'Research Indicator'. For instance, the University of Hong Kong, despite having the highest 'Citations Average' in the field of e-learning, ranks considerably lower in the SIR indicators. Specifically, it is positioned in the 3rd percentile for the 'Overall Indicator' and the 2nd percentile for the 'Research Indicator', indicating that it outperforms only 2% and 3% of institutions, respectively. This contrast suggests that although the university leads in terms of citation average within the e-learning domain, this does not directly translate to a high ranking in the SIR indicators. This may indicate its specialisation and excellence in e-learning research despite not reflecting high performance across broader indicators.

Table 3 shows that a few individual researchers significantly impact the distance education research landscape. For instance, the National Taiwan University of Science and Technology, the second most prolific affiliation, published 173 articles between 2018 to 2022, 141 of which were authored by Professor Gwo-Jen Hwang (Hwang, G-.J) where he appears in various positions among other authors.

Again, it is important to highlight that of the ten most prolific authors, six are affiliated with Asian institutions.

Table 3

Authors with more articles

Author	Affiliations[a]	Articles	Citations	Citations Average[b]	h-index[c]	FWCI[d]
Gwo-Jen Hwang	National Taiwan University of Science and Technology (Asia)	141	2,849	20.21	80	4.30
Dragan Gasevic	Monash University (Oceania)	47	1,079	22.96	60	4.19
Di Zou	Lingnan University (Asia)	32	585	18.28	31	3.68
Wanli Xing	University of Florida (North America)	30	450	15.00	25	2.31
Tenzin Doleck	Simon Fraser University (North America)	26	268	10.31	23	1.76
Hiroaki Ogata	Kyoto University (Asia)	26	348	13.38	34	1.46
Haoran Xie	Lingnan University (Asia)	25	678	27.12	42	2.75
Florence Martin	North Carolina State University (North America)	24	1159	48.29	25	4.68
Chin Chung Tsai	National Taiwan Normal University (Asia)	24	538	22.42	84	3.18
Nian Shing Chen	National Taiwan Normal University (Asia)	23	396	17.22	50	2.12

Source: The authors.

Note. [a]During the analysis period of this investigation, researchers may have changed their affiliated institutions. The data presented (Jun/24) here are the current data extracted from the affiliations of Scopus Authors. [b]The average number of citations was calculated as the ratio between the number of citations and the number of articles (SciMAT). [c]Current h-index retrieved from Scopus Authors (Jun/24). The h-index is a bibliometric indicator measuring both the productivity and impact of a researcher's publications,

calculated based on the number of citations their publications have received relative to the number of publications. [d] FWCI Current FWCI retrieved from Scopus Authors (Jun/24).

It is important to highlight that Professor Gwo-Jen Hwang has the highest number of publications among the researchers analysed, totalling 141 articles, a considerable difference compared to the second most prolific author, who published 47 articles; he also maintains the four-highest average number of citations per article. However, when analysing these data in conjunction with the FWCI indicator (which is the second-highest among the studied authors and the second-highest h-index) it is observed that Professor Hwang has, presently, the most significant impact in the field of distance education. This result underscores the extent and significance of his influence and scientific contribution, positioning him in a leading position in terms of academic impact on this subject.

The joint analysis of data from 'Affiliations with the highest number of articles' (Table 2) and 'Authors with more articles' (Table 3) reveals significant findings. The National Taiwan University of Science and Technology in Taiwan published 141 articles, boasting the second-highest citation average (20.21) and highest 'Research Indicator' (47) (Table 2). This positions the university theoretically in a privileged spot. However, when cross-referencing this data with the authors, it becomes evident that Professor Gwo-Jen Hwang is a central figure, contributing as 141 of the 173 articles. This accounts for 81.5% of the institution's publications in the e-learning field. These figures indicate a concentration of publications within a single author, suggesting that the second-highest (18.01) citation average may not represent an institutional position but rather that of a specific individual. This underscores the importance of analysing metric indicators collectively rather than in isolation to provide a more accurate representation of institutional performance.

Journals

In Table 1 (qualitative data column), we showed 40 journals with their respective production and impact metrics (2022), namely the number of articles published, the number of citations and their average, and SNIP. With these data, it is possible to evaluate the influence of these journals on the distance education field.

Considering the SNIP metric, the main journals are Elsevier's Internet and Higher Education (1st) and Computers and Education (2nd); Springer Nature's International Journal of Educational Technology in Higher Education (3rd) and International Journal

of Artificial Intelligence in Education (5th); and Taylor & Francis's Distance Education (4th).

Articles

The COVID-19 pandemic affected the publication dynamics; researchers have engaged in overcoming the difficulties brought by the pandemic. Some articles related to this topic attracted significant interest, such as the article *Covid-19 pandemic and online learning: the challenges and opportunities* (Adedoyin & Soykan, 2020), which garnered 662 citations and the second largest FWCI, the article *Exploring the critical challenges and factors influencing the E-learning system usage during COVID-19 pandemic* (Almaiah et al., 2020). Although not most cited, the article that had the most significant impact according to the FWCI was *a systematic review of immersive virtual reality applications for higher education: Design elements, lessons learned, and research agenda* (97.78) (Radianti et al., 2020) as shown in *Table 4*.

Table 4

Articles most cited in the period

Nº Article	**Title/ Authors/ Affiliations**	**Journal (Year)**	**FWCI[a] (Citations)**
1	Covid-19 pandemic and online learning: The challenges and opportunities • Olasile Babatunde Adedoyin (University of Kyrenia) • Emrah Soykan (University of Kyrenia)	Interactive Learning Environments (2020)	58.09 (662)
2	A systematic review of immersive virtual reality applications for higher education: Design elements, lessons learned, and research agenda • Jaziar Radianti (Universitetet i Agder) • Tim A. Majchrzak (Universitetet i Agder) • Jennifer Fromm (Universität Duisburg-Essen) • Isabell Wohlgenannt (Universität Liechtenstein)	Computers and Education (2020)	97.78 (565)

3	The technology acceptance model (TAM): A meta-analytic structural equation modeling approach to explaining teachers' adoption of digital technology in education • Ronny Scherer (Universitetet i Oslo) • Fazilat Siddiq (University of South-Eastern Norway) • Jo Tondeur (University of Wollongong)	Computers and Education (2019)	63.69 (491)
4	A review of the use of virtual reality head-mounted displays in education and training • Lasse Jensen (Københavns Universitet) • Flemming Konradsen (Københavns Universitet)	Education and Information Technologies (2018)	44.01 (438)
5	The flipped classroom: A review of its advantages and challenges • Gökçe Akçayır (University of Alberta) • Murat Akçayır (University of Alberta)	Computers and Education (2018)	34.41 (411)
6	Exploring the critical challenges and factors influencing the E-learning system usage during COVID-19 pandemic • Mohammed Amin Almaiah (The University of Jordan) • Ahmad Al-Khasawneh (Hashemite University) • Ahmad Altunibat (Al-Zaytoonah University of Jordan)	Education and Information Technologies (2020)	69.50 (358)
7	Engagement matters: Student perceptions on the importance of engagement strategies in the online learning environment • Florence Martin (NC State University) • Doris U Bolliger (Texas Tech University)	Online Learning Journal (2018)	24.34 (344)
8	Augmented reality for STEM learning: A systematic review	Computers and Education (2018)	33.03 (343)

	• María-Blanca Ibáñez (Universidad Carlos III de Madrid) • Carlos Delgado-Kloos (Universidad Carlos III de Madrid)		
9	Blended learning: the new normal and emerging technologies • Charles D. Dziuban (University of Central Florida) • Charles R. Graham (Brigham Young University) • Patsy D. Moskal (University of Central Florida) • Anders Norberg (Umeå Universitet) • Nicole Sicilia (University of Central Florida)	International Journal of Educational Technology in Higher Education (2018)	26.26 (313)
10	Systematic review of research on artificial intelligence applications in higher education – where are the educators? • Olaf Zawacki-Richter (Universität Oldenburg) • Victoria I. Marín (Universitat de Lleida) • Melissa Bond (University of South Australia) • Franziska Gouverneur (Universität Oldenburg)	International Journal of Educational Technology in Higher Education (2019)	21.07 (298)

Source: The authors.

Note. [a]FWCI for articles. [b] During the analysis period of this investigation, researchers may have changed their affiliated institutions. The data presented here are the current data extracted from the affiliations of Scopus Authors.

The ten most cited articles were signed by 29 authors affiliated with 22 distinct institutions. It is pertinent to highlight that none of these authors or institutions feature among those most cited in previous tables (Table 3 for authors and Table 2 for institutions). This suggests a potential link to the specific topics addressed in these articles. Notably, two of these articles explore virtual and augmented reality (articles 2, 4, and 8 in Table 4), designated in the strategic diagram as an emerging topic in e-learning (lower-left quadrant). Additionally, two articles focus on themes related to COVID-19 (articles 1 and 6 in Table 4), recognised in the strategic diagram both as a highly developed theme (upper-right quadrant) and an isolated cluster (upper-left quadrant).

3.3 Science Mapping

We used the simple centres algorithm to develop the themes in the clustering algorithm (Coulter et al., 1998) as Cobo et al. (2011a).

3.3.1 Themes and Thematic Networks

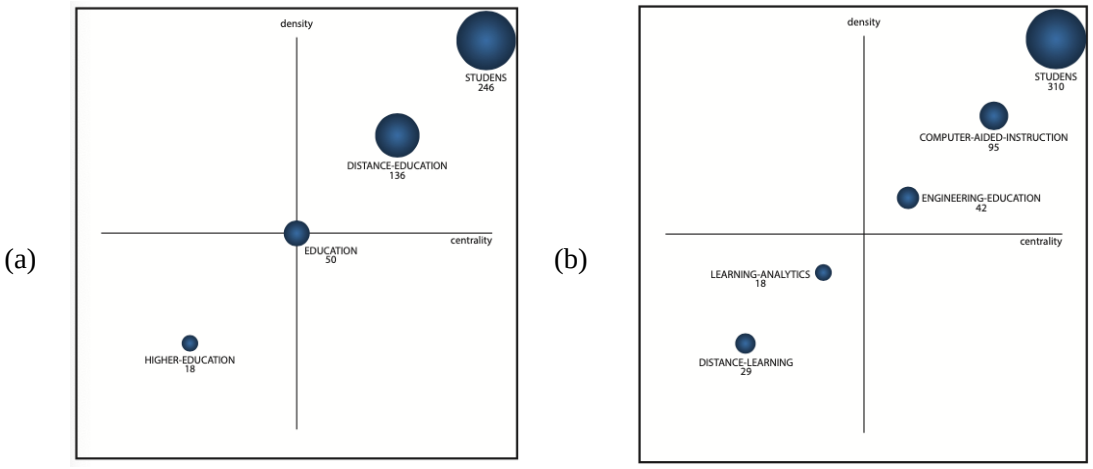
We employed the strategic diagram and cluster network to illustrate the themes and thematic networks. In both techniques, the volume of each sphere is proportional to the number of published documents associated with each theme.

3.3.1.1 Strategic Diagram

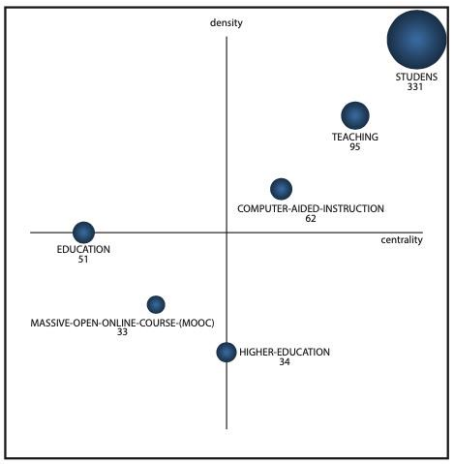
Strategic diagrams, represented by Callon's density and centrality, were built to show the detected clusters in a two-dimensional space. The strategic diagrams obtained for each period are presented in Figure 5.

Figure 5

Strategic diagram

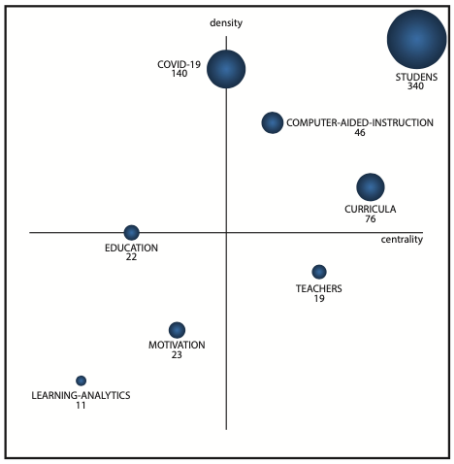


(c)



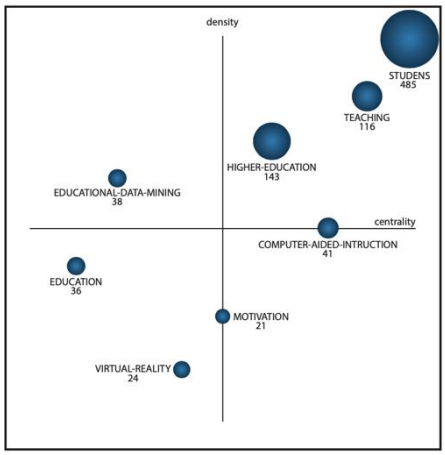
2020

(d)



2021

(e)



2022

Quadrant motor clusters (upper-right)

The quadrant motor clusters' themes are very important for structuring the research field. Furthermore, they can present solid external relationships. As can be observed in Figure 5, the theme STUDENT was the only one consistently appearing across all periods, always as a quadrant motor cluster. The theme presented high values for density and centrality and a growing number of documents using it (2018: 246; 2019: 310; 2020: 331; 2021: 340; e 2022: 485).

From 2019, the theme COMPUTER-AIDED-INSTRUCTION also became present, although its prevalence exhibited a declining trend over time (2019: 11.44; 2020: 5.22; 2021: 3.30 and 2022: 2.52). This decline followed a trajectory towards the lower-right quadrant, indicating that the theme might evolve towards a more basic and transversal position in the field of distance learning. However, it also raises the possibility that the

theme is at risk of losing its capacity "...to maintain itself and to develop over time..." (Callon et al., 1991, p. 165).

As would be expected, the theme of COVID-19 appeared in 2021. The location between the motor cluster quadrant (upper-right) and the highly developed and isolated cluster (upper-left) demonstrates that the theme has external solid relationships and is highly developed and isolated. Such strong external relationships might be related to the nature of the pandemic, where several fields of knowledge started researching the theme and its impact on several areas of knowledge. Regarding its higher development, this might be partially explained by the information provided in Table 4, where the theme COVID-19 was the object of study in the most cited article (Adedoyin & Soykan, 2020) and the article with the 2nd highest FWCI (Almaiah et al., 2020).

Highly developed and isolated cluster (upper-left)

The theme of EDUCATION was present only in 2018, 2020, and 2021. In 2019, no specific theme was identified, and in 2022, only the theme EDUCATIONAL-DATA-MINING was identified, mainly due to its specialised character. As mentioned earlier, the theme of COVID-19 surfaced only in 2021. These findings indicate well-established internal connections but deficient external ones. Despite being highly specialised and internally developed themes, they are marginalised.

Emerging or declining clusters quadrant (lower-left)

The themes in this quadrant present poor development and marginal significance, potentially indicating that they are either emerging themes or in the process of extinction.

The theme LEARNING-ANALYTICS appeared only in 2019 and 2021. MOTIVATION appeared in two consecutive years, 2021 and 2022, although in the latter with greater centrality, which may indicate a changing trend from an emerging theme to a transversal one (lower-right).

The HIGHER-EDUCATION theme showed the greatest changes over the period, moving from the lower left quadrant in 2018, an emerging theme, to the lower right quadrant in 2020, a cross-cutting theme, but reappearing in 2022 in the upper right quadrant, i.e., a crucial theme for structuring distance education.

The VIRTUAL-REALITY theme makes its sole appearance in 2022. It can be identified as an emerging topic in e-learning. This indication is supported by its central presence in the article by Radianti et al., (2020), which holds the highest FWCI (97.78) and is the second most cited article (n=565) in this study.

Basic and transversal clusters quadrant (lower-right)

The themes in this quadrant exhibit a basic and transversal character in the years under analysis. In 2019, no theme was identified in this quadrant. The theme of EDUCATION appeared solely in 2018, while HIGHER-EDUCATION and TEACHERS only appeared in 2020 and 2021, respectively. However, in 2022, two themes emerged: MOTIVATION and COMPUTER-AIDED-INSTRUCTION.

3.3.1.2 Cluster Network

In the previous section, we were interested in visualising the strategic positions of research themes regarding influence and connectivity in distance education. With cluster network, we now analyse the keywords and their interconnections, highlighting the most significant keywords based on their centrality.

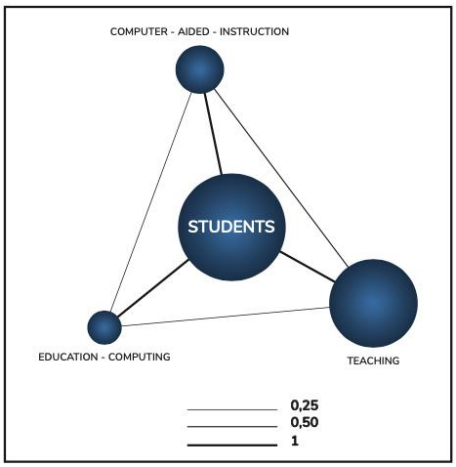
Figure 6 presents the cluster network for the keyword STUDENTS. The keyword STUDENTS presented the highest centrality in the analysed periods.

The extent of interaction within the research network, involving keywords from distinct themes, was significantly prominent. This observation highlights the robustness of external connections among different themes, which also significantly enhance the overall thematic network's connectivity.

Figure 6

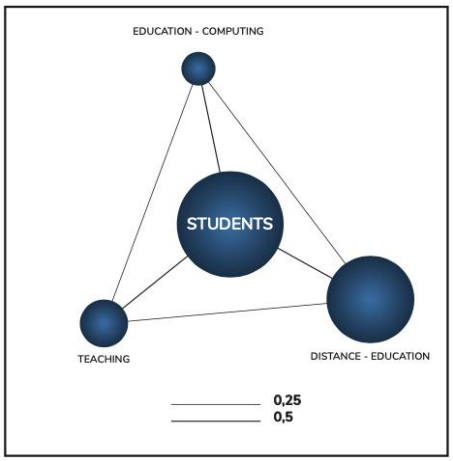
Cluster network

(a)



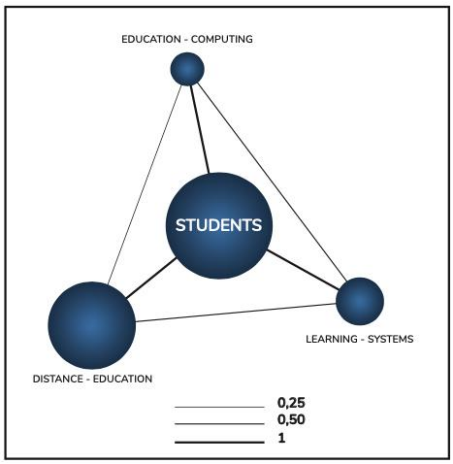
2018

(b)



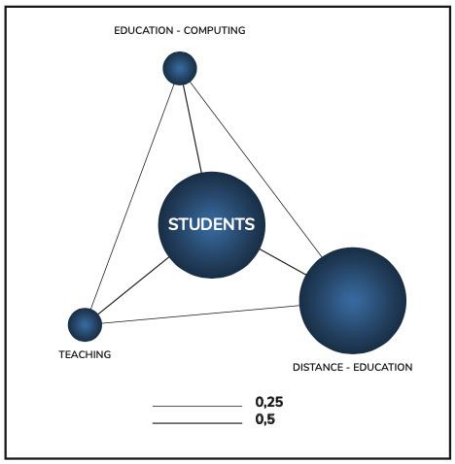
2019

(c)



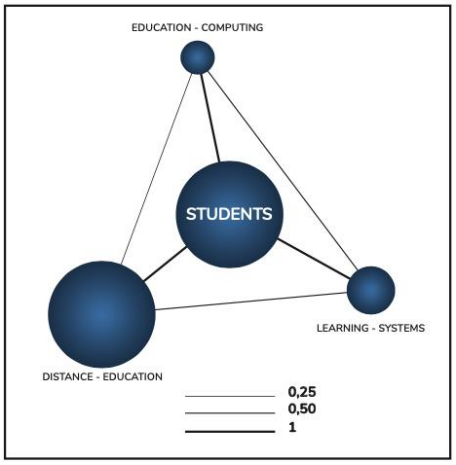
2020

(d)



2021

(e)



2022

In 2018 (Figure 6a), the thematic connections between STUDENTS and TEACHING displayed a robust dynamic, accompanied by a moderate interplay with EDUCATION-COMPUTING and COMPUTER-AIDED-INSTRUCTION, while manifesting a weaker interaction between the remaining themes.

In 2019 (Figure 6b), beyond its significant interaction with TEACHING, the STUDENTS theme also showcased a strong link with EDUCATION-COMPUTING and a moderate one with DISTANCE-EDUCATION.

In 2020 (Figure 6c), DISTANCE-EDUCATION and LEARNING-SYSTEMS emerged with more robust connectivity with the STUDENT. A moderate association was observed between EDUCATION COMPUTING and both DISTANCE-EDUCATION and LEARNING-SYSTEMS and between LEARNING-SYSTEMS and EDUCATION-COMPUTING.

In 2021 (Figure 6d), a strong association was noted between TEACHING and DISTANCE-EDUCATION, a moderate association with EDUCATION-COMPUTING, and a weaker one with the remaining.

Finally, in 2022 (Figure 6e), a strong connection was identified among DISTANCE-EDUCATION, LEARNING-SYSTEMS, and EDUCATION-COMPUTING, and a moderate association was observed between DISTANCE-EDUCATION and LEARNING-SYSTEMS, as well as between LEARNING-SYSTEMS and EDUCATION-COMPUTING. Finally, a weak association was found between DISTANCE-EDUCATION and EDUCATION-COMPUTING.

It is worth noting that during the whole period, the EDUCATION-COMPUTING presented a strong or moderate association with the STUDENT, which presented the biggest centrality despite the relatively small number of documents.

The DISTANCE-EDUCATION appears from 2019 until the end of the analysed period (2022), with a steady increase in the number of documents used (size of the sphere) observed. We can also identify a weak relationship with the of EDUCATION-COMPUTING throughout the period.

3.3.2 Evolution of Themes

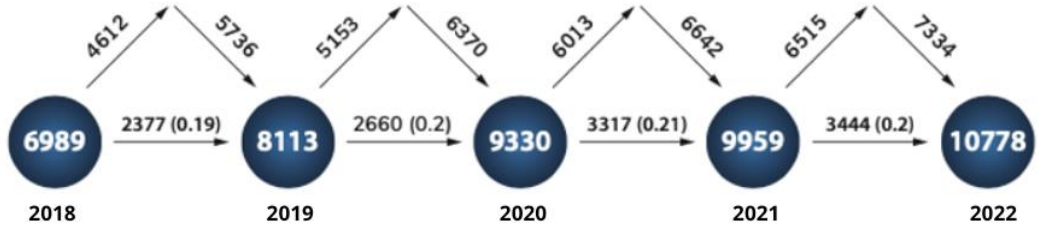
To analyse the evolution of themes in the distance education field, we explored the keyword dynamics using the overlapping map and the evolution of the thematic areas through the conceptual evolution map.

3.3.2.1 Overlapping Map

Following the filtering process, we identified 29,434 keywords. Figure 7 illustrates the distribution of these keywords across the different years, with each circle depicting the number of keywords for the respective year placed at its center.

Figure 7

Longitudinal analysis – overlapping map of the stability between periods.



The flow of keywords from one year to another is represented above the horizontal arrows. For example, 6,989 keywords were found in 2018 and 8,113 in 2019. From the 8,113 found in 2019, 2,377 were reused from 2018, and an additional 5,736 new keywords were introduced (incoming arrow), summing up to 8,113. The SI (Small, 1977), presented in parentheses, was 0.19.

Despite the relevant 54,21 % increase in the number of keywords, soaring from 6,989 in 2018 to 10,778 in 2022, we can assert that the terminology is still being consolidated, considering the low and stable SI represented in the horizontal arrow and ranging marginally from 0.19 to 0.21. The stability in the SI confirms the persistence and coherence of the identified keywords over the analysed period, suggesting an acceptable level of stability and continuity.

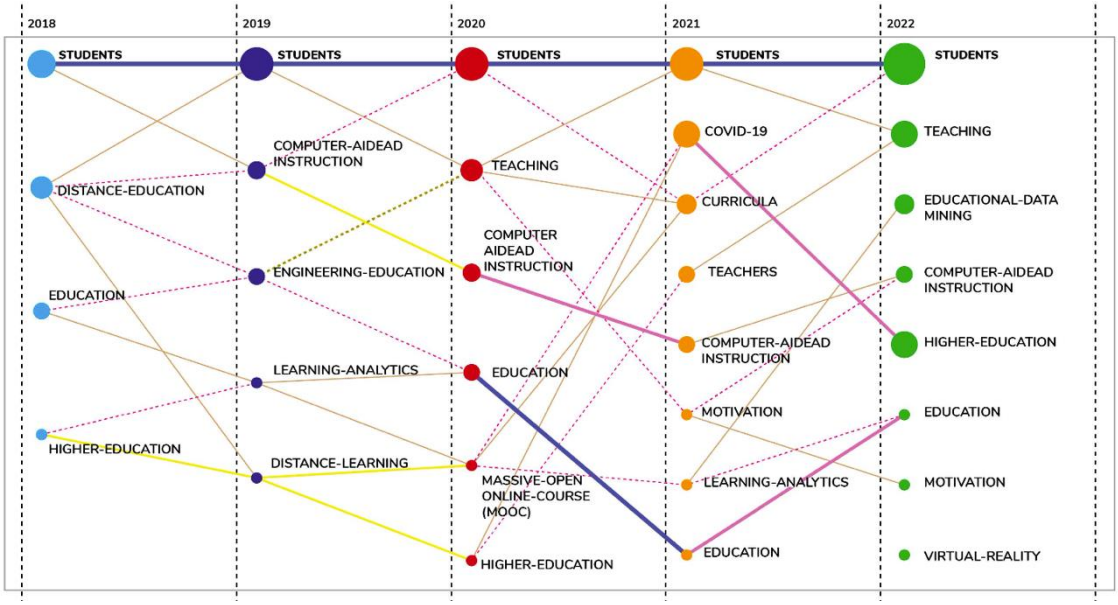
3.3.2.2 Conceptual Evolution Map

In the conceptual evolution map, the solid lines indicate that the linked cluster shares the main item, while dotted lines mean themes share elements other than the main item. The

thickness of the line is proportional to the Inclusion Index, and the volume of the spheres corresponds to the number of published documents associated with each cluster.

Figure 8

Longitudinal analysis – evolution map of the themes



By analysing Figure 8, a few observations can be made:

- The diversity of themes under research expanded from four in 2018 to eight in 2022, with the most significant change occurring in 2021, primarily due to the impact of the COVID-19 pandemic.
- Most themes exhibited robust cohesion, consistently stemming from the preceding periods, except the theme VIRTUAL-REALITY, which appears isolated in 2022. Interestingly, this theme is exclusively situated in the lower-left quadrant of the strategic diagram, indicating its status as an emergent theme in the distance education area.
- Each theme evolves continuously and coherently throughout the period, with no gaps. This indicates a sustained and unbroken interest from community members across the analysed periods.
- Regarding the evolution in the number of documents, as represented by the volume of the spheres, the growing evolution of the theme STUDENT is very

clear. Also, a high number of starts were observed throughout the period. This reflects a progressive increase in the research interest and emphasis on students.

- The theme COMPUTER-AIDED-INSTRUCTION, which involves integrating computer technology into the learning environment to assist teachers and learners, is depicted as a subset (solid lines) within the theme STUDENTS. Concerning DISTANCE-EDUCATION the dotted line indicates the sharing of elements beyond the theme name.

4. Conclusion

Traditionally, understanding previous research relied on qualitative literature reviews and/or quantitative meta-analyses, but currently bibliometric methods and scientific mapping have emerged as new investigative methods. These methods allow us to analyse relationships and trends across disciplines, research fields, individual articles, and journal performance. This approach broadens the scope of research analysis and enhances our understanding of the intricate interconnections within the scientific landscape of distance education research.

In this article, we used several methods of bibliometrics analysis to analyse the thematic dynamics in the distance education field of knowledge. The methodology adopted for the selection of journals has proven suitable for this purpose, as three out of the five keywords most used (DISTANCE-EDUCATION, LEARNING-SYSTEMS, and DISTANCE-LEARNING) are directly connected to the research in the field of distance education.

The growth in published articles followed a relatively consistent trend from 2018 to 2021, ranging from 10.04 to 13.59 %. The number of publications increased significantly from 2021 to 2022, experiencing a 24.23% increase.

Findings highlight a significant influence of the COVID-19 pandemic on the research on distance education evolving process. First, the theme COVID-19 is present in the 2021 strategic diagram (science mapping), appearing both as motor cluster (upper-right) and as a highly developed and isolated cluster (upper-left). Second, the high number of articles in the database (67 articles) containing the term COVID-19 and published between 2020 and 2022; and finally, several of these articles have garnered significant impact, as the example of the most cited article and the second most influential article based on FWCI.

This suggests that research related to COVID-19, may have contributed to the substantial increase of the publication volume, as previously quantified, during the studied period and the selected journals.

Based on editorial factors, we were able to draw two interesting observations. Concerning the selected journals in this study, 42.5% (n=17) were published by the five largest international publishers. This concentration is also evident when examining the five journals with the most considerable impact (SNIP) in the distance education field; these five largest international publishers edit four of these. The journal Educational Technology and Society, published by the National Taiwan Normal University, has yet to be published in the five leading international scientific publishers. Factors such as publication cost and open access policies do not appear relevant for impact, as these five journals significantly differ in terms of such policies.

Furthermore, most publishers (67.5%) are based in the United Kingdom or the United States of America. On the other side, two interesting findings emerged related to the institutions and authors and their institutions, as we observed that six out of ten institutions most frequently indicated as affiliations by the authors are based in Asia, likewise the most cited authors. It is essential to mention that, notwithstanding the Asian dominance in terms of the volume of articles and citations (encompassing both institutions and authors), this phenomenon contrasts with the geographical distribution of the editorial based on the journals selected for this analysis. Merely 7.5% (n=3) of the journals are based in Asia, which suggests a propensity among Asian authors to direct their submissions toward international journals for disseminating their work.

In analysing the data from institutions most frequently indicated as affiliations and authors, a noticeable mismatch emerges between the institutions listed as the most prolific knowledge producers in the field of distance education and the SIR indicators. This suggests that these institutions have a specialised research focus in distance education compared to other institutional research areas. However, this analysis may not apply to the National Taiwan University of Science and Technology. Given that 81.5% of the scientific output in this field involves Professor Gwo-Jen Hwang as one of the authors, this specialisation appears to be more attributable to the researcher than to the institution itself. This author, who has demonstrated the highest production and scientific impact

throughout this study, underscores the need to analyse metric indicators collectively rather than in isolation.

The results presented and discussed earlier regarding the ten most cited articles of this study reveal a remarkably diverse distribution of contributions, involving 29 authors from 22 distinct institutions, with no overlap with the institutions or authors previously highlighted for their production and impact in the field. This absence of overlap suggests a capacity for rapid thematic evolution in response to emerging themes such as virtual and augmented reality, and urgent issues like the COVID-19 pandemic. These themes not only underscore the relevance and applicability of current research but also outline future directions for distance education, demonstrating its ability to adapt and respond promptly to global challenges.

Regarding the themes analysed by science mapping (strategic diagram), we identified the STUDENT theme as the most relevant motor cluster (most significant density and centrality), indicating that the theme plays a pivotal role in structuring the field of distance education research, being relatively expected, because students being frequently studied in this field of research.

As previously mentioned, the COVID-19 theme emerged only in 2021, which relates to the pandemic's peak. The strategic diagram presents a moderate density between the upper-right and upper-left quadrants. In its evolution map, the COVID-19 theme is depicted as a subset (solid lines) of both the HIGHER-EDUCATION and MASSIVE-OPEN-ONLINE-COURSE (MOOC) themes, making clear that these themes share elements other than the name or some keywords (dotted line). The linkage of the COVID-19 theme to the HIGHER-EDUCATION theme in the evolution map suggests a correlation, possibly attributed to the maturity and consolidation of distance education in higher education. The absence of other educational levels in science mapping and performance analysis supports this observation.

The appearance of the LEARNING-ANALYTICS theme in 2019 and its subsequent reappearance in 2021, showing lower density and centrality, may suggest a decline in the prominence of this theme. In contrast, a different situation can be observed with the VIRTUAL-REALITY theme, which, despite appearing only in the last period (2022), might be considered an emerging theme in distance education due to its role as a central

theme in the article with the highest FWCI (Radianti et al., 2020) and the second-highest number of citations (Jensen & Konradsen, 2018).

Based on the analysis conducted in this article, the terminology in the distance education field can be seen as consolidated. This is supported by the consistently low and firm SI of keywords obtained in the overlapping map (evolution of themes). Additionally, it is worth mentioning that all themes evolved continuously and cohesively over the entire period under analysis, presenting no gaps in their evolution, as presented by the conceptual evolution map (evolution of themes). Finally, the emergence of only the VIRTUAL-REALITY theme as an indicator of novelty in the strategic diagram (themes and thematic networks) corroborated its status as an emerging theme.

A limitation of this study is the exclusive use of the Scopus database for collecting relevant data. While Scopus is widely recognised for its quality and breadth in scientific and technical literature and openly provides its metadata, relying on a single source can limit the scope and diversity of the analysed corpus. This may result in the omission of relevant studies that are available in other academic databases.

For future studies, it is recommended to expand the analysed database and extend the analysis period. This will allow not only to confirm the trends observed in this study but also to identify new patterns and emerging themes that may arise over time. Incorporating different databases and expanding the analysed time interval (2018-2022) will provide a more holistic and detailed view of the publishing dynamics and thematic changes in the field of distance education. Such an approach will enrich the understanding of the complex interactions between different themes and their evolution, contributing significantly to the existing literature and offering valuable insights for academics, practitioners, and policymakers involved in distance education.

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Statement by the author(s) regarding the use of LLM

This article has not used texts from an LLM (ChatGPT or others) for its writing.

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References

Adedoyin, O. B., & Soykan, E. (2020). Covid-19 pandemic and online learning: the challenges and opportunities. *Interactive Learning Environments*. https://doi.org/10.1080/10494820.2020.1813180

Akçayır, G., & Akçayır, M. (2018). The flipped classroom: A review of its advantages and challenges. *Computers and Education*, *126*, 334–345. https://doi.org/10.1016/j.compedu.2018.07.021

Almaiah, M. A., Al-Khasawneh, A., & Althunibat, A. (2020). Exploring the critical challenges and factors influencing the E-learning system usage during the COVID-19 pandemic. *Education and Information Technologies*, *25*(6), 5261–5280. https://doi.org/10.1007/s10639-020-10219-y

Börner, K., Chen, C., & Boyack, K. W. (2003). Visualizing knowledge domains. *Annual Review of Information Science and Technology*, *37*, 179–255. https://doi.org/10.1002/aris.1440370106

Bitzenbauer, P. (2021). Quantum physics education research over the last two decades: a bibliometric analysis. Education Sciences, 11(11), 699. https://doi.org/10.3390/educsci11110699

Callon, M., Courtial, J. P., & Laville, F. (1991). Co-word analysis as a tool for describing the network of interactions between basic and technological research: The case of polymer chemistry. *Scientometrics*, *22*(1), 155–205. https://doi.org/10.1007/BF02019280

Cobo, M. J., López-Herrera, A. G., Herrera-Viedma, E., & Herrera, F. (2011a). An approach for detecting, quantifying, and visualizing the evolution of a research field: A practical application to the Fuzzy Sets Theory field. *Journal of Informetrics*, *5*(1), 146–166. https://doi.org/10.1002/asi.21525

Cobo, M. J., López-Herrera, A. G., Herrera-Viedma, E., & Herrera, F. (2011b). Science

mapping software tools: Review, analysis, and cooperative study among tools. *Journal of the American Society for Information Science and Technology*, *62*(7), 1382–1402. https://doi.org/10.1002/asi.21525

Cobo, M. J., López-Herrera, A. G., Herrera-Viedma, E., & Herrera, F. (2012). SciMAT: A new science mapping analysis software tool. *Journal of the American Society for Information Science and Technology*, *63*(8), 1609–1630. https://doi.org/10.1002/asi.22688

Cobo, M. J., F. Chiclana, A. Collop, J. de Ona and E. Herrera-Viedma, "A Bibliometric Analysis of the Intelligent Transportation Systems Research Based on Science Mapping", in IEEE Transactions on Intelligent Transportation Systems, vol. 15, no. 2, pp. 901-908, April 2014. https://doi.org/10.1109/TITS.2013.2284756

Coulter, N., Monarch, I., & Konda, S. (1998). Software Engineering as Seen through Its Research Literature : A Study in Co-Word Analysis. *Journal of the American Society for Information Science*, *4571*(January). https://doi.org/10.1002/(SICI)1097-4571(1998)49

Debackere, K., Verbeek, A., Luwel, M., & Zimmermann, E. (2002). Measuring progress and evolution in science and technology - II: The multiple uses of technometric indicators. *International Journal of Management Reviews*, *4*(3), 213–231. https://doi.org/10.1111/1468-2370.00085

Dorta-González, P., & Dorta-González, M. I. (2010). Indicador bibliométrico basado en el índice h. Revista Espanola de Documentacion Cientifica, 33(2), 225–245. https://doi.org/10.3989/redc.2010.2.733

Donthu, N., Kumar, S., Mukherjee, D., Pandey, N., & Lim, W. M. (2021). How to conduct a bibliometric analysis: An overview and guidelines. *Journal of Business Research*, *133*(April), 285–296. https://doi.org/10.1016/j.jbusres.2021.04.070

Donthu, N., Reinartz, W., Kumar, S., & Pattnaik, D. (2021). A retrospective review of the first 35 years of the International Journal of Research in Marketing. *International Journal of Research in Marketing*, *38*(1), 232–269. https://doi.org/https://doi.org/10.1016/j.ijresmar.2020.10.006

Dziuban, C., Graham, C. R., Moskal, P. D., Norberg, A., & Sicilia, N. (2018). Blended learning: the new normal and emerging technologies. *International Journal of Educational Technology in Higher Education*, *15*(1). https://doi.org/10.1186/s41239-017-0087-5

Eck, N. J. van, & LudoWaltman. (2009). How to Normalize Cooccurrence Data? An Analysis of SomeWell-Known Similarity Measures. *Journal of the American Society for Information Science and Technology*, *60*(8), 1635–1651. https://doi.org/10.1002/asi

Fahimnia, B., Sarkis, J., & Davarzani, H. (2015). Green supply chain management: A review and bibliometric analysis. *International Journal of Production Economics*, *162*, 101–114. https://doi.org/10.1016/j.ijpe.2015.01.003

Guerrero-Bote, V. P., & Moya-Anegón, F. (2012). A further step forward in measuring journals' scientific prestige: The SJR2 indicator. *Journal of Informetrics*, *6*(4), 674–688. https://doi.org/10.1016/j.joi.2012.07.001

Herrera-Viedma, E., López-Robles, J. R., Guallar, J., & Cobo, M. J. (2020). Global trends in coronavirus research at the time of COVID-19: A general bibliometric approach and content analysis using SciMAT. *Profesional de La Informacion*, *29*(3), 1–20. https://doi.org/10.3145/epi.2020.may.22

Hossain, S., Batcha, M. S., Atoum, I., Ahmad, N., & Al-Shehri, A. (2022). Bibliometric

Analysis of the Scientific Research on Sustainability in the Impact of Social Media on Higher Education during the COVID-19 Pandemic. *Sustainability (Switzerland)*, *14*(24). https://doi.org/10.3390/su142416388

Ibáñez, M.-B., & Delgado-Kloos, C. (2018). Augmented reality for STEM learning: A systematic review. *Computers and Education*, *123*, 109–123. https://doi.org/10.1016/j.compedu.2018.05.002

Jensen, L., & Konradsen, F. (2018). A review of the use of virtual reality head-mounted displays in education and training. *Education and Information Technologies*, *23*(4), 1515–1529. https://doi.org/10.1007/s10639-017-9676-0

Khan, F. M., & Gupta, Y. (2022). A bibliometric analysis of mobile learning in the education sector. *Interactive Technology and Smart Education*, *19*(3), 338–359. https://doi.org/10.1108/ITSE-03-2021-0048

Machado, C. F., & Davim, J. P. (2022). Higher Education for Sustainability: A Bibliometric Approach—What, Where and Who Is Doing Research in This Subject? *Sustainability (Switzerland)*, *14*(8). https://doi.org/10.3390/su14084482

Marín Suelves, D., Cuevas Monzonís, N., & Gabarda Méndez, V. (2021). Competencia digital ciudadana: análisis de tendencias en el ámbito educativo. *RIED. Revista Iberoamericana de Educación a Distancia*, *24*(2), 329. https://doi.org/10.5944/ried.24.2.30006

Martin, F., & Bolliger, D. U. (2018). Engagement matters: Student perceptions on the importance of engagement strategies in the online learning environment. *Online Learning Journal*, *22*(1), 205–222. https://doi.org/10.24059/olj.v22i1.1092

Moed, H. F. (2009). Measuring contextual citation impact of scientific journals. *ArXiv*, *4*(3). https://doi.org/10.48550/arXiv.0911.2632

Moral-Muñoz, J. A., Herrera-Viedma, E., Santisteban-Espejo, A., & Cobo, M. J. (2020). Software tools for conducting bibliometric analysis in science: An up-to-date review. *El Profesional de La Información*, *29*(1), 1–20. https://doi.org/10.3145/epi.2020.ene.03

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., … Moher, D. (2021). The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ*, n71. https://doi.org/10.1136/bmj.n71

Radianti, J., Majchrzak, T. A., Fromm, J., & Wohlgenannt, I. (2020). A systematic review of immersive virtual reality applications for higher education: Design elements, lessons learned, and research agenda. *Computers and Education*, *147*. https://doi.org/10.1016/j.compedu.2019.103778

Santos, C., Pedro, N., & Mattar, J. (2024). Metadata of the Top 40 Journals in Distance Education: A Bibliometric Analysis of Impact 2018-2022 [Data set]. Zenodo. https://doi.org/10.5281/zenodo.11196054

Scherer, R., Siddiq, F., & Tondeur, J. (2019). The technology acceptance model (TAM): A meta-analytic structural equation modeling approach to explaining teachers' adoption of digital technology in education. *Computers and Education*, *128*, 13–35. https://doi.org/10.1016/j.compedu.2018.09.009

Schmidt, F. (2008). Meta-analysis: A constantly evolving research integration tool. *Organizational Research Methods*, *11*(1), 96–113. https://doi.org/10.1177/1094428107303161

Sherwood, G., Jones, C. B., Conklin, J. L., & Dodd, A. (2023). Quality and safety

education for nurses: A bibliometric analysis. *Journal of Nursing Scholarship, July 2022*, 1–12. https://doi.org/10.1111/jnu.12876

Small, H. G. (1977). A Co-Citation Model of a Scientific Specialty: A Longitudinal Study of Collagen Research. *Social Studies of Science*, *7*(2), 139–166. https://doi.org/10.1177/030631277700700202

Sternitzke, C., & Bergmann, I. (2009). Similarity measures for document mapping: A comparative study on the level of an individual scientist. *Scientometrics, 78*(1), 113–130. https://doi.org/10.1007/s11192-007-1961-z

Waltman, L., van Eck, N. J., van Leeuwen, T. N., & Visser, M. S. (2012). Some modifications to the SNIP journal impact indicator. *Journal of Informetrics, 7*(2), 272–285. https://doi.org/10.1016/j.joi.2012.11.011

Wu, Y. C. J., & Wu, T. (2017). A decade of entrepreneurship education in the Asia Pacific for future directions in theory and practice. *Management Decision, 55*(7), 1333–1350. https://doi.org/10.1108/MD-05-2017-0518

Zawacki-Richter, O., Marín, V. I., Bond, M., & Gouverneur, F. (2019). Systematic review of research on artificial intelligence applications in higher education – where are the educators? *International Journal of Educational Technology in Higher Education*, *16*(1). https://doi.org/10.1186/s41239-019-0171-0

Zupic, I., & Čater, T. (2015). Bibliometric Methods in Management and Organization. *Organizational Research Methods*, *18*(3), 429–472. https://doi.org/10.1177/1094428114562629