TRENDS IN THE M-LEARNING SUBJECT AREA OVER A 15-YEAR PERIOD (2002-2017) USING SCOPUS

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Abstract

The current social dynamics perceive education as an impeller of social and economic change. However, there are problems of coverage, relevance and methodology in the educational process, mainly in Higher Education Institutions (HEIs). Recently, tools have emerged that adopt and appropriate ICTS in learning processes, such as mobile learning, which seeks to meet the requirements of mobility, accessibility and interactivity that traditional teaching mechanisms have not covered satisfactorily. Based on the necessity to identify the factors that drive the adoption of mobile learning by different HEIs, this research identifies the factors that encourage the adoption of mobile learning in the institutions. For this, results of an exercise of technological surveillance in indexed database (Scopus) were analyzed by means of scientometric indicators. Some of the most significant factors detected are: preparation of the professor, perceptions and attitudes of students, technological culture, and technological environment that leverages new learning models.
Keywords: *bibliometric analysis, high education, mobile learning, research trends.*

Introduction

The adoption of mobile devices in the field of education is undoubtedly one of the most important characteristics of education in the 21st century. Literature on mobile learning provided evidence supporting the efficacy of mobile technology in learning and teaching (Ktoridou, Gregoriou & Eteokleous, 2007; cited by Alfarani, 2014; Moreno & Valencia, 2017), and also points out that the success of this new educational paradigm is based in extending both teaching and learning beyond the traditional classroom led by teachers (learning space in which the communication between and among teacher and students is face to face); expanding learning opportunities, providing flexible teaching materials; generating new methods of improved learning in technology; allowing new modes of teaching; facilitating the implementation of pedagogies that revolve around the student and allow access to materials for learning at any moment and encouraging the active participation of students in their teaching process (Picek & Grčić, 2013; cited by Alfarani, 2014).

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Previous Research

Effective information is relevant for high quality processes. In this sense, Gan and Zhu (2007) suggested that sharing knowledge, having communication, interaction, discussion and collaborative work in solving problems related to active learning and continuing knowledge construction in different groups students with common interest can be allowed by the use of mobile devices in a virtual learning environment.

In the last ten years, mobile learning (m-learning) has achieved great development, with a significant impact on education sector, especially on high education (Klassen, Eibrink-Lunzenauer, & Gloggler, 2013; cited by Alfarani, 2014; Gaviria, Arango, & Valencia, 2015; Mejía, Arias, & Echeverri, 2017), which has allowed to co-build and reconfigure the role of teachers in the teaching process and understanding m-learning usage impact on student learning supporting (Diez, Valencia, & Bermudez, 2017). The popularity of these devices has been supported, as their system is increasingly powerful (given the inclusion of functions associated with computers), and because they are tools that allow students the opportunity to take their institution into their own hands (Taleb & Sohrabi, 2012; cited by Klassen, Eibrink-Lunzenauer, & Gloggler, 2013; Chalela, Valencia, Bermudez, & Ortega, 2016).

Different studies (Ibrahim, Kim-Soon, Ahmad, & Sirisa, 2017; Kim-Soon, Ibrahim, Razzaly, Ahmad, & Sirisa, 2017; Sapargaliyev, 2011) focused on how researchers must receive training in basic education techniques enriched by digital means, and thus be able to implement courses of professional development that include this type of formation. The adoption of progressive pedagogies based on the exploration of emerging technologies will lead to an attitude change in the academic world (Villa, Valencia, & Valencia, 2016).

Therefore, a more frequent implementation of new educational technologies which design sources of information according to certain aspects and which are accessible to all users is logical. This generates a change in the pedagogical paradigm, proposing a training model focused on problem-solving, in which students do not passively receive static data, but must address issues using the acquired contents (Sloep & Berlanga, 2011).

In accordance with the special requirements that have emerged for the higher education system (HES), institutions are called upon to provide training centered on the teaching of students, which promotes continuous and independent self-training to gaining knowledge. For example, in the research undertaken by Shurygin and Krasnova (2016), it was noted that autonomous study is crucial for potentiating educational activities, revitalizing research activities and forming not only general but professional competencies.

Problem of Research

Following a frame of reference in which higher education institutions have begun to combine their teaching activities and curricular designs with the use of Information and Communication Technologies, it has been found that, mobile learning must be properly managed in such a way as to overcome a number of barriers that limit their adoption, including: 1) lack of empirical evidence on the effectiveness of its classroom usage, 2) distractions that can be created in classrooms by using mobile devices, 3) shortage of effective m-learning models that satisfy the needs of current students, and 4) resistance to educational innovations by teachers (Messinger, 2012; cited by Alfarani, 2014). As stated above, the aim of this research was to carry out an exploratory study through a bibliometric analysis, and following questions were answered:

What are the factors that encourage the adoption of mobile learning in the Higher Education Institutions (HEIs)?

What are some recommendations on the factors that Higher Education Institutions (HEIs) must be taken into account to favor the development of education by virtual learning tools?

Research Methodology

General Background

A technological mapping was carried out through an exercise of technological surveillance in indexed databases (Scopus), and its results were analyzed by means of bibliometric indicators. Through these indicators, information about the intrinsic factors related to the academic context that allow the connection of learning activities in technological contexts and characteristics such as volume, evolution, visibility and structure was obtained. Specifically, quantity, impact and structure indicators were used to obtain results in terms of the characteristics mentioned above. In order to do so, a time period from 2002 to 2017 was considered.

Instrument and Procedures

This research was carried out using Scopus, which is one of the most powerful electronic databases. Scopus offers 20% more coverage than WoS and, unlike Google Scholar, the database provides accurate and consistent results with the search matrix (Falagas et al., 2008; cited by Sweileh, Al-Jabi, Sawalha, AbuTaha, & Sa'ed, 2016).

Subsequently, to create the search strategy, the terms equivalent to mobile learning (mobile learning/mlearning/m-learning) were considered as criteria. A total of 283 records were obtained, including conference paper (45.9%), research articles (42.8%), book chapters (7.8%) and other publications equivalent to less than 2%. In terms of the language of the publication, English was the most used (95.24%), followed by Spanish (2.16%), Portuguese (0.87%), Chinese and German (0.43%). Since the purpose of the research was to perform the analysis and monitoring of the scientific production of the m-learning subject, the search was executed without any time restriction. Finally, the following search matrix was obtained:

Search equation – mobile learning

TITLE({m-learning} OR mlearning OR (learn* W/2 mobile) OR (teach* W/2 mobile) OR (learn* W/8 LMS) OR (teach* W/2 mobile)) AND TITLE ((high PRE/1 (education OR institut*)) OR undergraduat* OR universit* OR bachelor)

Data Analysis

The country, institutional affiliation, type of published documents, title of the journal in where documents were published, cited articles, most productive authors and collaboration networks were the main bibliometric indicators included in this research.

Thus, aspects like productivity, impact and connections were analyzed, which are measured by quantity, quality and structure indicators respectively. Research productivity was assessed by the quantity of publications, while total citations were used to identify the most relevant articles in the area.

Gephi software was used for visualized bibliometric maps and networks. To carry out the quantitative analysis of the network structure, the Theory of Graphs (Diestel, 2018) was used with the following attributes of centrality: cohesion; degree of clustering, number of nodes connected, average number of collaborating authors, etc.; analyzing the scientific production of the 616 active researchers in this academic community.

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Research Results

Quantity Bibliometric Indicators

Quantity indicators are based on the volume or count of scientific publications. As shown in Figure 1, the amount of annual publications has increased gradually from 2002 to 2017. The total of annual registers fluctuated and peaked in 2013, 2015 and 2016.

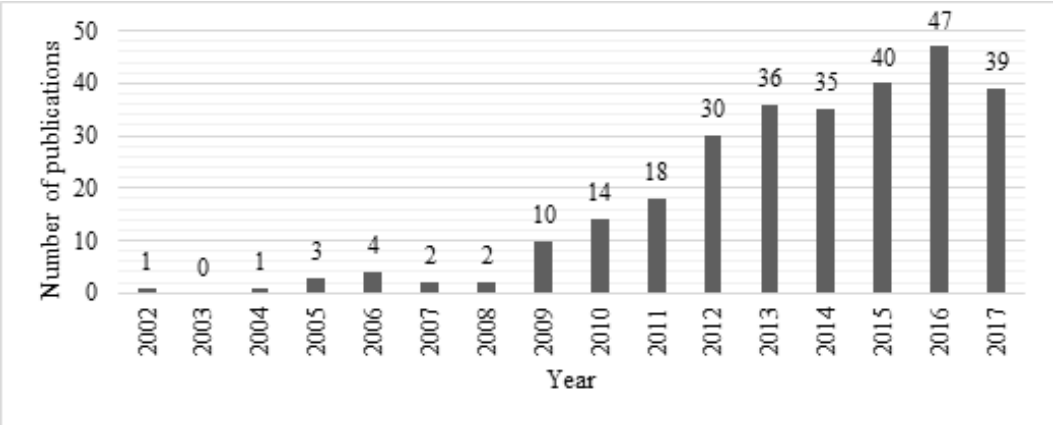

Figure 1. Annual number of papers published.

Figure 2 presents the 10 most productive journals in this field. These main journals equal only 39.7% of all journals researched, which implies a diversified distribution of publications. The International Journal of Mobile Learning and Organization was ranked atop the list and registers an impact of 3 citations per publication. Typically, its scientific production was represented by universities and Swiss research centers with expertise in computational sciences applied to education and social sciences. The presence of several universities in the country was favorable to the journal, since they show their results regarding this topic and propose contextual results favoring a line of work essential for the development of the national educational system. Other leading journals included information and communication sciences, as well as distance learning.

Figure 2. Distribution of the ten most productive journals in the field.

Productivity showed the most active authors in knowledge-production of a particular scientific discipline. Results showed that only 39% of authors have written more than one article, which may denote that, in this topic, there are not many transient or occasional authors; instead there is a tendency to specialize in the study theme.

Once the calculations for the 10 researchers with most registers was completed, Daniyar Sapargaliyev and Mohamed Sarrab were identified as the authors with the most publications, as both had 4 publications (Figure 3).

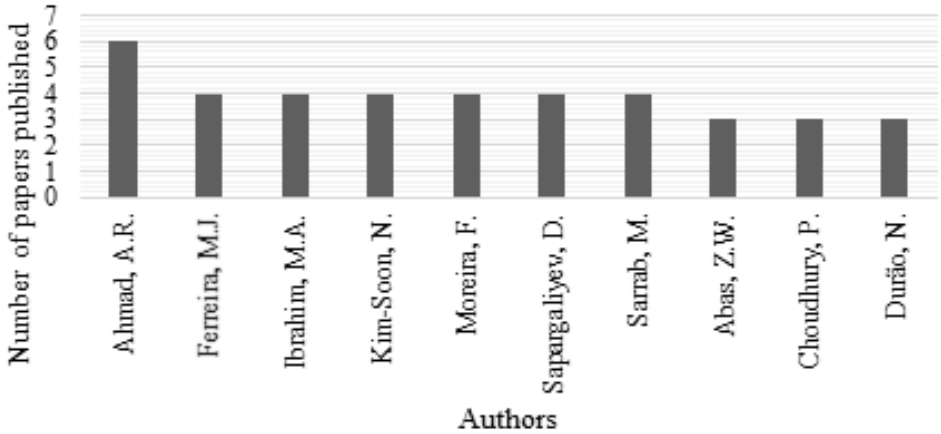

Figure 3. Distribution of the ten most productive authors in the field.

The different studies of the mentioned scholars focused on how researchers must receive training in basic education techniques enriched by digital means, and thus be able to implement courses of professional development that include this type of formation.

Table 1 shows the performance of the 10 most productive institutions, also most of them were in the top 5 producing countries. The University of South Queensland operates seven research centers and three research institutes that are focused on a wide range of agricultural, scientific, environmental, commercial, and technological issues, and is the second-best institution in Australia. The University Utara Malaysia and King Abdulaziz University provided field productivity as well, each with 4 publications. Both institutions work on the same subject matter, especially in computer sciences, social sciences, media and communications. In general, the United Kingdom, Malaysia and the United States are the countries with most research institutions dedicated to these topics.

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Table 1. Institutions with the largest number of published works on the field.

Affiliation	Number of publications
Tun Hussein Onn University of Malaysia	6
University of Southern Queensland	5
University of North Malaysia	4
King Abdulaziz University	4
King Saud University	4
Brunel University London	4
Aveiro University	4
Sultan Qaboos University	4
Tunku Abdul Rahman University	4
L.N. Gumilyov Eurasian National University	4

There are 65 countries responsible for publications in the field. 43% of them produced 80% of the studies. According to this information, countries were divided into quartiles: 5% of them publish 25% of studies, 15% publish 50%, and 37% publish 75%. The information gathered from the bibliometric analysis shows that the most prominent country is Malaysia with 35 publications, followed by the UK with 28, and the USA with 23. Furthermore, the top 10 countries account for 52% of the total publications, and 49% of countries amount to two or fewer publications. As evidenced, productivity is concentrated in developed countries such as Malaysia, UK, USA, Australia, Spain and Germany, with significant advances in the matter.

Quality Bibliometric Indicators

Figure 4 shows the number of publications from the top 10 most incidence authors, with at least 1 citation by publication. Evans C. was the most cited amounting to 302 citations for his 2008 publication titled "The effectiveness of m-learning in the form of podcast revision lectures in higher education". It was published in *Computers and Education*, the journal with greater impact, which seeks to use podcasting as a learning tool in higher education.

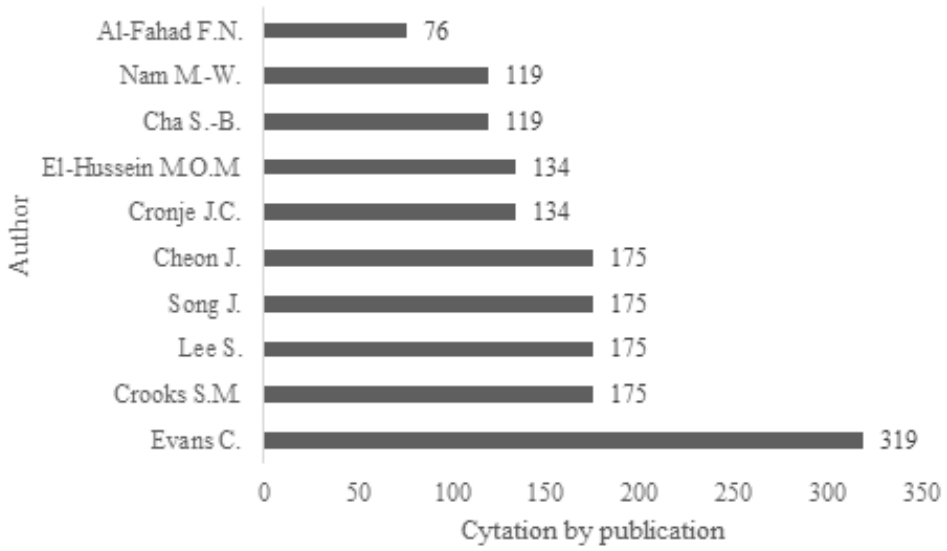

Figure 4. Impact of authors' productions in the field.

Figure 5 shows the ten journals with the most citations per publication in the field. *Computers and Education* heads the list with 213 citations per publication, followed by *The Journal of Computer Assisted Learning* with 97 citations, and then *Educational Technology and Society* with a total of 53 citations. When comparing this list with the top productive journals, the matches were *British Journal of Educational Technology* (fourth on impact and seventh on productivity) and *Turkish Online Journal of Educational Technology* (seventh on impact and second on productivity).

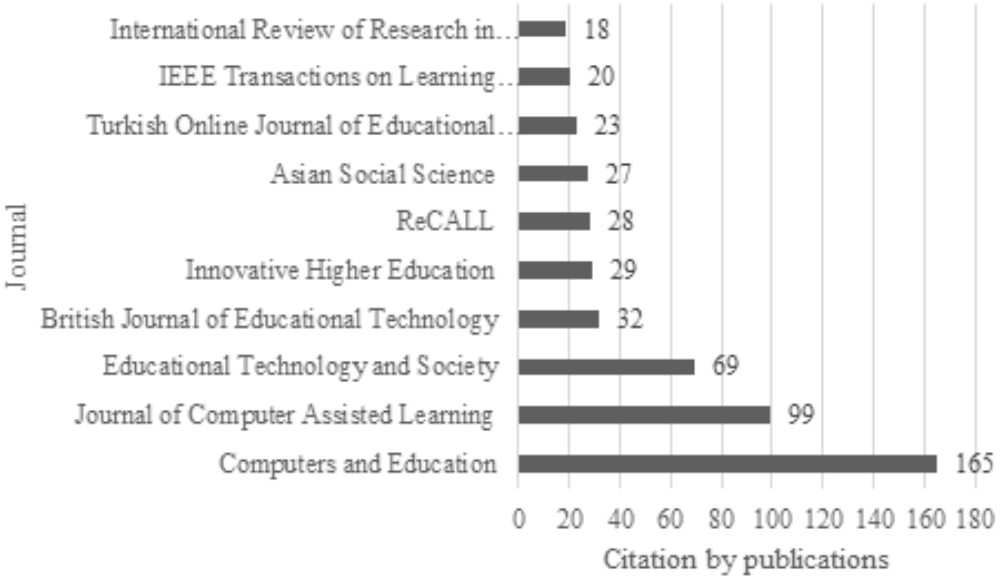

Figure 5. Distribution of the ten journals with greatest publication impact.

Structure Indicators

Knowledge networks were defined as a group of researchers and institutions interested in the resolution of a common problem, in order to share knowledge and enhance resources and benefits, through cooperation, collaboration and constructive solidarity, using information and communication technologies.

This analysis is presented below, in which the fragmented time window (five periods, each of which ranged between 2 and 3 years) is presented in accordance with the average proportion of academic production from Scopus. Figure 6 shows the topological map of the network of authors for the area of knowledge on mobile learning.

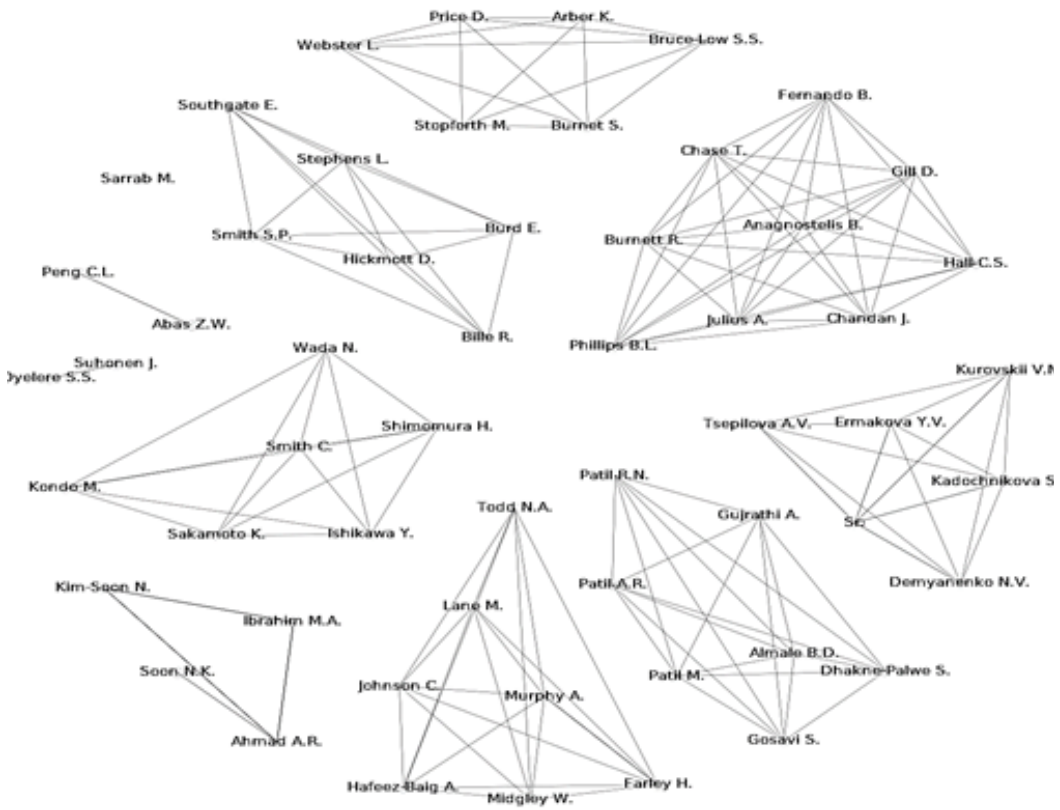

Figure 6. Topological map of author network in the mobile learning field throughout the period of 2002-2017 (Top 50).

Figure 6 presents a non-directed network with only one type of node and a single species of edge, which shows determined particularities and important characteristics, visible in results for author networks indicators showed in Table 2. It is evident that:

There were 616 authors and 8.28% of them publish independently. The intermediation of this network is 1089, which indicates that researchers must pass through a central actor to communicate with the rest, thus guaranteeing relational flows throughout the network. Nevertheless, the density of the network was close to zero (0.004). The potential connection between the authors is not being used properly as observed.

Table 2. Structure indicators.

Indicator	2002-2005	2002-2007	2002-2010	2002-2013	2002-2017
Nodes	15	30	92	268	616
Graph density	0.200	0.080	0.023	0.008	0.004
Network diameter	1	1	2	2	3
Shortest paths	1.0	1.0	1.021	1.022	1.172
Connected components	4	10	35	107	226
Average number of neighbors	2.8	2.33	2.065	2.015	2.305
Clustering coefficient	1.0	0.833	0.623	0.607	0.653
Network centralization	0.016	0.025	0.022	0.011	0.011
Network heterogeneity	0.143	0.356	0.538	0.606	0.680
Isolated nodes	0	1	5	21	44
Connected nodes	26.66%	33.33%	38.04%	39.92%	36.68%
Isolated components	0%	3.33%	5.43	7.83%	7.14%

Moreover, grouping between nodes (authors) was determining in the created subnets, since they have a grouping degree of 0.680. This centrality explains the connection power that determined nodes have within a network, and as a result, they are identified as "hinges" of nodes in the management of resources through the network. A large number of triangles in the network, defined by three vertices, connected among each other (grouping coefficient) was also identified.

Finally, the network showed a well-leveraged neighborhood (2.305), where, in social network language, your friend's friend may also become your friend and can easily influence other authors. Furthermore, they control information of particular groups of nodes with the other nodes of the network in 36.68%.

Discussion

Figure 7 shows the quantitative process performed for the selected period of keywords. The time window was divided into two periods, one between 2005-2010 and another between 2011-2017. The aim was to find papers related to the issues of interest, so in this way, identifying over time fields of expertise, research topics and relationships between scientific specialties and disciplines.

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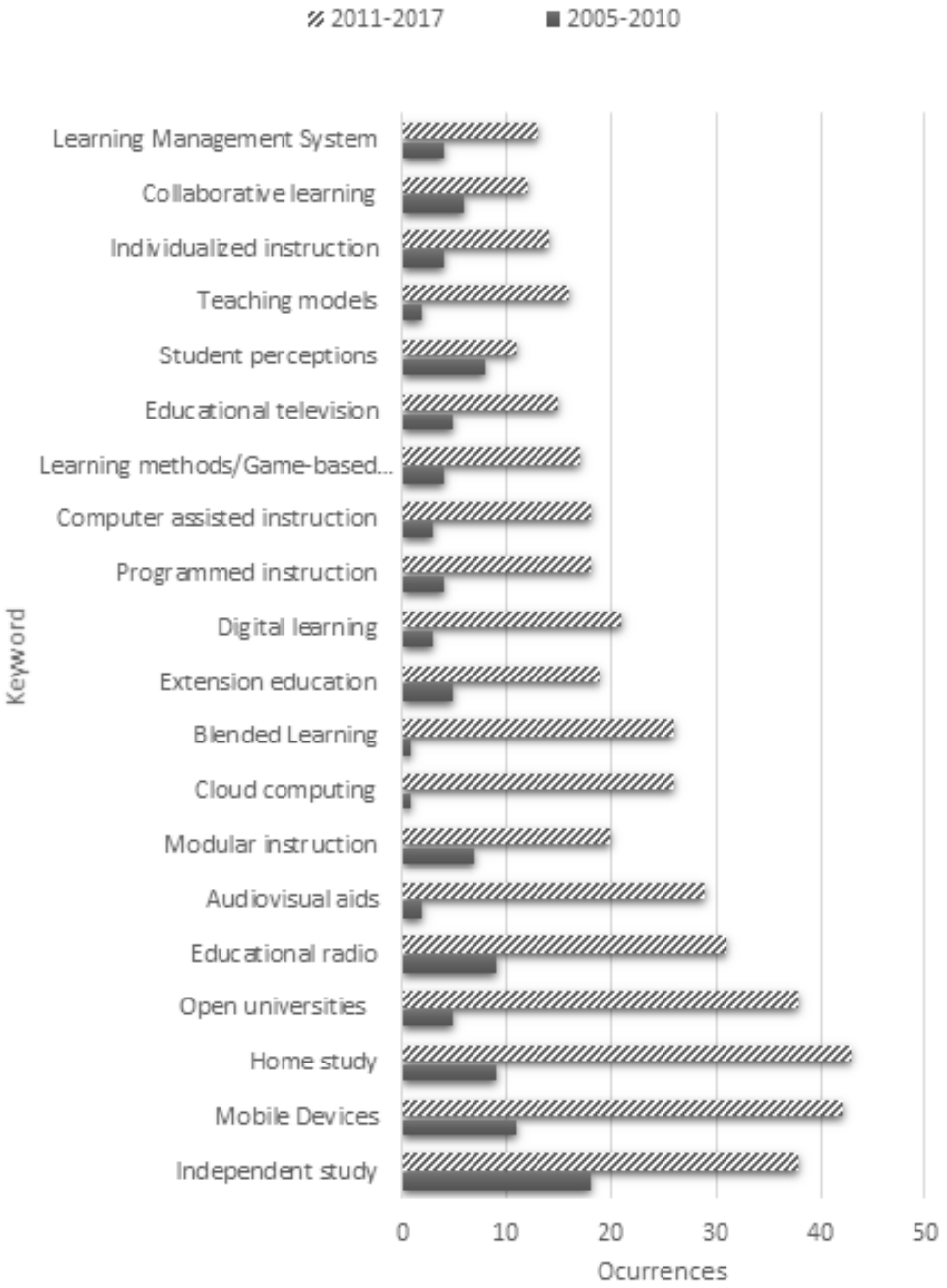

Figure 7. Emerging, growing and decreasing themes of the field.

Figure 7 shows keyword dynamic in growing, declining and emerging fields, specifically concerning words related to the area of interest. A variable behavior of terms is evident. For instance, it may be noted that keyword behavior reflects an important growth in the use of the term "Distance education", conceived as training with potential to provide more educational opportunities to a greater number of people. For Moore (2013), this term should include a set of processes such as: electronic learning, asynchronous learning, distributed learning, flexible learning and open learning – not just one of them.

The term "home study" refers to an educational modality or system from distance. It is supported by information and communication technologies, in which each participant can study synchronously or asynchronously through online learning courses without demographic, economic and geographical restrictions (Hsieh, 2016).

Another important trend refers to "educational radio", whose term denotes the use of this medium in formal learning systems at different educational levels. This method is typically a means of delivering course material in some cases, and is sometimes integrated with various types of interaction, as is the case in classrooms, in discussion groups, or by telephone. It also involves informal learning processes through which communities plan, own and operate their own radio stations. Informal learning topics of community radio often include child nutrition and education, religious education, family planning and agricultural counselling (Berman, 2008). Even though there have been words with considerable growth between timeframes considered, such as "open universities", "modular instruction" and "blended learning", there is a large number of words arising in the second period (2015-2011). Regarding decreasing fields, no disappearing keywords were found in either period.

Figure 8 shows how the development of computing and high performance communications are providing new network channels that lead to the creation of virtual communities. The innovative pedagogy promoted by emerging media enables an evolution of asynchronous, joint and specific distance education modalities overcoming temporal-spatial barriers under an alternative based on the instructional paradigm and the concept of distributed learning. Specifically, advances in computer-supported collaborative learning and experiential simulation provide creative potential for learning environments available anywhere, anytime, and on demand.

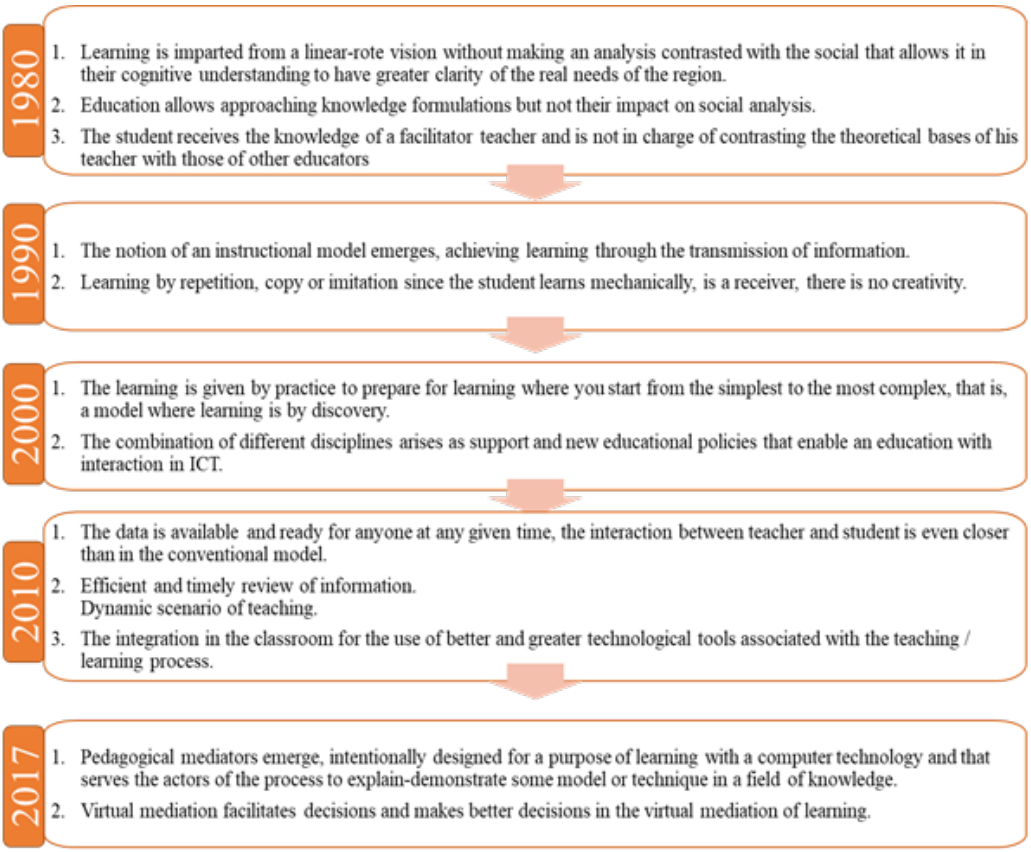

Figure 8. Topic time-evolution.

It should also be noted that during the first years (1980 and 1990) students learned in a linear-rote way that lacked analysis or comparisons to real-life, which would allow a clearer understanding of economic, political and financial life, as well as allow them to become architects of their own destiny and proactively contribute to each regional context. It is also evident that research in the field has progressed gradually, going from studies that explored the simple process of transmitting information and imparting knowledge, to implementing strategies that cultivate a creative culture, in which the student is conceived as the architect of his own training and is not reduced to the role of a passive receiver (1990-2000). Research has included studies that aim to facilitate the development of better methodological approaches, such as the case of social constructivism and philosophical pragmatism. Thus, they generate significant teaching with other non-traditional forms of education, acting hand in hand with current society and information economy with a technological emphasis, key to the information economy and pedagogy based on technological and active orientations (2000 -2010). Finally, in recent years there is an effort aimed to strengthen its structure in a globalized economy that operates in networks. The objective of this new training strategy is to create practical learning from the simplest to the most complex, ergo, a model where learning takes place through discovery (2010-2017).

Research Agenda

Based on Figure 8, a research agenda is presented below. It provides recommendations on the factors that must be taken into account to favor the development of education by virtual learning tools. This agenda is intended to be a guide for future research on this topic.

1. First, considering the evolution of the educational field, it was found that television and radio services can also help governments in terms of economic and social development. Mass media can generate transformative changes and environments that build a more inclusive, equitable, sustainable and resilient world, a world without educational barriers, a world that fosters diversity of opinions and training without ties.
2. Regarding the development of an education focused on practical tasks, analysis suggests that it can be enhanced through the improvement of government policies to support measures that facilitate access to industries; the reinforcement of the academic bases from real problems; the improvement of technological infrastructures and synchronized education services through mobile devices. Aligning social problems that have an impact on education is vital for behavioral transformation and an environment conducive to the development of the region.
3. On the other hand, advances in collaborative learning supported by computer, multimedia and experiential simulation offer the potential to create learning environments by sharing tools available anywhere, at any time and on demand. The findings point to the importance of how emerging technologies can reshape face-to-face education and distance education, through shared knowledge networks, virtual communities, and synthetic environments to understand the new types of instructional messages that enable distributed learning.
4. Regarding the establishment of a culture of collaborative environments, emphasis should be placed on the emergence of pedagogical mediators designed intentionally for a computer-based learning purpose that will help actors in explaining a model or technique in a field of knowledge.
5. Finally, future work to be considered includes a meta-analysis of educational innovation and its influence on distance education in emerging economies, seeking to propose a model according to the political, cultural, economic and social context

that allows strengthening both private and public collaborations aimed at a more inclusive education system.

Conclusions

The bibliometric research showed that the number of articles published in this field has multiplied by more than 40 times in the last decade. Registrations were published in 135 different journals, where a total of 48 articles (25%) were published by the ten most productive journals. The journal that has the most publications was the International Journal of Mobile Learning and Organization, and yet citations per article was greater for the Computers and Education magazine.

Regarding emerging terms, these are related to new educational applications and trends that take place in a society of information, and to strategy and tool adoption in curricular designs mandated by institutions. These words include: the incorporation of ideologies that accept ICT-based learning environments coupled with the development and implementation of educational applications that are supported by innovative teaching models, where learning environments are formed by networks that combine physical spaces and virtual spaces. These strengthen the idea of learning anytime and anywhere, and thus generate learning sans seams or fissures.

The growth of research in distance learning is accompanied by a general increase in several educational fields, such as e-learning. Papers that are not originally in English also indicate an increasing interest worldwide regarding mobile teaching, as well as a notable increase in publications, suggesting a wider audience as a tool to improve formation quality.

According to the issues mentioned before, it has become clear that technology and education are not independent and impervious spheres, but rather that they are two overlapping areas, closely linked to one another, constantly feeding off each other.

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