# Two Decades of Research in e-Learning: A Deep Bibliometric Analysis

Sónia Rolland Sobral

*Abstract*—E-learning is the electronic version of distance learning: a planned teaching that presupposes a physical separation between the teacher and the student. The distance is either geographic or temporal, and communication can be asynchronous or synchronous, respectively. E-learning has been a target of high-quality research for the last two decades. The purpose of this paper is to analyze the scientific production on e-learning in journals indexed on Elsevier's Scopus. The sample was composed by 25330 articles from 2000 to 2019. The results obtained by bibliometric analysis showed that rates publication continue to increase. A report was made on the journals, languages, authors, keywords, organizations and countries that publish in the field. This analysis was done for all articles as well as for the most cited articles. The bibliometric analysis was done for a total of 20 years, as well as for four 5-year periods. This article provides information from the past, but mostly clues about research on e-learning in the future.

*Index Terms*—Distance learning, e-learning, bibliometrics, data analysis.

## I. INTRODUCTION

Distance learning is planned teaching that presupposes a physical separation between the teacher and the student. The distance is either geographic - so that the two agents of the teaching-learning process are separated in space - or temporal, and communication can be asynchronous or synchronous, respectively. E-learning is the Internet version as a mean of communication, assuming computer supported collaborative learning (CSCL). E-learning appears at the end of the last century with the growth of the Internet. In 1989, the University of Phoenix became one of the first schools to offer courses on the Internet and introduced FlexNet, which combines online and classroom learning [1]. The concern was whether e-learning was going to replace classrooms [2] or how it would be accepted in in high-tech companies [3]. E-learning was defined as technology-based learning in which learning materials are delivered electronically to remote learners via a computer network [2], a system that includes instruction delivered via all electronic media including the Internet, intranets, extranets, satellite broadcasts, audio/video tape, interactive TV, and CD-ROM [4] or a web-based system that makes information or knowledge available to users or learners and disregards time restrictions or geographic proximity [5]. At the beginning of the century, there were problems with the adoption of distance learning mediated by the Internet, such as technical difficulties, lack of pedagogical models, pre-conceived ideas

regarding the old distance learning or even the expectations generated around e-learning. Above all, there were fears: that the teacher's working time would be much longer and even questions related to the ownership of documents and the possibility of copying them. If e-learning is the electronic version of learning, b-learning is blended or mixed [6], m-learning is mobile [7], u-learning is ubiquitous [8], x-learning is the version that includes all the others [9].

Higher education institutions were the privileged places for adopting e-learning. The concern was to measure and test pedagogical and technical methods [10]-[12]. Quickly, e-learning started to be used in secondary schools and the concerns were similar [13]. There was great enthusiasm for the possibilities of distance learning in medical schools [14]. The e-learning platforms, or Learning Management System (LMS), are electronic tools that integrate a large number of interesting applications from the teaching-learning point of view by bringing this grouping quite advantages. Applications have two operating dimensions: asynchronous, not assuming a temporal simultaneity between them (for example, use of electronic mail and discussion forums) and synchronous, in which the activities of the participants take place at the same time and examples of which are online conversations, chats, and systems computer video conference. The discussion was much about technology and the use of learning management systems, like Blackboard [15], MOODLE [16], moving from Blackboard to MOODLE [17] or from MOODLE to Facebook [18].

Some literature reviews were made about some aspects of e-learning: Predictors of E-learning satisfaction in teaching and learning for school teachers [19], the nursing educator's role in e-learning [20] and about the factors influencing e-learning and blended learning in relation to learning outcome, student satisfaction and engagement [21]. Meta-analyzes on the comparison of e-learning with the classroom [22] and the media and pedagogy in undergraduate distance education [23] were also published. Bibliometric analyzes were carried out: 689 journal articles and proceedings retrieved from the Science Citation Index from 2000 to 2008 [24] and 324 articles on workplace e-learning published in academic journals and conference proceedings from 2000 to 2012 [25]. Two decades of quality research in e-learning are celebrated and a bibliometric analysis is necessary.

Bibliometric analysis [26] is the quantitative study of bibliographic material: it provides a general picture of a research field that can be classified by papers, authors and journals. Bibliometric methods employ a quantitative approach for the description, evaluation and monitoring of published research. These methods have the potential to

introduce a systematic, transparent and reproducible review process and thus improve the quality of reviews [27]. Bibliometric analysis provides objective criteria that can assess the research development in a field and act as a valuable tool for measuring scholarship quality and productivity [28]. Bibliometric methods offer systematization and replication processes that can improve understanding of the dissemination of knowledge in a field and can highlight gaps and opportunities that contribute to the advancement of the discipline [29].

The aim of this study is to conduct a literature review of the e-learning research using bibliometric methods. The next section presents the research questions. The methodology is defined in the third section. Then the results are presented and at the end they are discussed and a conclusion is made.

## II. THE RESEARCH QUESTIONS

The questions, along with the purpose of the review, the intended deliverables and the intended audience, determine how the data are identified, collected and presented [30]. There are several questions that we want to answer in this paper:

- How has the evolution of the publication of articles in quality journals related to e-learning been?
- What are the characteristics of journals where there is a greater number of publications related to the subject?
- What is the approach to e-learning?
- Who publishes on the subject? Where do researchers who are interested in e-learning work? What country do they work in? What are the languages in which most of these articles are published?
- What are the most cited articles?
- What is the purpose of the most cited articles? What is the perspective with which the articles approach the theme?
- Who writes the most cited articles? And where do they work?

It is intended that all these questions are answered for the total of 20 years, either for four groups of five years periods.

## III. METHODOLOGY

The term bibliometrics was first used in 1969 by Alan Pritchard [31], hoping that the term would be explicitly used in all studies which seeked to quantify the processes of written communication and that it would quickly gain acceptance in the field of information science. Moed [32] mentioned the potential of this type of study that reveals the enormous potential of quantitative, bibliometric analyses of the scholarly literature for a deeper understanding of scholarly activity and performance, and highlighted their policy relevance. In scientific research, it is important to get a wider perspective of research already being conducted concerning a relevant subject matter [33] and a bibliometric analysis profile on the research trajectory and dynamics of the research activities across the globe [34]. This is a bibliometric study that systematically analyses the literature using articles indexed at Elsevier's Scopus (Scopus) database. This study conducts a bibliometric analysis of international

journal papers that we expect provider a useful reference for future research.

The search strategy was:

TITLE-ABS-KEY ("distance learning" OR "e-Learning")
DocType: Article OR Review
PUBYEAR > 1999 AND PUBYEAR < 2020

## IV. RESULTS

A set of 25330 published papers were collected from SCOPUS. There is a clear annual growth. This growth is even more visible if five-year periods are considered: there are 2377 articles in the period 2000-2004 (average 475.4), 4860 2005-2009 (972), 7437 2010-2014 (1487.4) and 10656 articles for 2015-2019 (2131.2) (Fig. 1. Annual evolution published papers and five-year period average). 23793 are article type and 1537 are review type (94% and 6%, respectively) as shown in the table (Table I Articles by type and 5-year period).
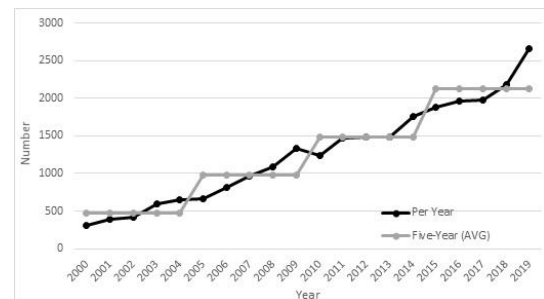


Fig. 1. Annual evolution published papers and five-year period average.

TABLE I: ARTICLES BY TYPE AND 5-YEAR PERIOD

| Type | 2000-2004 | 2005-2009 | 2010-2014 | 2015-2019 | Total |
|---|---|---|---|---|---|
| Article | 2069 | 4358 | 7110 | 10256 | 23793 |
| Review | 308 | 502 | 327 | 400 | 1537 |

Papers were published in 413 international journals, 11 published of which two hundred or more articles (Table II Journals information's.). Four of those 11 journals were published in the United Kingdom (UK) and two in Germany. Computers in Human Behavior has the best SJR 2018 rank (SCImago Journal Rank measures weighted citations received by the serial [35]) and Lecture Notes In Computer Science the best h-index (324). The most common WoS subjects of those 11 journals are Social Sciences and Computer Science. The most common WoS categories of those 11 journals are Social Sciences (Education) and Social Sciences (E-Learning). Most of those journals are ranked in the first quartile in Journal Citation Reports. Computers And Education published 713 articles (0.28) and International Journal of Emerging Technologies in Learning published 468 (0.185).

In the period 2000-2004 most articles were published in the Lecture Notes In Computer Science Including Subseries Lecture, which is not the case in the following 3 periods. On the contrary: the newspaper Computers In Human Behavior since 2005-2009 has doubled the publication on e-learning every 5 years (Table III Journal publication by 5-year period.): P1: 2000-2004; P2: 2005-2009; P3: 2010-20 14; P4: 2015-2019.

TABLE II: JOURNALS INFORMATION'S

| Journal | Subject Area and Category | H | Q |
|---|---|---|---|
| Computers And Education | Computer Science (Computer Science (miscellaneous)); Social Sciences (Education; E-learning) | 149 | Q1 |
| International Journal Of Emerging Technologies In Learning | Engineering (Engineering (miscellaneous)); Social Sciences (Education; E-learning) | 15 | Q2; Q2; Q3 |
| Computers In Human Behavior | Arts and Humanities (Arts and Humanities (miscellaneous)); Computer Science (Human-Computer Interaction); Psychology (Psychology (miscellaneous)) | 137 | Q1 |
| Turkish Online Journal Of Distance Education | Social Sciences (Education) | 17 | Q3 |
| British Journal Of Educational Technology | Social Sciences (Education; E-learning) | 81 | Q1 |
| International Review Of Research In Open And Distance Learning | Social Sciences (Education; E-learning) | 56 | Q1 |
| Distance Education | Social Sciences (Education; E-learning) | 40 | Q1 |
| Lecture Notes In Computer Science Including Subseries Lecture Notes In Artificial Intelligence And Lecture Notes In Bioinformatics | Computer Science (Computer Science (miscellaneous)); Mathematics (Theoretical Computer Science) | 324 | Q2; Q3 |
| Educational Technology And Society | Engineering (Engineering (miscellaneous)); Social Sciences (Education; E-learning; Sociology and Political Science) | 73 | Q1 |
| Journal Of E Learning And Knowledge Society | Computer Science (Computer Science Applications); Social Sciences (Education; E-learning) | 12 | Q3 |
| Computer Applications In Engineering Education | Computer Science (Computer Science (miscellaneous)); Engineering (Engineering (miscellaneous)); Social Sciences (Education) | 24 | Q2; Q1; Q2 |

TABLE III: JOURNAL PUBLICATION BY 5-YEAR PERIOD

| Journal | P1 | P2 | P3 | P4 |
|---|---|---|---|---|
| Computers And Education | 22 | 177 | 231 | 283 |
| International Journal Of Emerging Technologies In Learning | | 36 | 119 | 313 |
| Computers In Human Behavior | | 51 | 101 | 247 |
| Turkish Online Journal Of Distance Education | 3 | 106 | 149 | 89 |
| British Journal Of Educational Technology | 15 | 76 | 86 | 163 |
| International Review Of Research In Open And Distance Learning | 23 | 63 | 111 | 112 |
| Distance Education | 7 | 58 | 105 | 133 |
| Lecture Notes In Computer Science Including Subseries Lecture Notes In Artificial Intelligence And Lecture Notes In Bioinformatics | 25 1 | 2 | 36 | 6 |
| Educational Technology And Society | 62 | 83 | 62 | 33 |
| Journal Of E Learning And Knowledge Society | | 11 | 51 | 166 |
| Computer Applications In Engineering Education | 2 | 12 | 61 | 128 |

For all publications, the most common WoS subjects are social sciences and computer sciences (0.51 and 0.41), but there are publications in 27 subjects. In the following table (Table IV Subjects, more than 500 articles, 5-year period) we list the subjects with more than 500 articles. There has been a huge increase in the area of medicine and the arts and humanities, in this case the event is especially visible in the last decade.

E-learning, Education, Teaching, Human, Students, Article, Humans, Learning Systems, Distance Learning, Internet and Distance Education are the most common keywords (Fig. 2 Most common keywords.).

TABLE IV: SUBJECTS, MORE THAN 500 ARTICLES, 5-YEAR PERIOD

| Subject Area | P1 | P2 | P3 | P4 | |
|---|---|---|---|---|---|
| Social Sciences | 1214 | 2688 | 4061 | 5008 | |
| Computer Science | 809 | 1762 | 3003 | 4842 | |
| Engineering | 404 | 870 | 1437 | 3187 | |
| Medicine | 268 | 531 | 767 | 1062 | |
| Business, Management and Accounting | | 341 | 415 | 500 | 610 |
| Mathematics | | 296 | 153 | 413 | 725 |
| Arts and Humanities | | 58 | 172 | 413 | 650 |
| Psychology | | 54 | 194 | 259 | 457 |
| Nursing | | 81 | 152 | 225 | 218 |
| Decision Sciences | | 36 | 169 | 180 | 230 |
| Materials Science | | 21 | 79 | 72 | 375 |



Fig. 2. Most common keywords.

If World Wide Web and Websites are in the 2000-2004 period top 20 keywords list, they cease to be in the following periods. Web Services, Educational Measurement and Blended Learning appear in 2005-2009; Surveys, Learning Algorithms and Machine Learning appear in 2010-2014. In 2015-2019, the keywords Human Experiment are new, as well as Forecasting and Major Clinical Study (Table V 20 most common keywords, 5-year period.)

26% of the articles have only one author and 24% have two co-authors (Fig. 3. Number of authors). We found 48545 authors. There are 16 authors with twenty or more articles, and four with over 30: Hwang, G.J. (36), Tsai, C.W. (35), Richardson, J.T.E. (32) and Shih, T.K. (32) (Table VI Authors with 20 or more articles.). Taiwan is the country affiliation from seven of these 16 authors.
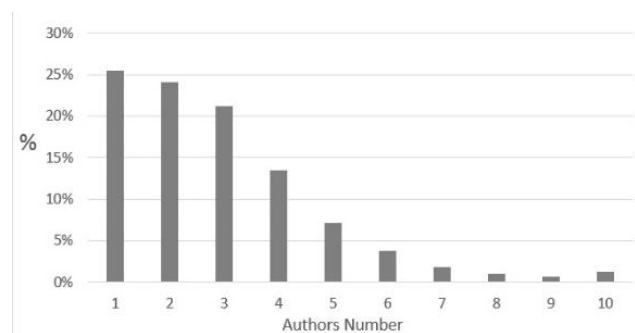


Fig. 3. Number of authors.

Considering country affiliation, the papers are from 168 countries. There are 14 countries that are responsible for at least 500 papers. These 14 countries represent 75% of the total papers (Fig. 4 Countries with at least 500 papers.).

TABLE V: 20 MOST COMMON KEYWORDS, 5-YEAR PERIOD

| # | 2000-2004 | 2005-2009 | 2010-2014 | 2015-2019 |
|---|-----------|-----------|-----------|-----------|
| 1 | E-learning | E-learning | E-learning | E-learning |
| 2 | Distance Learning | Education | Teaching | Education |
| 3 | Internet | Internet | Education | Teaching |
| 4 | Distance Education | Teaching | Human | Human |
| 5 | Education | Learning Systems | Students | Students |
| 6 | Teaching | Distance Education | Article | Learning Systems |
| 7 | Article | Article | Humans | Learning |
| 8 | Human | Distance Learning | Distance Learning | Humans |
| 9 | Computer Aided Instruction | Human | Online Learning | Computer Aided Instruction |
| 10 | Humans | Humans | Distance Education | Article |
| 11 | Learning | Students | Learning Systems | Online Learning |
| 12 | Students | Learning | Internet | Female |
| 13 | Education, Distance | Medical Education | Learning | Distance Education |
| 14 | Learning Systems | Education, Distance | Computer Aided Instruction | Male |
| 15 | World Wide Web | Online Systems | Medical Education | Procedures |
| 16 | Medical Education | Computer Aided Instruction | Methodology | Learning Algorithms |
| 17 | Methodology | Methodology | Female | Distance Learning |
| 18 | Websites | Curricula | Male | Adult |
| 19 | Information Technology | Multimedia Systems | Curricula | Medical Education |
| 20 | Multimedia Systems | Computer-Assisted Instruction | Higher Education | Curricula |

TABLE VI: AUTHORS WITH 20 OR MORE ARTICLES

| Author | P1 | P2 | P3 | P4 | Affiliation |
|--------|----|----|----|----|-------------|
| Hwang, Gwojen | 2 | 8 | 9 | 17 | National Taiwan University of Science and Technology, Taiwan |
| Tsai, Chia Wen | | 4 | 20 | 11 | Ming Chuan University, Taiwan |
| Shih, Timothy K. | 9 | 11 | 9 | 3 | Tamkang University, Taiwan |
| Richardson, John T,E, | 5 | 11 | 9 | 7 | Open University, Milton Keynes, United Kingdom |
| Sandars, John Edward | 1 | 12 | 14 | 1 | Edge Hill University, Lancashire, United Kingdom |
| Chen, Nian Shing | | 5 | 13 | 9 | Griffith University, Brisbane, Australia |
| Huang, Ray Yueh Min | 1 | 11 | 7 | 6 | National Cheng Kung University, Taiwan |
| Kinshuk | | 2 | 9 | 13 | University of North Texas, Denton, United States |
| Koper, Rob | 1 | 19 | 2 | 2 | Open University of the Netherlands, Heerlen, Netherlands |
| Wang, Minhong | | 1 | 15 | 6 | The University of Hong Kong, Pokfulam, Hong Kong |
| Virvou, Maria K. | 3 | 1 | 10 | 8 | Panepistimion Pireos, Piraeus, Greece |
| Chen, Chihming | 12 | 6 | 4 | | National Chengchi University, Taiwan |
| Shen, Peidi | 5 | 11 | 5 | | Ming Chuan University, Taiwan |
| Rienties, Bart C. | 2 | 5 | 14 | | Open University, Milton Keynes, United Kingdom |
| Hoi, Steven C.H. | | | 8 | 12 | Singapore Management University, Singapore City, Singapore |
| Tsai, Chin Chung | 3 | 6 | 11 | | National Taiwan Normal University, Taiwan |
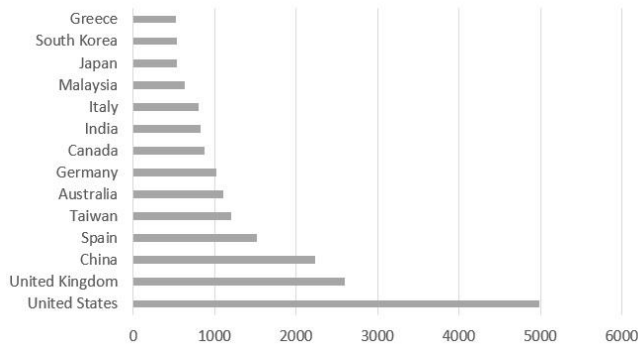

Fig. 4. Countries with at least 500 papers.
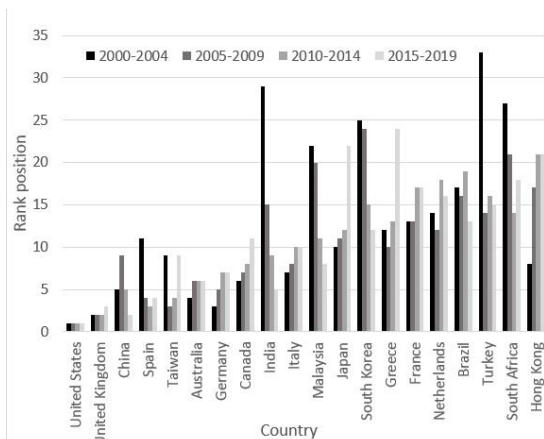

Fig. 5. Country rank, 5-year period.

United States has always been first in terms of the number of articles on these last 20 years. But there are cases like Spain: from 2000-2004 was on the 11th position but that in the other 15 years it was the country where more articles were published. The case of India should also be considered: 29th position in 2000-2004, but 5th in 2015-2019 (Fig. 5 Country rank, 5-year period.).

Open University from United Kingdom is the organization with the most references (306). There are 22 organizations with more than 80 articles (Table VII Organizations with more than 80 references).

Since we had not used the language exclusion criterion, we can now see that English is used in 93% of the articles (Fig. 6. Language articles). There are other 37 languages, like are Spanish 1.6%, German and Chinese 1%. Portuguese and French is used in 0.67% of the articles
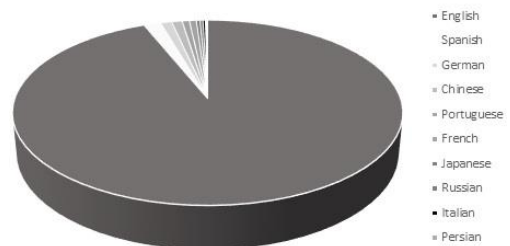

Fig. 6. Language articles.

TABLE VII: ORGANIZATIONS WITH MORE THAN 80 REFERENCES

| Organization | P1 | P2 | P3 | P4 |
|---|---|---|---|---|
| Open University | 61 | 83 | 74 | 88 |
| University of South Africa | 3 | 9 | 56 | 89 |
| Universitat Oberta de Catalunya | 4 | 17 | 64 | 70 |
| Nanyang Technological University | 11 | 26 | 44 | 51 |
| Universidad Nacional de Educacion a Distancia | 3 | 10 | 38 | 65 |
| The University of Hong Kong | 10 | 15 | 31 | 51 |
| Chinese Academy of Sciences | 0 | 10 | 23 | 68 |
| National Taiwan Normal University | 1 | 12 | 39 | 46 |
| Universiti Kebangsaan Malaysia | 1 | 9 | 45 | 41 |
| National Cheng Kung University | 3 | 32 | 37 | 24 |
| Universidad Politécnica de Madrid | 4 | 16 | 32 | 44 |
| Athabasca University | 4 | 25 | 39 | 24 |
| The University of Sydney | 4 | 19 | 30 | 38 |
| Tamkang University | 19 | 31 | 31 | 10 |
| University of Malaya | 0 | 3 | 32 | 55 |
| University of Manchester | 7 | 27 | 24 | 31 |
| Universidade de Sao Paulo - USP | 6 | 6 | 28 | 47 |
| National Taiwan University of Science and Technology | 0 | 18 | 27 | 41 |
| City University of Hong Kong | 21 | 14 | 20 | 30 |
| Tsinghua University | 21 | 13 | 17 | 34 |
| Deakin University | 16 | 17 | 24 | 24 |
| Hong Kong Polytechnic University | 11 | 18 | 21 | 30 |

In the following table (Table VIII) we list articles with over 500 citations.

In the keywords of the most cited articles we find 4 clusters: C1: Asynchronous learning, computer mediated communications, computer mediated leaning, distance learning, faculty satisfaction, interaction, learning effectiveness, perceived learning, social presence and student satisfaction. C2: data mining, distance education and telelearning, e-learning, e-learning management, evolution of cal system, learner satisfaction and web mining. C3: computer game, engagement, game mechanic, games-based learning, gamification and motivation. C4: elm feature space, elm kernel, ensemble extreme learning machine, incremental learning, online sequential learning, and support vector machine. Kent State University, Purdue University, University of California, University of Plymouth and VA Medical Center are the organization with two of the most cited paper.

TABLE VIII: MOST CITED PAPERS

| Authors Year Title Journal Cited Keyword |
|---|
| J. Duchi, E. Hazan and Y. Singer 2011 Adaptive subgradient methods for online learning and stochastic optimization Journal of Machine Learning Research 2523 Adaptivity; Online learning; Stochastic convex optimization; Subgradient methods |
| B. Babenko, M. H. Yang and S. Belongie 2011 Robust object tracking with online multiple instance learning IEEE Transactions on Pattern Analysis and Machine Intelligence 1619 multiple instance learning; online boosting; Visual Tracking |
| G. B. Huang, D. H. Wang and Y. Lan 2011 Extreme learning machines: A survey International Journal of Machine Learning and Cybernetics 1195 ELM feature space; ELM kernel; Ensemble; Extreme learning machine; Incremental learning; Online sequential learning; Support vector machine |
| P. C. Sun, R. J. Tsai, G. Finger, Y. Y. Chen and D. Yeh 2008 What drives a successful e-Learning? An empirical investigation of the critical factors influencing learner satisfaction Computers and Education 969 E-Learning; E-Learning management; Learner satisfaction |
| J. G. Ruiz, M. J. Mintzer and R. M. Leipzig 2006 The impact of e-learning in medical education Academic Medicine 881 |
| J. C. Richardson and K. Swan 2003 Examining social presence in online courses in relation to students' perceived learning and satisfaction Journal of Asynchronous Learning Networ 699 Asynchronous learning; Computer-mediated communications; Computer-mediated learning; Distance learning; Faculty satisfaction; Interaction; Learning |

effectiveness; Perceived learning; Social presence; Student satisfaction

M. N. Kamel Boulos, I. Maramba and S. Wheeler 2006 Wikis, blogs and podcasts: A new generation of Web-based tools for virtual collaborative clinical practice and education BMC Medical Education 668 J.

C. Roca, C. M. Chiu and F. J. Martínez 2006 Understanding e-learning continuance intention: An extension of the Technology Acceptance Model International Journal of Human Computer Studies. 637 Expectancy disconfirmation theory; Satisfaction; Technology acceptance model

G. H. Tzeng, C. H. Chiang and C. W. Li 2007 Evaluating intertwined effects in e-learning programs: A novel hybrid MCDM model based on factor analysis and DEMATEL Expert Systems with Applications 615 DEMATEL; E-learning; Factor analysis; Fuzzy integral; Multiple criteria decision making (MCDM)

A. Domínguez, J. Saenz-De-Navarrete, L. De-Marcos, L. Fernández-Sanz, C. Pagés and J. J. Martínez-Herráiz 2013 Gamifying learning experiences: Practical implications and outcomes Computers and Education 591 Computer game; e-learning; Engagement; Game mechanic; Games-based learning; Gamification; Motivation

C. Romero, S. Ventura and E. García 2008 Data mining in course management systems: Moodle case study and tutorial lComputers and Education 541 Data mining; Distance education and telelearning; E-learning; Evaluation of CAL systems; Web mining
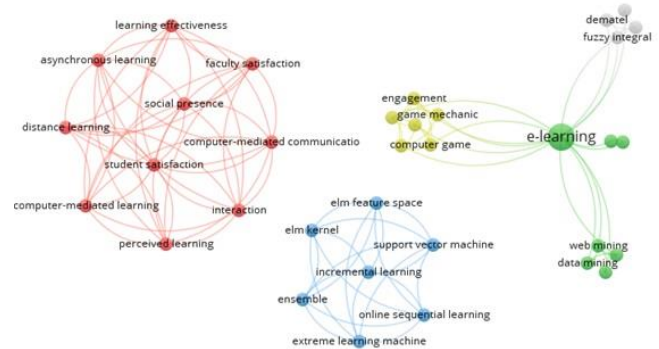


Fig. 7. Network visualization, keywords, more cited articles.

Kent State University, Purdue University, University of California, University of Plymouth and VA Medical Center, are the affiliation of two papers each. Using Vosviewer (Fig, 7) we made an analysis of the keywords of the most cited articles on each 5- year period, the authors who published the most each 5-year period and the countries which published the most each period- No significant clusters were find.

## V. DISCUSSION AND CONCLUSIONS

The purpose of this paper is to analyze the scientific production on e-learning in journals indexed in Elsevier's Scopus:

- How has the evolution of the publication of articles in quality journals related to e-learning been?

There is a clear annual growth. This growth is even more visible if five-year periods are considered: there are 2377 articles in the period 2000-2004, 4860 2005-2009, 7437 2010-2014 and 10656 articles for 2015-2019. In other words, there has been a huge growth.

- What are the characteristics of journals where there is a greater number of publications related to the subject?

Papers were published in 413 international journals, 11 of which published two hundred or more articles, the four of those 11 journals were published in the United Kingdom (UK) and two in Germany. The most common WoS subjects of those 11 journals are Social Sciences and Computer Science.

The most common WoS categories of those 11 journals are Social Sciences (Education) and Social Sciences (E-Learning). Most of those journals are ranked in the first quartile in Journal Citation Reports. Computers And Education published 713 articles (0.28) and International Journal of Emerging Technologies in Learning published 468 (0.185).

- What is the approach to e-learning?

World Wide Web and Websites were two of the 2000-2004 top 20 keywords; Web Services, Educational Measurement and Blended Learning appears in 2005-2009; Surveys, Learning Algorithms and Machine Learning in 2010-2014; and Human Experiment, Forecasting and Major Clinical Study in 2015-2019.

- Who publishes on the subject? Where do researchers who are interested in e-learning work in? What country do they work? What are the languages in which most of these articles are published?

We found 48545 authors. There are 16 authors with twenty or more articles, and four with over 30: Hwang, G.J. (36), Tsai, C.W. (35), Richardson, J.T.E. (32) and Shih, T.K. (32). Taiwan is the country affiliation from seven of these 16 authors. Considering country affiliation, the papers are from 168 countries. There are 13 countries responsible for at least 500 papers. The United States has always been first in terms of the number of articles on these last 20 years. Spain was on the 11th position from 2000 to 2004, but from 2005 to 2019 was a country where most articles were published. India was 29th position in 2000-2004, but 5th in 2015. English is used in 93% of the articles.

- What are the most cited articles?

J. Duchi, E. Hazan and Y. Singer; 2011; Adaptive subgradient methods for online learning and stochastic optimization; Journal of Machine Learning Research was cited 2523 times.

- What is the purpose of the most cited articles? What is the perspective with which the articles approach the theme?

In the keywords of the most cited articles we find 4 clusters: C1: Asynchronous learning, computer mediated communications, computer mediated leaning, distance learning, faculty satisfaction, interaction, learning effectiveness, perceived learning, social presence and student satisfaction. C2: data mining, distance education and telelearning, e-learning, e-learning management, evolution of cal system, learner satisfaction and web mining. C3: computer game, engagement, game mechanic, games-based learning, gamification and motivation. C4: elm feature space, elm kernel, ensemble extreme learning machine, incremental learning, online sequential learning and support vector machine.

- Who writes the most cited articles? And where do they work? J. Duchi, E. Hazan and Y. Singer wrote the most cited paper and B. Babenko, M. H. Yang and S. Belongie wrote the second one. Kent State University, Purdue University, University of California, University of Plymouth and VA Medical Center are the organizations with two of the most cited papers.

From the findings, we can see that e-learning continues to be an object of research with a lot of potential and that the best journals still have an interest on the field.

## CONFLICT OF INTEREST

The author declares no conflict of interest.

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