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Current Status of the E-Learning Research Field: Challenges and Opportunities in the E-Learning Research Field During COVID-19 Pandemic

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Abstract—If we stop to think, most of the things we do today require us to be connected. Whether for work, shopping or even to socialize, there is always an alternative for routine tasks to be performed over the Internet. As expected, all this technological evolution even transformed teaching, with the implementation of a methodology called e-learning. This refers to the learning process that takes place over the Internet and with the support of technological tools. Among its advantages we can point out: Substantial savings, Empowerment of human talent, the semiotics of the medium helps the student and teacher in their digital transformation, Triple-A access: (Anywhere, Anyplace and Anytime) and can be adapted to particular needs. However, this educational advance has been accelerated by the emergence of the COVID-19 pandemic. Thus, applying educational innovation, too, has become a necessity to respond to the increased demand for educational services on digital platforms. Therefore, the objective of this research is to carry out an analysis of bibliometric networks to identify the intellectual structure of the e-learning research field during the COVID-19 pandemic, to learn more about its evolution, trends, research areas, authors, among others.

Keywords—Electronic learning, e-learning, knowledge management, information and communication technologies, business intelligence, competitive intelligence, strategic intelligence, COVID-19.

I. INTRODUCTION

Talking about e-learning today can be a concept that is widely heard by everyone but little known from its conceptualization and origin, everyone can talk about it but few understand it and with this they manage to generate confusion in the way of designing and implementing strategies of teaching - Learning in Virtual Environments (VLE) in such a way that the purpose for which it was conceived is not achieved, which is to generate knowledge [1-5].

An e-learning platform, web educational platform or Virtual Teaching and Learning Environment (EVA) is a web application that integrates a set of tools for online teaching-learning, allowing non-face-to-face teaching (e-learning) and / or a mixed teaching (b-learning), where teaching on the Internet is combined with experiences in the face-to-face class [6-11].

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Distance education is not the same as e-learning, but perhaps one concept is the evolution of the other, we understand Distance Education as one that can be provided by call, video, traditional mail or monthly printed or digital deliveries, without having an electronic medium by means of the internet or a computer. Additionally, e-learning refers to online teaching and learning, through the Internet and Information and Communication Technologies (ICT), which tends to expand, reinforce, distribute, develop, evaluate, certify or accelerate the teaching-learning processes [12] with the pedagogical approach that each individual or group of individuals requires [13-22].

Electronic learning or e-learning from its conception and development as a training tool, has a pedagogical and technological duality, which, in both cases, can be a strength or a weakness, since pedagogically it can become a model to follow through instruments designed for teaching-learning (strength) or become a mere repository of content (weakness). Technologically, the entire Teaching-Learning process is sustained [23] in software and web applications, which require technological infrastructure and the support of human capital such as programmers and designers, which without it and without a good analysis of the requirements can be a failure, despite the fact that it is pedagogically well designed [9, 10, 24-28].

The origin of this concept is carried out in the 60's when technology courses began to be developed at the University of Illinois at PLATO (Programmed Logic for Automated Teaching Operations). Considered the first LMS platform (Learning Management System or Learning Management System), which included innovative elements such as chat, forums or email [29-31].

Regarding the characteristics of e-learning, the e-learning Triangle is mentioned [12, 32], that includes technology, content and services. Which support each other to grow one along with the other and thereby generate knowledge in a so-called information and knowledge society [33].

Faced with the SARS COVID 19 health contingency, the virtualization of the contents presents us, then, a new paradigm of ICT-assisted education; aims to facilitate the performance of activities in any academic context, with the help of information devices and taking into account the social relationships between students and the tutor for the generation of knowledge [6, 18, 34].

This vision requires means to support shared experiences, taking advantage of the communication and computing capabilities of connected devices, relying on direct communications or by taking advantage of available technological tools [35, 36].

This presents the educator with a challenge and a change in the way they do things. Among these challenges is developing a comprehensive change in relation to teaching methods, with a greater emphasis on technological resources where educational and government organizations must be involved to transform the homes of teachers and students into makeshift classrooms [26, 37-40].

The following research shows an analysis of bibliometric networks to identify the intellectual structure of the e-learning research field during the COVID-19 pandemic [41-46].

II. Methodology and Dataset

Bibliometrics is defined as the set of methods and tools for evaluating and analyzing the evolution of the scientific and academic publications and their citations. Its aim is to analyze its impact and evaluate how these contribute to the progress of science in the main subject areas. In addition, bibliometrics allows the measurement of scientific and academic productive quality of the research field.

In the bibliometric techniques categories, performance analysis and co-occurrence map can be highlighted. The performance analysis focuses on the impact of publications based on its production and citation evolution, while co-occurrences map represents how the main publications, research themes or authors are interrelated. This last category is widely used to understand, discover and visualize relationships that are difficult to see or that are hidden between core themes for the development of the field [47-55].

Based on a first review of the state of the art, scientific and academic production, it was decided to take as source *Scopus*. In this respect, the raw data has been retrieved from the using the following advanced query: *TITLE-ABS-KEY ("e-learning" OR "electronic learning") AND TITLE-ABS-KEY("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") AND (LIMIT-TO(PUBYEAR, 2020)) AND (LIMIT-TO(DOCTYPE, "ar") OR LIMIT-TO(DOCTYPE, "cp") OR*

LIMIT-TO(DOCTYPE, "re")). Finally, it is important to highlight that this search was re-fined, limiting the results to articles, proceedings and reviews in 2020 and published in English.

This search retrieved a total of 251 publications in 2020 (166 Open Access and 85 Other). Once this was done, all publication abstracts were downloaded and reviewed.

III. PERFORMANCE ANALYSIS OF COVID-19 AND E-LEARNING RESEARCH FIELD

In order to identify the intellectual structure of the e-learning research field during the COVID-19 pandemic, we evaluated its performance by carrying out an analysis of bibliometric networks of the following bibliometric indicators: Most productive authors, Organizations that promote the e-learning research during the COVID-19 pandemic, geographic distribution data from publications, databases or sources with more research and areas where research on these two concepts is most promoted.

The first indicator that was analyzed is most productive authors, where we obtained a list of authors, which are mentioned to the most outstanding in Table 1. Attias, M., Gamhewage, G., George, R., Ndiaye, N., Piroux, C. and Utunen, H. are the most productive, they already have three publications each, then 34 authors with two publications and 119 authors with one publication each were identified. For a total of 251 publications with 159 authors.

TABLE I. MOST PRODUCTIVE AUTHORS IN 2020

Publications	Author(s)
3	Attias, M.; Gamhewage, G.; George, R.; Ndiaye, N.; Piroux, C.; Utunen, H.
2	Adnan, E.; Adri, M.; Aisyah, E.N.; Anisah; Ashokka, B. Darni; Hapidin; Irsyad; Khaerudin; Kristanto, A.; Kuswandi, D.; Listyasari, W.D.; Muhardi; Nasrun; Nuranjani; Nurmaniah; Obeidat, N.; Oktaviani, H.I.; Olmos-Gómez, M.D.C.; Phansopkar, P.; Purnamawati, S.N.; Rahmulyani; Rusdinal; Santoso, Y.; Sri Martini Meilanie, R.; Sriadhi; Surahman, E.; Susarno, L.H.; Sy, A.Syafril; Wahyuningtyas, N.; Wardani, R.; Wedi, A. Zainul, R.

According to the results and expressed in Table II. Regarding the Bibliography Performance Analysis on its second indicator, the Organizations that most participated in e-learning research during the COVID-19 pandemic are *Harvard Medical School* with 6 publications, *The University of Hong Kong* with 5 publications and *Organization Mondiale de la Santé, University of Granada* and *Datta Meghe Institute of Medical Sciences Deemed to be University* with 4 publications each.

TABLE II. MOST PRODUCTIVE ORGANIZATIONS IN 2020

Publications	Organization(s)
6	Harvard Medical School
5	The University of Hong Kong
4	Organisation Mondiale de la Santé; Universidad de Granada; Datta Meghe Institute of Medical Sciences Deemed to be University
3	Universidad de Murcia; Boston Medical Center; Harvard University; The University of British Columbia; National University of Singapore; University of Arkansas for Medical Sciences; Al Qassim University; Alma Mater Studiorum Università di Bologna; National and Kapodistrian University of Athens; Jordan University of Science and Technology National University Health System
2	Stmik Hang Tuah Pekanbaru; Inserm; Universiti Sains Malaysia; Sorbonne Universite; Universiti Kebangsaan Malaysia; Albert Einstein College of Medicine of Yeshiva University; Universiti Utara Malaysia; Universidad de la Laguna; Tel Aviv University; Weill Cornell Medicine; CNRS Centre

Publications	Organization(s)
	National de la Recherche Scientifique; Università degli Studi di Catania; University of KwaZulu-Natal; Universidade Federal da Paraiba; Medizinische Universitat Wien; King's College London; Università degli Studi di Messina; Università degli Studi di Torino; Stanford University; The University of Texas at Austin; Università degli Studi di Brescia; University of Pittsburgh; Hôpital Universitaire Pitié Salpêtrière; VMMC & Safdarjang Hospital; University of Toronto; Università degli Studi di Napoli Federico II; Leicester Medical School; Rush University Medical Center; Monash University; Queen Mary University of London; University of Strathclyde; University of Wisconsin School of Medicine and Public Health; Huazhong University of Science and Technology; Yong Loo Lin School of Medicine; Universidad Complutense de Madrid; University of California, Los Angeles; King Khalid University; Universidad Politécnica de Madrid; Beth Israel Deaconess Medical Center; Università degli Studi di Milano; Children's Hospital Boston; King Faisal University; Università Cattolica del Sacro Cuore, Rome; NYU Langone Health; Università degli Studi di Roma La Sapienza; Yarmouk University; University of Lahore; Sultan Qaboos University; Fondazione Policlinico Universitario Agostino Gemelli IRCCS Università Cattolica del Sacro Cuore; Universitas Negeri Yogyakarta; Duke-NUS Medical School Singapore; Bina Nusantara University; International University of La Rioja; Imam Abdulrahman Bin Faisal university; Taylor's University Malaysia; Universitas Negeri Malang; Universitas Negeri Surabaya; Universitas Negeri Jakarta

A third indicator that was considered to identify the intellectual structure of the e-learning research field during the COVID-19 pandemic is the geographical distribution of the publications, in order to know which countries carry out more research on this topic. The data obtained from the analysis are shown in Table III. Highlighting United States with 39 publications, China with 36 publications, United Kingdom with 26 publications, India with 24 publications and Spain with 17 publications, among others.

TABLE III. MOST PRODUCTIVE COUNTRIES IN 2020

Publications	Country(ies)
39	United States
36	China
26	United Kingdom
24	India
17	Spain
14	Italy
13	Indonesia; Malaysia
12	Pakistan; Saudi Arabia
9	Australia
8	Canada
7	Germany; Switzerland
5	Brazil; Hong Kong; Oman; Poland; Russia; Singapore; South Africa
4	Austria; Ireland; Israel; Jordan; Nepal; Netherlands; Portugal
3	Denmark; Egypt; France; Greece; Philippines; Turkey; United Arab Emirates; Viet Nam

Another indicator is to know the Database or sources that handle more research on e-learning during the COVID-19 pandemic, according to the data obtained and expressed in Table IV, we find that the most prominent *Database is International Journal of Advanced Trends in Computer Science and Engineering* with 8 publications, followed by *Lecture Notes in Computer Science*

Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics with 7 publications each.

TABLE IV. MOST PRODUCTIVE SOURCES IN 2020

Publications	Source(s)
8	International Journal of Advanced Trends in Computer Science and Engineering
7	Lecture Notes in Computer Science Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics
5	International Journal of Environmental Research and Public Health; International Journal of Higher Education; Journal of Medical Internet Research; Journal of Physics Conference Series
4	International Journal of Research in Pharmaceutical; Sciences; Journal of Chemical Education; Pediatrics; Social Work Education
3	ACM International Conference Proceeding Series; Annals of Medicine and Surgery; Bangladesh Journal of Medical Science; Education Sciences; Journal of Critical Reviews; Journal of The College of Physicians and Surgeons Pakistan; Pakistan Journal of Medical Sciences; Studies in Health Technology and Informatics; Sustainability Switzerland

The last indicator we consider is to know the research areas where e-learning research is focused during the COVID-19 pandemic, the results of which are shown in Table V, the most prominent area is Medicine with 109 publications, then Social Sciences with 75 and Computer Science with 67 publications.

TABLE V. MOST PRODUCTIVE SUBJECTS IN 2020

Publications	Subject(s)
109	Medicine
75	Social Sciences
67	Computer Science
26	Engineering
15	Decision Sciences; Psychology
12	Mathematics
10	Biochemistry, Genetics and Molecular Biology; Environmental Science; Pharmacology, Toxicology and Pharmaceutics
8	Physics and Astronomy;
6	Arts and Humanities; Business, Management and Accounting; Health Professions
5	Economics, Econometrics and Finance; Energy; Neuroscience
4	Chemistry; Dentistry;
3	Chemical Engineering; Earth and Planetary Sciences; Materials Science; Nursing
2	Immunology and Microbiology; Multidisciplinary

On the other hand, the main sponsors are *European Commission, National Natural Science Foundation of China, Novartis* and *Shire.*

Finally, in order to effectively analyze to identify the intellectual structure of the e-learning research field during the COVID-19 pandemic, the following section determines the relationship between the main research topics developed in recent years using *VOSviewer*.

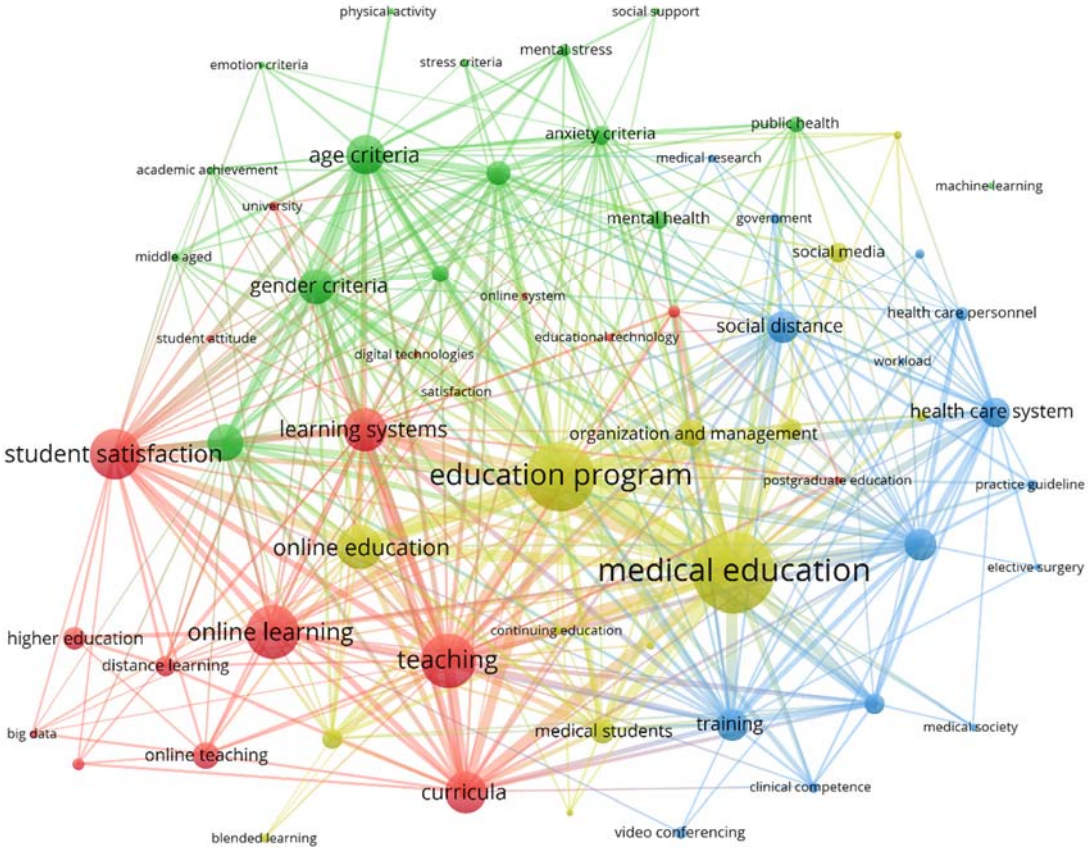
IV. SCIENCE MAPPING ANALYSIS

The co-occurrence map tool enables the analysis of scientific and academic papers, and can be used to visualize and evaluate

complex research topics.

In Figure 1, the co-occurrence map of the intellectual structure of e-learning research during the COVID-19 pandemic is shown. It is based on information retrieved from *Scopus*, covering publications in 2020.

When carrying out the bibliometric analysis, four clusters were identified, which were named and have the following characteristics: Distance Learning (17 items, 306 occurrences), Effects of Distance Education (16 items, 206 occurrences), Telemedicine (15 items, 185 occurrences) and Virtual Training (15 items, 291 occurrences).



Cluster	Themes (the most productive)	Weight	Total link strength	Occurrences
Distance Learning	teaching	54	266	44
	learning systems	55	212	34
	curricula	51	205	33
	student satisfaction	46	183	41
	online learning	51	162	43
	clinical practice	35	70	9
	distance learning	25	60	15
	online teaching	28	59	21
Effects of Distance Education	surveys and questionnaires	51	165	29
	age criteria	50	208	31
	gender criteria	50	214	28
	anxiety criteria	45	116	14
	psychological criteria	45	167	19
	mental health	42	89	14
	cross-sectional studies	40	98	13

	mental stress	40	75	9
Telemedicine	training	48	180	25
	telemedicine	44	172	25
	social distance	53	152	25
	health care system	45	147	23
	internship and residency education	41	125	15
	health care personnel	35	76	10
	clinical competence	30	61	8
	practice guideline	30	55	8
Virtual Training	medical education	58	414	68
	education program	58	390	57
	online education	56	217	36
	organization and management	48	150	20
	medical students	44	141	19
	computer-assisted instruction	33	95	15
	social media	43	85	15
	internet	35	75	16

Figure 1. Field network visualization map to identify the intellectual structure of e-learning research during the COVID-19 pandemic and the most relevant research topics.

The First Cluster is the most prominent, it was identified with the red color called Distance Learning and is mainly composed of the following lines of research: big data, clinical practice, curricula, digital technologies, distance learning, education computing, educational technology, higher education, learning systems, online learning, online system, online teaching, postgraduate education, student attitude, student satisfaction, teaching and university.

We identify the Second Cluster with the color green, Effects of Distance Education and is composed of the following lines of research: academic achievement, age criteria, anxiety criteria, cross-sectional studies, emotion criteria, gender criteria, machine learning, mental health, mental stress, middle aged, physical activity, psychological criteria, public health, social support, stress criteria and surveys and questionnaires.

Telemedicine (blue color) is the third group and the main topics within its area: clinical competence, elective surgery, government, health care personnel, health care system, internship and residency education, interpersonal communication, medical research, medical society, practice guideline, social distance, telemedicine, training, video conferencing and workload.

Finally, the fourth Yellow Cluster, Virtual Training and is made up of the following lines of research: blended learning, computer-assisted instruction, continuing education, education program, health personnel attitude, internet, medical education, medical students, mobile application, online education, organization and management, satisfaction, social media, telecommunication and undergraduate student.

Therefore, and taking into consideration the clusters, four baseline research lines are identified. These lines of research are related to distance education, the effects of online education, medical studies and preparation to combat COVID-19 and training or preparation using virtual platforms. Finally, these clusters establish the main research framework on the intellectual structure of the field of e-learning research during the COVID-19 pandemic.

V. Conclusions

The COVID-19 pandemic has created the largest change to education systems in history, affecting nearly 1.6 billion students in more than 190 countries and every continent. Closures of schools and other learning spaces have impacted 94 percent of the world's student population, up to 99 percent in low- and lower-middle-income countries.

The economic crisis generated by the pandemic, also affected existing education by reducing opportunities for many of the children, youth, and adults: especially those who live in poor or rural areas, girls, refugees, people with disabilities and people displaced by the force. Learning losses also threaten to spread beyond this generation and erase decades of progress. Some 23.8

million children and young people may be left out or not have access to school next year due to the economic impact of the pandemic alone.

On the other hand, this crisis has stimulated innovation within the education sector. We have seen innovative approaches in support of education and training continuity: from radio, television and the internet. This distance learning solution has been developed thanks to rapid responses from governments and partners around the world supporting the continuity of education, and recognizing the essential role of teachers who are key to the implementation of these strategies.

According to the analysis of bibliometric networks to identify the intellectual structure of the e-learning research field during the COVID-19 pandemic that we carried out, we identified four clusters that were named as follows and have the following characteristics: Distance Learning (17 items, 306 occurrences), Effects of Distance Education (16 items, 206 occurrences), Telemedicine (15 items, 185 occurrences) and Virtual Training (15 items, 291 occurrences).

The size of the literature related to e-learning during the COVID-19 pandemic has a considerable increase as of 2019, which makes sense, since this is when this disease begins, but when analyzing the different concepts and cluster, we identify that most of the research is oriented to distance learning, in the educational and training sense, especially in articles oriented to research on COVID-19 for its treatment and management, focused on medical or health personnel.

Another orientation of the investigations that jump when analyzing the clusters, are those focused on the effects caused by distance education, which represents the second most important cluster, specifically on issues of anxiety, psychological criteria, mental health and mental stress, all effects from e-learning during the COVID-19 pandemic.

The coronavirus pandemic has put the preparation of schools to the test to face a crisis that requires online and remote measures. Many of us were not prepared, but it is important to face the conditions of this new reality. Undoubtedly, online education is one of the most important challenges, but the sector must also ensure equal opportunities for vulnerable students and focus content on the development of transversal and socio-emotional skills. While it is the quickest response, it can also become an element of discrimination, taking into account the digital divide and the inequalities that students face.

Finally, as lines of research for future work, an individual analysis of e-learning and the digital divide could be carried out taking into account a longer period of time and enriching the consultation with its application in different economic fields.

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