


Review

# COVID-19 in the Field of Education: State of the Art

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**Abstract:** COVID-19 has produced a transformation in society that has, in turn, influenced the field of education. The purpose of this study was to analyze the influence of COVID-19 on education using the Web of Science database. A methodology based on bibliometrics was used. Specifically, a scientific mapping of the literature was carried out, as well as a co-word analysis on the state of the question. The analysis included 940 publications. The results show that the institution with the highest volume of production in this field is the University of London. Among the journals, the Journal of Chemical Education stands out. Furthermore, in the analysis of the structural and thematic development of co-words, a high percentage of keyword matching was observed. In 2020, the motor themes were mental-health, organic-chemistry, general-public, first-year-undergraduate, and upper-division-undergraduate, while in 2021, they were autism-spectrum-disorder, adoption, internet, and intervention. It can be concluded that investigation into COVID-19 in the educational field is in its initial process. The research is currently mainly oriented to pedagogical methods, especially e-learning or collaborative learning, although they are not the only trends in this field. Research is also focusing on mental health, students with various disorders, and higher education. In the near future, research on COVID-19 in the field of education will probably be oriented to the application of effective pedagogical methods to train students at various educational stages.

**Keywords:** bibliometric; scientific mapping; scimat; education; covid-19



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## 1. Introduction

No one could foresee the impact that the global pandemic due to COVID-19, which shook the world throughout 2020, would have [1]. That year will be remembered as the year of the pandemic and will go down in history because more than 1.5 billion people around the planet were confined to stop the spread of SARS-CoV2, the causal agent of COVID-19 [2,3]. The state of alarm decreed by several countries led to strict confinement. It affected society socially, economically, psychologically, and educationally [4,5].

On the European continent, in March and from one day to the next, face-to-face classes were suspended. This forced the transformation of all university teaching to the online format [6]. It was an unplanned emergency adaptation, and this has served to highlight the strengths and weaknesses of the current university [7].

Despite the progress of information and communication technologies (ICT), COVID-19 has highlighted the absence of knowledge on the use of digital resources and educational platforms that contemporary society has [8]. The competence shortages in digital matters by teachers and students have hampered the transformation of educational scenarios towards digital, up to the moment, face-to-face encounters [9]. Educational institutions had not realized the importance of different digital learning environments until the arrival

of this pandemic [10]. In addition, COVID-19, as well as the lack of technological resources and digital competence, increased the complexity of teaching [11].

Nonetheless, classes were virtualized, and a model designed for face-to-face teaching was adapted [12], which was implemented at all educational stages [13]. We have managed to adapt in times of pandemic, transposing elements from one model to another, but without retouching or rethinking educational design [14].

The virtual campuses of the universities resisted. Although they were designed as a complement to face-to-face teaching, they assumed all the teaching activities of all degrees [15]. The teachers did not have, on many occasions, sufficient digital skills. On the other hand, the students sometimes had limitations (in their family residence, some lacked the technological means necessary to work at maximum performance, or the desirable level of internet connection) [16]. Too much effort has gone into adaptation, which has undoubtedly made us discover the benefits of technology, but it has also highlighted the digital divide [17,18].

Regarding the teaching methodology, this has materialized with an immediate learning of video-conferencing tools between the months of March and April 2020 [19]. As the second most used tool in emergency transposition, the slide presentations were complemented with a background voice-over or narration [20]. This instructional panorama involved great inconveniences for training plans of university races based on practice, such as medicine, architecture, engineering, arts, and others. In these cases, the content and practices had to be adapted in specific centers to a purely digital environment. All of this brought with it a mediatic and training impact, due to the formative deficiencies of these students and future professionals in the near future [21–24].

Finally, as of June 2020, the evaluation processes began, which had to be carried out completely virtually [25]. Universities improved their virtual campuses, and the race began for the transposition of final exams that saturated the virtual university campuses because they brought together hundreds of students in a synchronous way to take tests for which very little time was allowed. This situation seriously stressed the entire university community [26].

The challenge continues; the evolution of the health situation due to the COVID-19 pandemic is uncertain and social and community health care is a priority. It is time to reflect on options and make profound and coordinated changes in education. Without any doubt, it is time to address new educational models of an active nature [27].

## 2. Justification and Objectives

This study derives from the impact that COVID-19 has had on the teaching and learning processes, a fact that continues to occur now [28]. In this sense, science advances quickly, above all, on topics of special relevance to the present, as is everything related to COVID-19. Recently published studies can improve knowledge and reduce the gap on the status of the issue by means of their findings. This is especially so in the field of health, because of the importance of knowing the most recent information on vaccines and treatments. The field of education also acquires a relevant value in society, to train future generations. For this reason, this research is valuable for the purpose of analyzing the volume of publications carried out on the status of the matter. This will serve to settle the knowledge bases on what was studied by different expert researchers in the field of education. This will create new progress and proposals to inform, act, and improve education in times of academic uncertainty.

To find out how this pandemic is causing alterations in educational systems around the world, this research was carried out from a bibliometric perspective of the scientific literature. Bibliometry is postulated as a research methodology focused on the analysis of scientific publications on a specific question or focus of study [29,30]. This allows the scientific community to know the progress and significance that a theme or construct has achieved throughout its existence [31].

An essential aspect of a bibliometric study is the selection of an adequate database. In this case, the analysis was produced on the basis of the Web of Science (WoS) database. The selection of this database is justified in the fact that it is considered one of the databases that compiles a large volume of studies concerning the field of social sciences, with education being framed in this field [32,33].

The purpose of this study was to analyze the influence of COVID-19 (and its derived names) in documents indexed in WoS. This will allow us to establish the bases of the knowledge generated by this question. In addition, it will serve as a reference to initiate future studies by the scientific community. Therefore, this work represents an exploratory vision of COVID-19 in the field of education.

Therefore, the objectives of this research are focused on knowing the documentary performance in WoS of COVID-19 in the field of education, determining its scientific evolution, revealing the most significant topics covered in the literature, locating the most influential authors so far, and predicting the themes and motor authors.

### 3. Method

In this work, an analysis of the literature was carried out, ranging from the study of documentary development, to the use of an innovative analytical approach based on scientific mapping of COVID-19 in education. To carry out an adequate study, the methodological guidelines proposed by experts in this type of research were followed [34,35]. In addition, a model for the presentation of the results validated by the scientific community was used [36,37].

#### 3.1. Research Design

Starting from bibliometrics as the main research methodology, a research design was carried out to carry out search, registration, analysis, and prediction actions of the literature [38]. This design was supported by a co-word analysis [39,40], as well as the analysis of the h, g, hg, and q2 indices. The different processes carried out in this design allowed both the making of maps with nodes that reflect the conceptual subdomains, as well as revealing the thematic evolution over time [41].

#### 3.2. Procedure

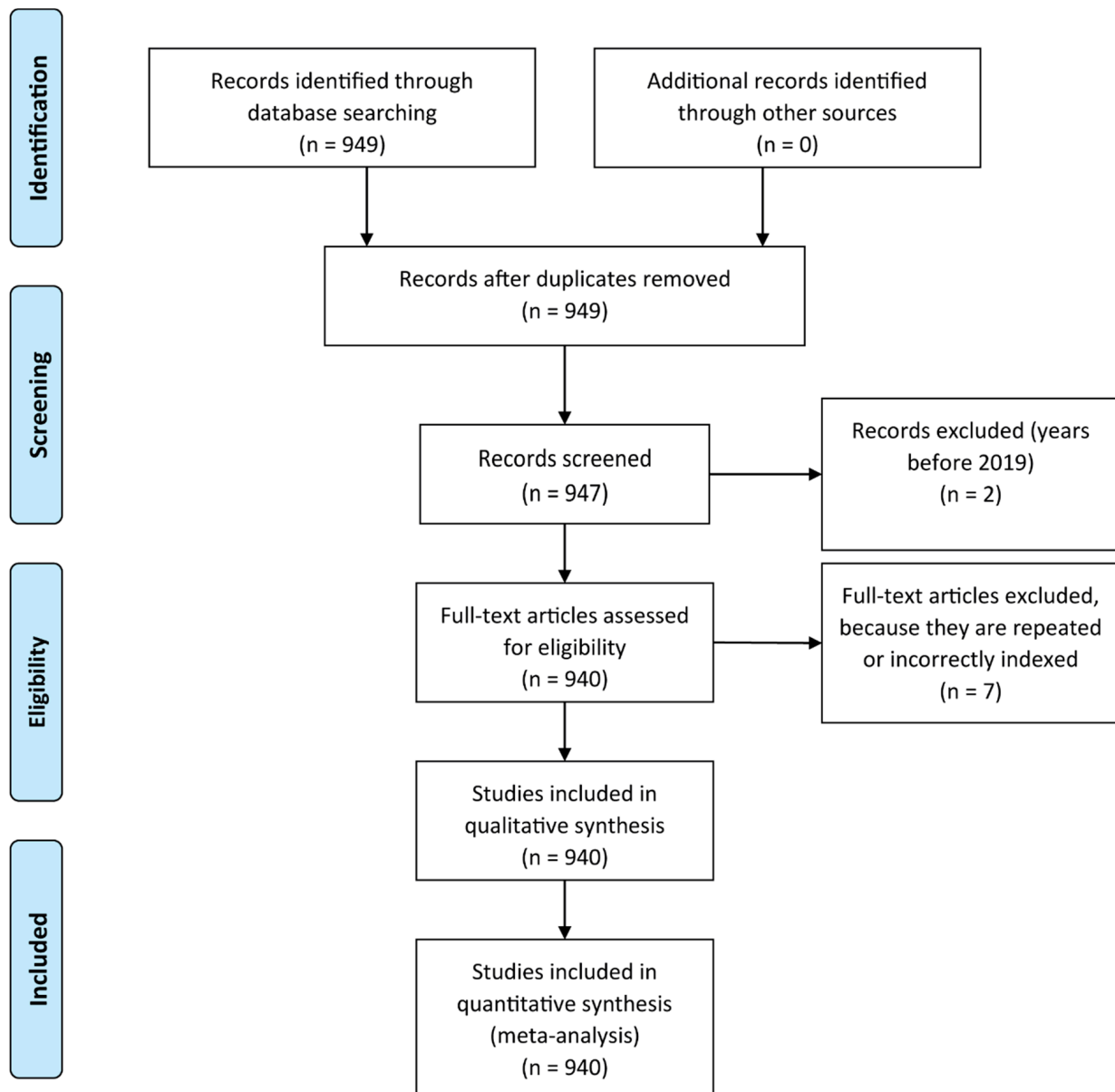
As previous studies have done [42,43], the investigative procedure was carried out in various steps:

- Select the database: In this case, WoS was chosen for the reasons described above and because it is considered a worldwide database, in addition to bringing together those documents indexed in the journal citation reports (JCR);
- Define the search concepts: For this, impact studies were reviewed [44] in order to generate a list of keywords to include in the search process. These words were: Wuhan coronavirus, Wuhan seafood market pneumonia virus, Covid19, Covid-19, Covid-2019, coronavirus disease 2019, SARS-CoV-2, sars2, 2019-nCoV, 2019 novel coronavirus, severe acute respiratory syndrome coronavirus 2, 2019 novel coronavirus infection, coronavirus disease 2019, coronavirus disease-19, novel coronavirus, coronavirus, SARS-CoV-2019 and SARS-CoV-19;
- Generate the search equation: Taking into account the keywords, the equation prepared was: ("Wuhan coronavirus" OR "Wuhan seafood market pneumonia virus" OR "Covid19" OR "Covid-19" OR "Covid-2019" OR "coronavirus disease 2019" OR "SARS-CoV-2" OR "sars2" OR "2019-nCoV" OR "2019 novel coronavirus" OR "severe acute respiratory syndrome coronavirus 2" OR "2019 novel coronavirus infection" OR "coronavirus disease 2019" OR "coronavirus disease-19" OR "novel coronavirus" OR "coronavirus" OR "SARS-CoV-2019" OR "SARS-CoV-19"). This equation was applied to find publications that had any of these terms in their titles;
- Select the search categories in WoS: Specifically, all those related to the field of education (Education Educational Research, Education Scientific Disciplines, Education

Special and Psychology Educational) were selected. The following WoS indices were covered: SCI-EXPANDED, SSCI, A and HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI, CCR-EXPANDED, IC.

The completion of these phases generated 949 scientific documents. Next, to refine the search, various search criteria were established. As inclusion criteria, all years were taken, and as exclusion criteria, documents prior to 2019 ( $n = 2$ ), and repeated or poorly indexed documents ( $n = 7$ ) were excluded. This resulted in a final total of 940 publications.

All this was materialized in a flow diagram that synthesizes the actions established in the PRISMA protocol (Figure 1).



**Figure 1.** Flow diagram of the PRISMA protocol.

In turn, different requirements, taken from previous studies, were configured to represent production and scientific performance adequately in this study [31]. These were language ( $x \geq 10$ ), knowledge areas ( $x \geq 90$ ), type of documents ( $x \geq 150$ ), institutions ( $x \geq 9$ ), authors ( $x \geq 4$ ), sources of origin ( $x \geq 20$ ), country ( $x \geq 40$ ), and the four most cited documents.

### 3.3. Data Analysis

To analyze the reported documents, Analyze Results, Creation Citation Report, and SciMAT were used. The first two programs allowed us to know the authorship, country, type of document, institution, language, medium, and most cited documents. With SciMAT, the structural and dynamic development of the reported publications was carried out from a longitudinal perspective [34]. The SciMAT program is an open source software tool. This resource performs a scientific mapping analysis. That is, it analyzes, through methods, algorithms, and measurements, scientific production from different perspectives (co-words, co-citation or co-authors), and is able to carry out various studies of bibliometric networks. In this case, the SciMAT program can process and view the results obtained in the analysis performed. In the results visualization it is possible to represent the strategic diagrams, the cluster networks, and the areas of evolution. In relation to the analysis of co-words, these are defined as studies of co-occurrences, or joint appearances, of two terms (keywords) in a given text with the intention of identifying the structure, both thematic and conceptual, of a certain field of knowledge [40]. To carry out an adequate analysis, the recommendations of other studies were taken into account [37]. Likewise, the co-word analysis was carried out in various processes:

- Recognition: The keywords ( $n = 2124$ ) of the different publications were analyzed. Co-occurrence node maps were designed. A standard contiguous word network was developed. The keywords were refined; in this case, 2124 were analyzed and those that were both singular and plural were grouped, and those that had spelling mistakes (or were missing a letter or the letter was changed for another) were corrected. Therefore, the number of keywords was reduced ( $n = 2039$ ). The most outstanding themes and concepts were delimited using a clustering algorithm;
- Reproduction: Thematic networks and strategic maps divided into four regions were generated. The upper right section covers the relevant topics and engines. The upper left section brings together isolated and deep-seated problems. The lower left section delimits the topics in disappearance or projection. The lower right section reveals cross-cutting and underdeveloped themes. In this process, the principles of density or internal strength of the network and the centrality or degree of connection established in the networks were taken into account [42];
- Determination: The reported literature was cataloged in two time periods ( $P_1 = 2019\text{--}2020$ ;  $P_2 = 2021$ ). In this case, 2019 was included since there was only one document on this topic in WoS. The strength of the association between these periods was measured by the number of keywords or themes in common [44]. However, for the authors' analysis, only one period was established ( $P_X = 2020\text{--}2021$ );
- Performance: In this last process, various production indicators were connected with their respective inclusion criteria (Table 1).

**Table 1.** Production indicators and inclusion criteria.

Configuration	Values
Analysis unit	Keywords authors, keywords WoS
Frequency threshold	Keywords: $P_1 = (2)$ , $P_2 = (2)$ Authors: $P_X = (2)$
Network type	Co-occurrence
Co-occurrence union value threshold	Keywords: $P_1 = (2)$ , $P_2 = (1)$ Authors: $P_X = (2)$
Normalization measure	Equivalence index: $e_{ij} = c_{ij} / \text{Root}(c_i - c_j)$
Clustering algorithm	Maximum size: 9; Minimum size: 3
Evolutionary measure	Jaccard index
Overlapping measure	Inclusion Rate

## 4. Results

### 4.1. Scientific Performance and Production

Studies related to COVID-19 in education were mainly written in English. Although Spanish and Portuguese appear on the list, their production volume is very small compared to English (Table 2).

**Table 2.** Scientific language used.

Language	n
English	876
Spanish	46
Portuguese	13

The main knowledge area that collects studies related to COVID-19 in education is Education Educational Research, followed by Education Scientific Disciplines. It is noteworthy that among the top positions are areas related to health and chemistry (Table 3).

**Table 3.** Knowledge areas.

Denomination	n
Education Educational Research	515
Education Scientific disciplines	385
Health Care Sciences Services	121
Chemistry Multidisciplinary	97

The type of document used by the scientific community to show its results is the research article. The other types of texts are very different from research articles (Table 4).

**Table 4.** Type of document.

Denomination	n
Article	694
Preprint	164
Editorial material	159

The institution with the highest volume of production in the study on aspects related to COVID-19 in education is the University of London. The rest of the institutions had lower production volumes, although not much lower than the first (Table 5).

**Table 5.** Institutions.

Denomination	n
University of London	24
University of California System	17
University of North Carolina	15
Harvard University	14
State University System of Florida	11
University of Toronto	10

The academic production of the authors is quite even. Of all the authors who investigate COVID-19 in the educational field, two stand out (Cleland, J. and Peters, M.A.), with 5 productions each (Table 6).

**Table 6.** Most prolific authors.

Authors	n
Cleland, J.	5
Peters, M.A.	5



The main sources of provenance for research on COVID-19 are found mainly in research journals. Of all the journals, the one that has generated the highest volume of production to date is the Journal of Chemical Education, with a total of 97 manuscripts. The rest of the journals present a lower volume of production. It is noteworthy that the lines of study of the first four journals are focused on Chemistry and Medicine in the educational field (Table 7).

**Table 7.** Source of provenance.

Denomination	n
Journal of Chemical Education	97
Academic Medicine	56
Medical Education	39
Medical Education Online	23
Education Sciences	21

The country with the most scientific articles on COVID-19 in education is the United States. The rest of the countries have produced far fewer (Table 8).

**Table 8.** Most prolific countries.

Countries	n
USA	327
England	99
Canada	54
Australia	41

The volume of citations of the most cited manuscripts in studies related to COVID-19 in the educational field is noteworthy. The manuscripts were published in 2020, and many of them have more than 25 citations. The study by Chick et al. (2020) has the most citations with 73 (Table 9).

**Table 9.** Most cited manuscripts.

Reference	Citations
Chick, R.C., Clifton, G.T., Peace, K.M., Propper, B.W., Hale, D.F., Alseidi, A.A., and Vreeland, T.J. (2020). Using Technology to Maintain the Education of Residents During the COVID-19 Pandemic. <i>Journal of Surgical Education</i> , 77(4), 729–732. <a href="https://doi.org/10.1016/j.jsurg.2020.03.018">https://doi.org/10.1016/j.jsurg.2020.03.018</a>	73
Huh, S. (2020). How to train health personnel to protect themselves from novel coronavirus (COVID-19) infection. <i>Journal of Educational Evaluation for Health Professions</i> , 17(10), 1–6. <a href="https://doi.org/10.3352/jeehp.2020.17.10">https://doi.org/10.3352/jeehp.2020.17.10</a>	46
Ripp, J., Peccoraro, L., & Charney, D. (2020). Attending to the Emotional Well-Being of the Health Care Workforce in a New York City Health System During the COVID-19 Pandemic. <i>Academic Medicine</i> , 95(8), 1136–1139. <a href="https://doi.org/10.1097/ACM.00000000000003414">https://doi.org/10.1097/ACM.00000000000003414</a>	29
Pather, N., Blyth, P., Chapman, J.A., Dayal, M.R., Flack, N.A.M.S., Fogg, Q.A., Green, R.A., Hulme, A.K., Johnson, I.P., Meyer, A.J., Morley, J.W., Shortland, P.J., Strkalj, G., Strkalj, M., Valter, K., Webb, A.L., Woodley, S.J., & Lazarus, M.D. (2020). Forced Disruption of Anatomy Education in Australia and New Zealand: An Acute Response to the Covid-19 Pandemic. <i>Anatomical Science Education</i> , 13(3), 284–297. <a href="https://doi.org/10.1002/ase.1968">https://doi.org/10.1002/ase.1968</a>	27

#### 4.2. Structural and Thematics Development

In the present study, two years (2020 and 2021) were taken as the reference. The keyword continuity analysis shows the volume of keywords collected in each period. In this case, in 2020 there are a total of 1580 keywords, while in 2021 there are 683. This is normal, given that the volume of production from one year to another differs. The up arrow shows the number of keywords that are not used in the next period. The down arrows shows new keywords being introduced into the field of COVID-19 research in education. Based on this data, plus the volume of keywords for the years 2020 and 2021, the percentage of keyword matching between both periods is established. Currently, the

match percentage is 34% (represented by a horizontal arrow). This indicates that the field of study on COVID-19 in education has established a line of research, although new scientific trends are being generated today (Figure 2).

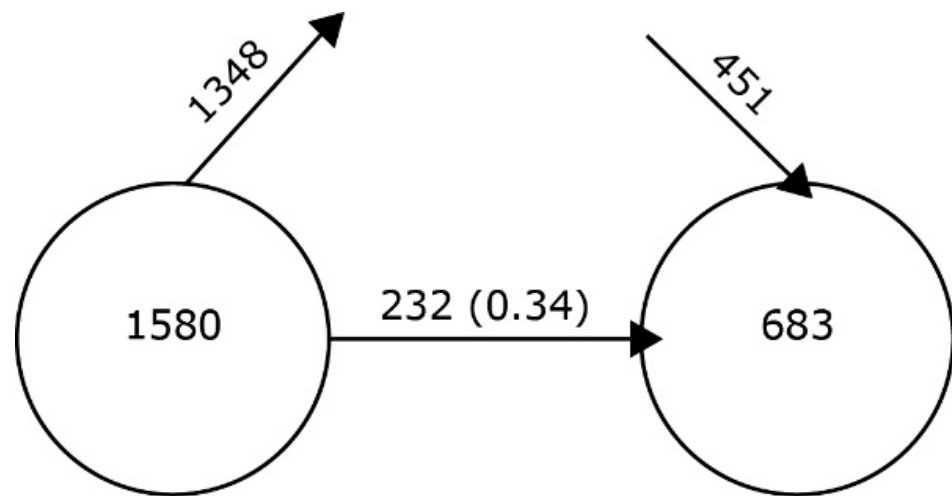


Figure 2. Keyword continuity between contiguous intervals.

Academic performance shows data on bibliometric indicators generated after applying the co-word analysis. In the first period (2020), the topic with the highest bibliometric indicators is “medical-education”. In the second period (2021), the topic with the highest bibliometric indicators is “education”, although its values are relatively low (Table 10).

Table 10. Thematic performance of COVID-19 in the field of Education.

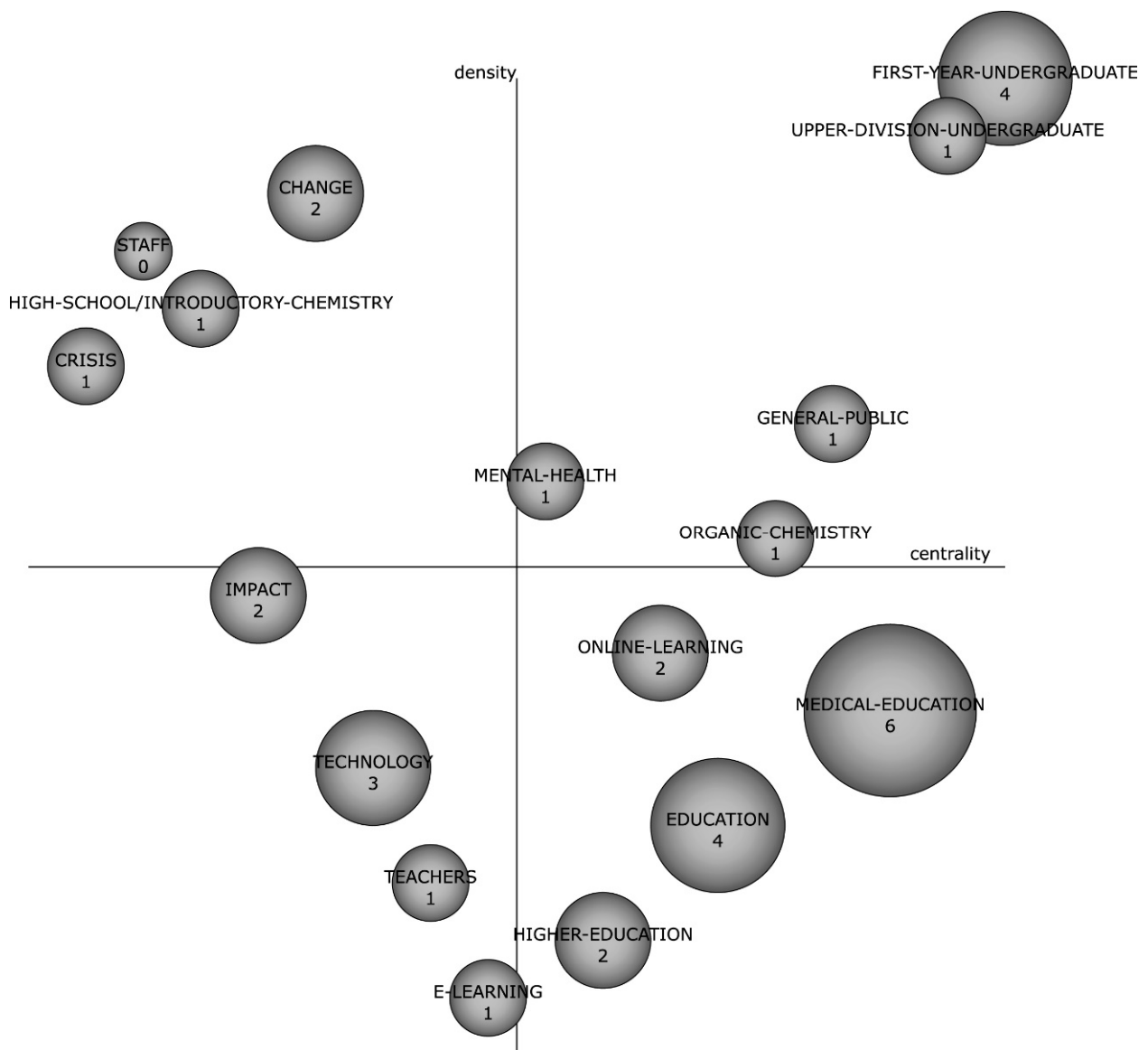
Interval 2020						
Denomination	Works	h-Index	g-Index	hg-Index	q <sup>2</sup> -Index	Citations
First-year-undergraduate	80	4	7	5.29	8.49	72
Upper-division-undergraduate	21	1	1	1	1.41	5
Medical-education	47	6	9	7.35	10.39	109
Technology	14	3	4	3.46	4.24	18
Organic-chemistry	13	1	1	1	1	4
Higher-education	15	2	5	3.16	5.1	27
Education	26	4	6	4.9	4.47	40
Online-learning	13	2	3	2.45	2.83	17
General-public	19	1	4	2	4.36	25
Mental-health	8	1	2	1.41	1.73	5
E-learning	8	1	1	1	1	1
Change	3	2	3	2.45	15.1	20
Teachers	5	1	2	1.41	2.24	7
Staff	3	0	0	0	0	0
High-School/Introductory-chemistry	3	1	1	1	1	1
Crisis	4	1	1	1	1	1
Impact	4	2	2	2	2.45	5
Interval 2021						
Denomination	Works	h-Index	g-Index	hg-Index	q <sup>2</sup> -Index	Citations
Autism-spectrum-disorder	3	1	1	1	3	9
Adoption	4	0	0	0	0	0
Performance	4	1	1	1	1	1
Psychological-impact	4	1	1	1	1	2
Internet	5	1	1	1	1	1
Intervention	5	1	1	1	3	9
Teachers	7	1	1	1	1.41	3
Mental-health	4	1	1	1	1.41	2



Table 10. Cont.

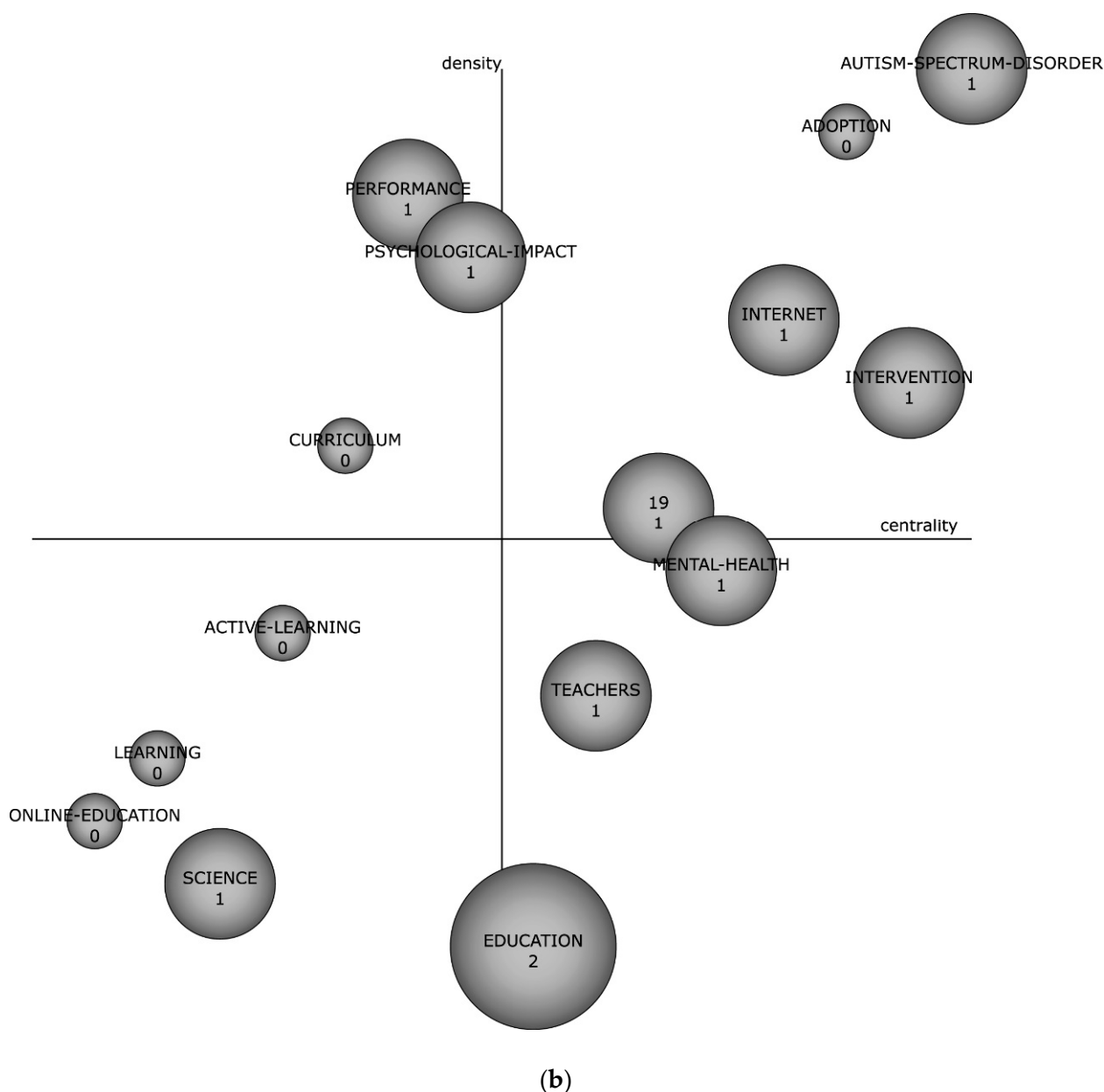
Denomination	Interval 2020					
	Works	h-Index	g-Index	hg-Index	q <sup>2</sup> -Index	Citations
Education	5	2	2	2	4.9	14
Curriculum	3	0	0	0	0	0
Active-learning	2	0	0	0	0	0
Science	2	1	1	1	1.73	3
Online-education	2	0	0	0	0	0
Learning	1	0	0	0	0	0

The strategic diagrams of the themes resulting from the co-word analysis show the level of relevance of each one of them. This strategy diagram is categorized according to the h-index. The Cartesian axis shows the centrality of a theme (represented by the X axis), which indicates the internal relationship existing in each of the themes, and the density (represented by the Y axis), which indicates the external relationship between the various themes resulting from the study (Figure 3).



(a)

Figure 3. Cont.



**Figure 3.** Strategic diagram by h-index of COVID-19 in the field of Education. Note: (a) Interval 2020; (b) Interval 2021.

In the first period (2020), “mental-health” appears as a motor theme related to “depression”, “age”, “parents”; “children”, “stress” and “adolescents”. Other motor themes are “organic-chemistry”, which is related to “chirality/optical-activity”, “conference”, “online-video-library”, “classroom”, “mechanisms-of-reactions”, “smoke/puzzles/games”, “noncovalent-interactions” and “multimedia-based-learning”; “general-public”, which is related to “chemistry”, “problem-solving/decision-making”, “analogies/transfers”, “performance”, “professional-development”, “interdisciplinary/multidisciplinary” and “communication/writing”; “first-year-undergraduate”, which is related to “testing-assessment”, “collaborative/cooperative-learning”, “student-centered-learning”, “internet/web-based-learning”, “distance-learning”, “curriculum”, “laboratory-instruction” and “second-year-undergraduate”; and “upper-division-undergraduate”, which is related to “kinetics”, “nucleic-acid/dna/rna”, “enzymes”, “biochemistry”, “inquiry-based/discovery-learning”, “computer-based-learning”, “physical-chemistry” and “analytical-chemistry”. In this period, motor themes are mainly focused on mental health, both of children and parents, in

the training of chemistry students, in pedagogical methods used by teachers for teaching and learning processes, and in students at various university stages.

In the second period (2021), the motor themes are “autism-spectrum-disorder”, which is related to “stay-at-home”, “young-adults”, “exercise”, “perspectives”, “emotional-wellbeing”, “toddlers”, “adolescent” and “barriers”; “adoption”, which relates to “social-isolation”, “information-technology”, “extension”, “behavior”, “intention”, “higher-education”, “e-learning” and “technology-acceptance-model (TAM)”; “Internet”, which relates to “parental-involvement”, “determinants”, “user-acceptance”, “developmental-disabilities”, “experience”, “perceptions”, “school-closure” and “self-efficacy”; and “intervention”, which is related to “health”, “participation”, “social”, “school”, “engagement”, “parents”, “children-with-asd”, and “psysical-activity”. In this period, studies have focused on children with autism, on the pedagogical models used by teachers for the training of students, the acceptance of technology, the use of the Internet, and interventions aimed at health and wellness. In addition, given their location in the diagram, the themes “active-learning”, “learning”, “online-learning”, and “science” must be taken into account. These will probably be the driving themes in the coming months. In other words, studies on COVID in the educational field will most likely focus on active pedagogical processes and online teaching.

#### 4.3. Thematic Evolution

The evolution of the various themes, divided by time periods, shows the relationship between the themes of different periods. The relationships that can be established are of a conceptual nature (represented with a continuous line), where it is shown that there is a relationship based on themes; and non-conceptual relationships (represented by a dashed line), where it is shown that there is a relationship based on keywords. In addition, the thickness of the line indicates the number of matching themes or keywords. The thicker it is, the greater the number of themes or matching keywords.

According to the data presented in Figure 4, there is no conceptual gap, since there are themes that are repeated in both periods, such as “mental-health” or “teachers”. This does not indicate that it is the only line of research established and relevant in the studies of COVID-19 in the educational field. Other relevant lines of research are observed, such as “online-learning\_education”, “e-learning\_adoption” or “higher-education\_adoption”. In these cases, there is a trend of research oriented to the mental health of students, teachers, online training, adaptation to other pedagogical methods and the adaptation of various university teachings. As can be seen, the number of conceptual connections is greater than the number of non-conceptual connections. This shows that the investigations are interrelated.

#### 4.4. Authors with the Highest Relevance Index

In relation to the authors, Onalu, C.E. and Penuelas, S.A.P. are considered, to date, the main authors in the study of COVID-19 in the educational field. In addition, due to his location in the diagram, Maity, S. should be taken into consideration. He will probably be a relevant author in the near future in this field of study (Figure 5).

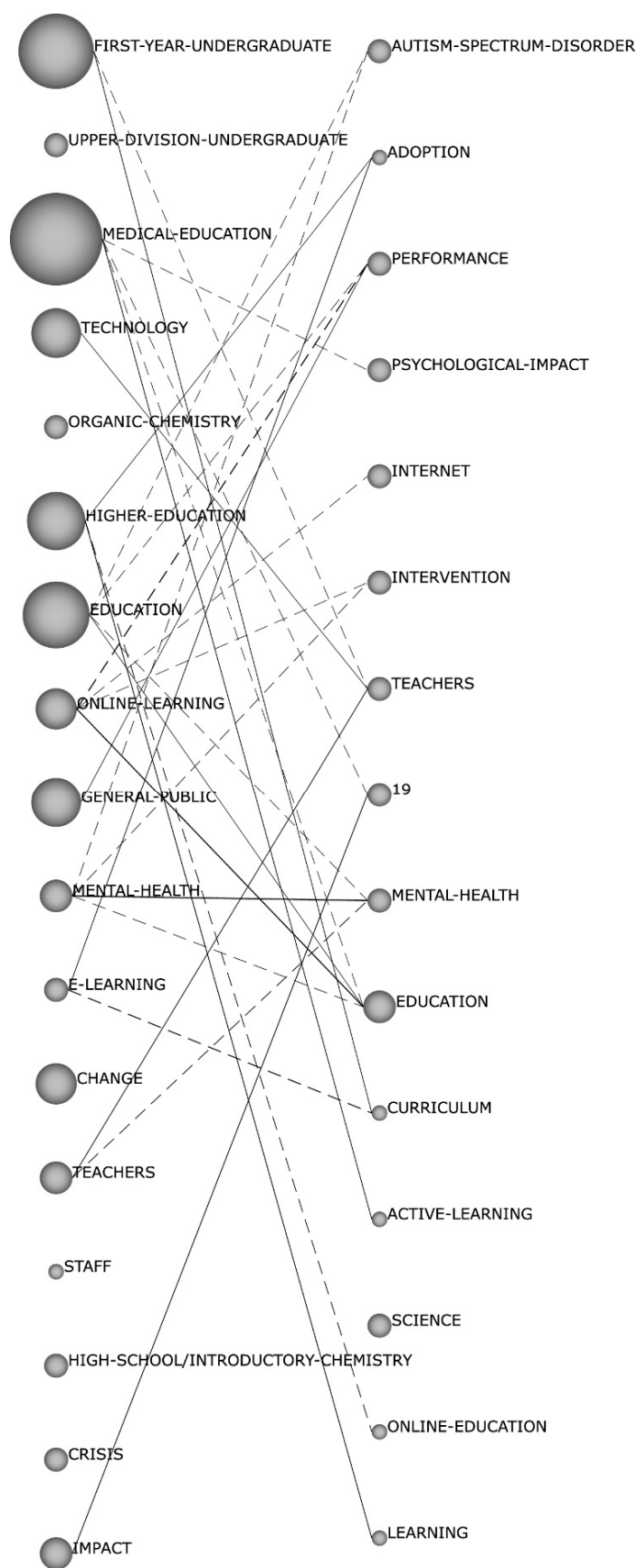


Figure 4. Thematic evolution by h-index of COVID-19 in the field of Education.

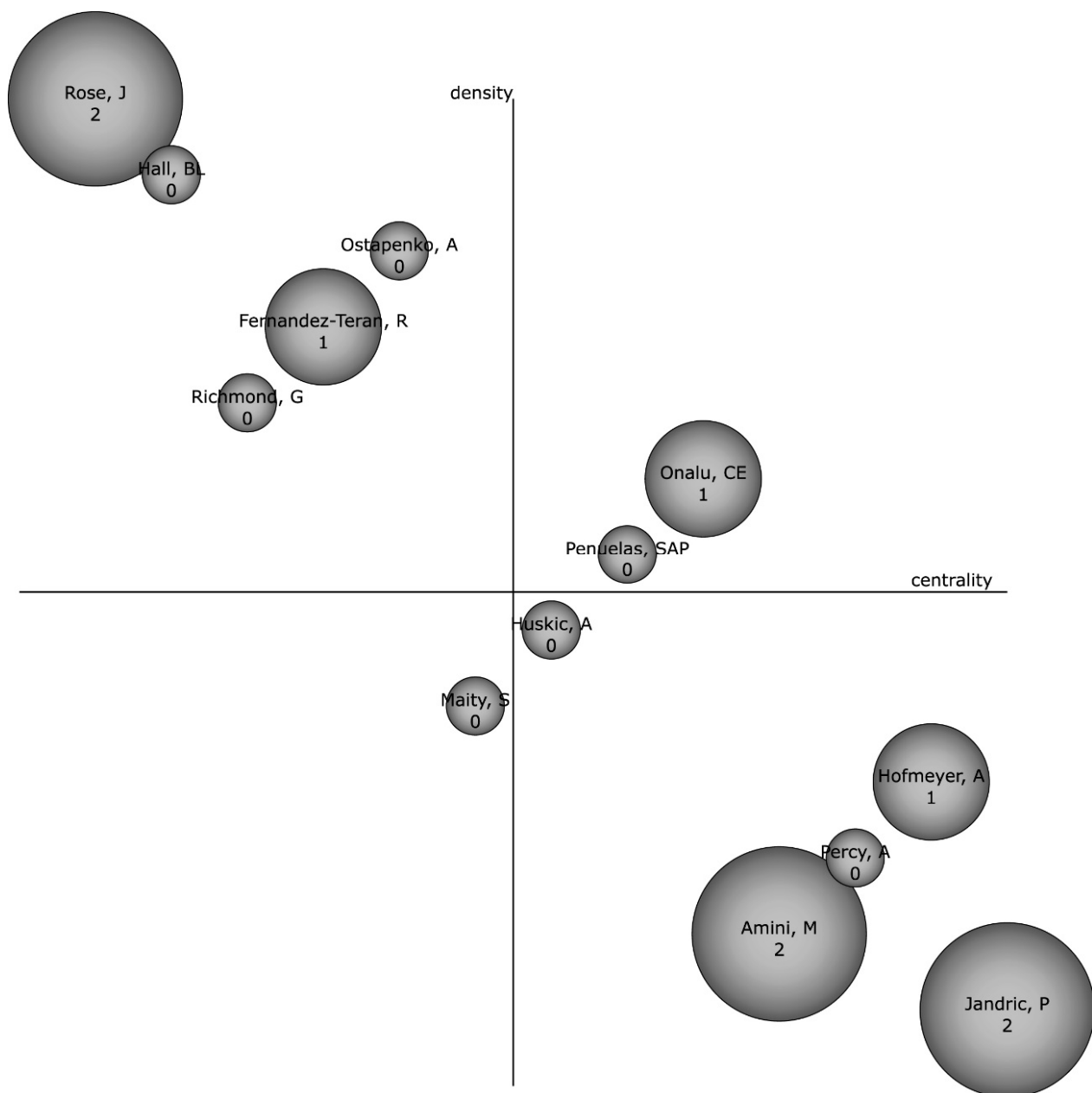


Figure 5. Strategic diagram of authors of all production on COVID-19 in the field of Education.

## 5. Discussion

This study has revealed to the scientific community the state of the art on the research carried out on COVID-19 in the field of knowledge related to education. This has made it possible to establish new knowledge bases for future work, as this work acquires a component of sustenance to start new directions or paths through which this hot topic is currently running.

Regarding the academic performance of the publications on COVID-19 in the educational field, the findings extracted from the study have shown that the works are mainly written in English, as the predominant language. This is somewhat understandable, given that WoS focuses more on the Anglo-Saxon field. In addition, the strong collaboration established by the scientific community to share information makes this the most suitable language for it. The main WoS category where these studies are collected is Education Educational Research, focusing research on the educational field. The main format where the works are presented is the scientific article. This indicates that, although this field of

study is in its initial phase, the investigations are of great relevance and interest. The most prominent institution worldwide is the University of London, which is today a benchmark in this field of study. The most prominent country is the United States, and the journal with the greatest capacity on the subject under analysis is the Journal of Chemical Education.

With respect to the most prolific authors in research on COVID-19 in education, Cleland, J. and Peters, M.A. stand as researchers with the highest volume of production. Onalu, C.E. and Penuelas, S.A.P. are presented as the most relevant due to their strategic position in the diagram, given their values achieved in the analyzed indices. Maity, S., who may become a motor author in the near future, should also be kept in mind as reflected by her position in the diagram. The authors with the highest number of citations are Chick et al. in their article published in 2020 in the Journal of Surgical Education.

Regarding the structural and thematic development of the studies of COVID-19 in the educational field, the percentage of coincidence of keywords is medium-high. This indicates that there are established and coincident lines of research. Of the hottest topics in this field of study, based on their bibliometric values, “medical-education” stands out in 2020 and “education” stands out in 2021. In both delimited temporary spaces, the common denominator is “education”. The fact that in 2020 it will be “medical-education” is mainly due to the high volume produced in the field of medicine. In addition, this field of knowledge has more journals indexed in WoS than other fields of study, such as the Social Sciences.

Regarding the motor themes of 2020, these focus on “mental-health”, “organic-chemistry”, “general-public”, “first-year-undergraduate”, and “upper-division-undergraduate”. In a more concrete way, in this first year of study, motor themes are mainly focused on mental health, both of children and parents, in the training of chemistry students, in pedagogical methods used by teachers for the processes of teaching and learning, and in students at various university stages.

On the other hand, the motor themes of the year 2021 are focused on “autism-spectrum-disorder”, “adoption”, “internet”, and “intervention”. Specifically, research from this current year focuses on children with autism, on the pedagogical models used by teachers for the training of students, the acceptance of technology, the use of the Internet, and on interventions oriented to health and wellness.

One aspect to take into consideration is the presence of topics such as “active-learning”, “learning”, “online-learning”, and “science”. Based on the results obtained, these will probably be the driving themes in the near future. This is understandable due to the organizational and educational management problems that the pandemic is generating, as well as the great concerns that it is causing. Some themes, such as “mental-health” or “teachers”, are repeated in both periods but this does not indicate that they are the only established and relevant line of research in studies on COVID-19 in education. In this sense, other relevant lines of research are observed, such as “online-learning\_education”, “e-learning\_adoption”, or “higher-education\_adoption”. All of this indicates that there is a trend of research oriented to the mental health of students, teachers, online training, adaptation to other pedagogical methods and the adaptation of various university teachings.

## 6. Conclusions

It can be concluded that investigation into COVID-19 in the educational field is in its initial process. Current research is mainly oriented to pedagogical methods, especially e-learning or cooperative learning, although they are not the only trends in this field of study. Research is also focusing on mental health, students with various disorders, and higher education. In the near future, research on COVID-19 in the field of education will probably be oriented to the application of effective pedagogical methods to train students of various educational stages.

A series of limitations were found in this study. One of them is the purification of the reported WoS data, in which repeated documents were found, as well as other studies that were not related to the object of study analyzed, that is, they had been incorrectly



indexed. Another limitation focuses on the criteria established by the authors to present the most relevant results to the scientific community. For this reason, the findings shown here should be interpreted with caution.

For future lines of study, we intend to initiate two paths under the same methodological approach, with bibliometrics as the link between the various investigations. On the one hand, we intended to carry out a systematic analysis of the literature on COVID-19 linked to teaching and learning methodologies. On the other hand, we intended to compare the results achieved here with other impact databases, with Scopus and Pubmed being among the most prominent. In addition, to cover all the effects of COVID-19 in the field of education, the search criteria for the documentary report will be refined and specified in accordance with the evolution of the pandemic and its incidence in the training processes.

## 7. Implications of the Study

This work is an exploratory and novel study that analyzes the publications to date on COVID-19 in the field of education. Therefore, the results obtained lead to a set of implications. In theoretical terms, this manuscript increases the literary volume on the state of the question. Likewise, the results reveal the current trends on which the publications on this pandemic at an educational level are based and run. This has a double interpretation, on the one hand it shows the focuses of interest that researchers have taken and, on the other, it shows where this field of study tends to be oriented. In addition, the various bibliometric indicators presented have made it possible to develop a scientific profile on the state of the art. This can serve as theoretical support so that other researchers interested in this field can access the information highlighted in this work, alluding to institutions, journals and prominent authors. In addition, current and upcoming trends in studies on COVID-19 in education are shown. This can serve as a guide and orientation for the development of future work by any member of the scientific community.

From a practical perspective, this work highlights a set of implications of special interest for professionals, agents, and educational organizations. The main pedagogical foci, approaches and actions that are carried out in various population groups, such as students with special educational needs, are discussed and exposed, as well as what is carried out in educational stages such as higher education. Emerging and active methodologies are mentioned, some of them mediated by technology. In short, findings on new training practices carried out in times of the pandemic are elucidated. This will contribute to the promotion of new innovative actions in learning spaces to satisfy the demands of a learning group increasingly familiar with technology and digital environments.

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