



E-Technology in Education: A Bibliometric Analysis on the Topic of Technology as a Didactic Tool

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Abstract: The use of electronic technologies (e-technologies) in educational process gains a significant approach on the academic debate from the 1990's on. The discussion of such topic intensifies specially with Internet phenomenon, besides the rising of a globalized access to electronic technologies and the need of both educators and researchers to understand the relationship of such technologies in the process of learning. This article aims to analyze the current status of studies about technologies as a didactic tool, by the use of bibliometric analysis, in order to get an overview of the studies published in the period 1995 to 2015, as well as to verify how other topics has been associated and how relevant they can be considered to global studies concerning the relationship between technology and education. The analysis involves both qualitative and quantitative data. It is important to state that in terms of qualitative approach the aspects surrounding technology and didactic tools were carried out using the procedures of content analysis, key words and relevant topics. As far as quantitative approach, the following variables were adopted: authors, source, total number of publications, publication year, main institutions, languages and countries. All the information was obtained by consulting the electronic database ISI Web of Science, selecting the main journals, as well as their impact factor index, by searching at Journal of Citation Report (JCR). The methodology used in this article implies the data obtained from ISI Web of Science, showing the most cited journals and most prolific authors, as a way to analyze the trends of research and avenues for future studies.

Keywords: education, technology, didactic tool, bibliometric analysis

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INTRODUCTION

The reflection on the topic of education currently demands the analysis of subjects referring to globalization and its technological contributions. The phenomenon of globalization can be understood at first in the context of the global market; however, it can also be analyzed in the sphere of generating and sharing both information and knowledge. In this sense, new electronic technologies have enabled significant changes in terms of information and knowledge management in society as a whole. This happens mainly because information, which in the past used to require a great deal of time to be collected, analyzed, transmitted and shared by people, communities, organizations, countries etc. Today information can be easily accessed and shared in real time.

The rise of accessibility to such new technologies in society has occurred in an intense way, both in qualitative and quantitative aspects, aiming the increase in diverse knowledge areas, especially because such kind of technology enables fast spread of information and knowledge, what renders an interdisciplinary approach on the set of information produced by an individual or in a group context.

After the globalization advent, societies have earned each more for information and knowledge and this fact proves that information management has become very important for such societies in terms of providing access to information and knowledge in different perspectives and needs. Both information and knowledge have gained from information technologies and intensified the development of other industries, related to the need to meet the needs of a diversified demand in different areas of human participation. This fact can be observed in the development of virtual solutions, like software, creation of different tools and technological applications, as well as the increase and improvement of the existent tools.

In the context of this information society, in which electronic technologies represent a way to information and knowledge management, the role of such technologies in the learning process is crucial both in the individual background, so as he/she can live and adapt in this knowledge society and also because the use of such technologies as tools in the process of knowledge production and transfer.

It is intended in this article to analyze the state of art of research on educational technologies as a didactic tool, i. e., how academic literature has dealt with this concept and others associated to education and technological devices.

THEORETICAL APPROACH

Hill and Hannafin (1997) in an article devoted to cognitive learning strategies in the context of internet have investigated the strategies used by adult students in a hyper media information system. Among the discoveries related to the systems it was observed that students used several strategies in terms of use of technologies and that had impact on the usual pedagogical procedures.

In another study dedicated to analyze the impact of educational technology, Dillon and Gabbard (1998) evaluate the results from experimental studies regarding hypermedia, emphasizing the quantitative methods, empiric data to evaluate the learning process results. In this particular study, the authors classified the research in three sections: student comprehension studies compared between the use of hypermedia and other communication means and

the effects in the individual learning results. The results show that the benefits in the use of hypermedia in education are limited once they depend on the way information is searched and manipulated.

Sharples (2000) writes about the design of mobile technologies for personal use intended to learning process, and for such purpose the author develops a chart to conceive a new educational technology gender, in which computer systems enable learning practices anywhere and anytime.

Pelgrum (2001), in an article about the obstacles to information technologies integration and communication in education, evaluates the perceptions of education professionals about the obstacles that prevent the accomplishment of targets such as information technology and communication at schools. The results are obtained from a global survey with representative samples of schools in 26 countries. The article presents a summary of the project conception, a review on the main indicators of Information Technologies and Communication (ITC) in secondary schools and main obstacles between the contextual factors related to each participant country.

Albirini (2006), in an approach on teachers' attitudes towards ITC, suggests that teachers do have positive attitudes for ITC in education. The results point to the importance of the own view of teachers regarding technology, their own experience, and the cultural conditions surrounding the perception of their attitudes towards technology in general.

Chittaro and Ranon (2007), in a discussion on learning technologies, education and background, present the purpose of education based in virtual reality, using Web3D technology. After describing the main Web3D technologies, the authors summarize the pedagogical background that motivates their investigation in the context of education as they present the main characteristics of the process.

Kim (2008), in a text about the phenomenon of blogs and theoretical model of the use of blog, analyze the traditional applications of communication mediated by computers, exploring the effect of educational blogs. This article presents a review of previous studies and develops a model for the use of blog in educational contexts.

Greenhow, Robelia and Hughes (2009), in a discussion on learning, teaching, teaching and scholarships in Web 2.0 and resources at classroom, have proposed a survey about the World Wide Web in classroom. In the text they analyze the characteristics of Web 2.0 and what differs from the 1990's period. The authors also describe the contextual conditions the students access Web today and how Web 2.0 can influence the process of learning.

METHODS AND DATA

The methodology was exploratory bibliographic research, aiming to analyze by bibliometric index the academic production on the concept of electronic technology and didactic tools. Basically, the study was divided into three phases as shown in figure 1:



Figure 1 - Systematization of the research steps.
Source: Authors (2015).

All information to elaborate this work was obtained from ISI Web of Science (2015) and the inquiry was stimulated by the following questions:

- 1) How the articles are related to the concept of electronic technologies and didactic resources?
- 2) What other concepts come from technologies and how such concepts deal with literature in terms of future works?

After posting the research questions, some procedures were adopted in order to obtain a sample to meet effectively the bibliometric criteria. As a search of the topic “technology as a didactic tool” in ISI Web of Science from 1995 to 2015, the following terms and expressions were used: educational Technologies, teaching resource, technologies as a teaching resource, and educational technologies.

Initially over 19,526 hits were obtained, however using filters, the following sources were selected: Web of Science™ Core Collection, SciELO Citation Index, KCI-Korean Journal Database e Derwent Innovations IndexSM, excluding Biological Abstracts. The filter also was used in the domains by selecting Social Sciences and Science and Technology in the area EDUCATION EDUCATIONAL RESEARCH e COMPUTER SCIENCE, excluding the other areas. Only articles were accepted in the search what resulted in 3,193 hits.

In order to provide a more representative approach on the academic relevant production on the chosen topic, 25 articles with the greatest number of citations were selected for this article. All searches were performed on April 20th, 2015.

ANALYSIS AND RESULTS

In the year 2009 there was the major amount of publications on the topic, equivalent to 16% of the total (See Table 1), having as sample 25 of the most cited articles. It is possible to verify that the greatest amount of publications occurred between 2007 and 2009, getting to nine publications equivalent to 36% of the total. In the year of 1999, there were three publications, corresponding to 12%. However, it is important to state that it was not possible to get access in ISI Web of Science to the first 25 publications from the years 1995, 1996, 2006, 2012, 2013, 2014 e 2015.

TABLE 1
Publishing year

Year of publication	Number of publications	% de 25
1997	1	4
1998	1	4
1999	3	12
2000	1	4
2001	2	8
2002	2	8
2003	1	4
2004	1	4
2005	2	8
2006	0	0
2007	3	12
2008	2	8
2009	4	16
2010	1	4
2011	1	4

Source: ISI Web of Science(2015)

Regarding the total of citations of publications by year, during the analyzed period there were counted 2,691 total citations, and most of them are concentrated on the years 2007, 2008 and 2009, what represents 32,4% of the total of citations in the period, as we can see in Table 2.

TABLE 2
Citations year

Year of publication	Number of citations	% de 2691
1997	127	4,7
1998	198	7,4
1999	326	12,1
2000	162	6,0
2001	224	8,3
2002	195	7,2
2003	97	3,6
2004	127	4,7
2005	166	6,2
2006	0	0,0
2007	305	11,3
2008	160	5,9
2009	406	15,1
2010	118	4,4
2011	80	3,0

Source: ISI Web of Science(2015)

The amount of publications along with the frequency of citations of publications enable a more accurate analysis on relevant articles elaborated in certain periods. This happens because not necessarily the total amount of publications is related to the total amount of citations, as it can be seen, for example, in the years 2001 and 2002. In 2001 two articles were published about the topic and 224 citations were done regarding such articles; however in 2002 two other articles were published but there were 195 citations of those. So, it is possible to state that the degree

of relevance of the publications of 2001 were higher than those published in 2002, as it can be seen in Figure 2.

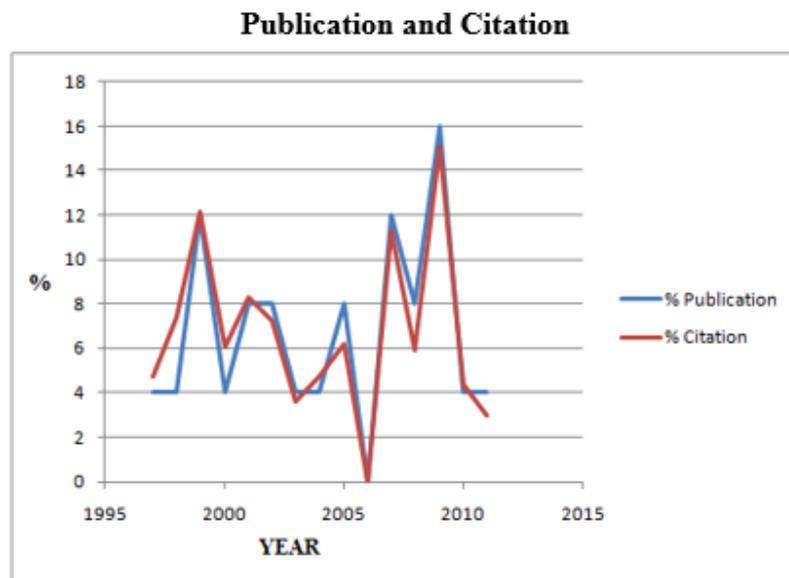


Figure 2 - Publication and citation.
Source: ISI Web of Science (2015).

Regarding journals, 25 of the most cited articles occurred in 16 journals, and from those there is the remarkable presence of Computers & Education, with 7 publications, representing 28% of publications in the period among the 25 articles, as it can be checked in Table 3.

TABLE 3
key sources

Periodicals	Count	% de 25
COMPUTERS & EDUCATION	7	28
ENERGY EDUCATION SCIENCE AND TECHNOLOGY	2	8
JOURNAL OF COMPUTER ASSISTED LEARNING	2	8
REVIEW OF EDUCATIONAL RESEARCH	2	8
AMERICAN EDUCATIONAL R.	1	4
BRITISH JOURNAL OF EDUCATIONAL STUDIES	1	4
BRITISH JOURNAL OF EDUCATIONAL TECHNOLOGY	1	4
EDUCATIONAL RESEARCHER	1	4
ET&D-EDUCATIONAL TECHNOLOGY RESEARCH	1	4
IBM SYSTEMS JOURNAL	1	4
INTERNET AND HIGHER EDUCATION	1	4
JOURNAL OF CURRICULUM STUDIES	1	4
JOURNAL OF EDUCATION POLICY	1	4
JOURNAL OF TEACHER EDUCATION	1	4
JOURNAL OF VISUAL LANGUAGES AND COMPUTING	1	4
TEACHING AND TEACHER EDUCATION	1	4

Source: ISI Web of Science(2015)

TABLE 4
2013 Impact Factor

Periodicals	Impact factor
REVIEW OF EDUCATIONAL RESEARCH	5000
EDUCATIONAL RESEARCHER	2963
COMPUTERS & EDUCATION	2630
AMERICAN EDUCATIONAL R.	2275
JOURNAL OF TEACHER EDUCATION	2208
INTERNET AND HIGHER EDUCATION	2048
TEACHING AND TEACHER EDUCATION	1607
BRITISH JOURNAL OF EDUCATIONAL TECHNOLOGY	1394
JOURNAL OF COMPUTER ASSISTED LEARNING	1023
JOURNAL OF EDUCATION POLICY	921
ET&D-EDUCATIONAL TECHNOLOGY RESEARCH	919
JOURNAL OF CURRICULUM STUDIES	779
JOURNAL OF VISUAL LANGUAGES AND COMPUTING	660
BRITISH JOURNAL OF EDUCATIONAL STUDIES	636
ENERGY EDUCATION SCIENCE AND TECHNOLOGY	-
IBM SYSTEMS JOURNAL	-

Source: ISI Web of Science(2015)

In terms of the main sources, the most relevant journal is Review of Education Research, and the second is Educational Researcher, what is understandable, once most part of the debate on educational technology as didactic tool occurs in educational area. The relevance of the researched articles can be evaluated by the Impact Factor (IF), as it can be seen in table 4. The IF is used as an evaluation measure of publication relevance of the source, what is usually taken as a quality indicator in publications. The IF of an article is calculated by the average number of citations of article published two years before.

The impact factors of a given year are published only in the following year, in order the publications of the previous year can be received by the indexation agency. The general evaluation of relevant production can be more precise having the history of IF by the journal, as it can be seen in figures 2 to 15.

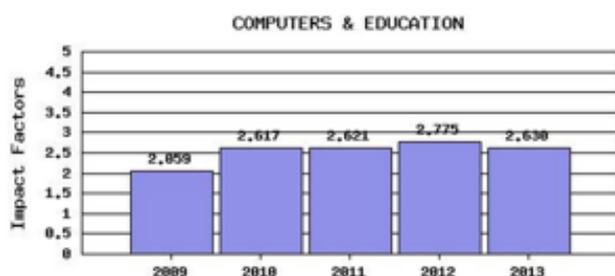


Figure 3 – FI trend of Computer & Education
Source: Journal Citation Reports (2015)

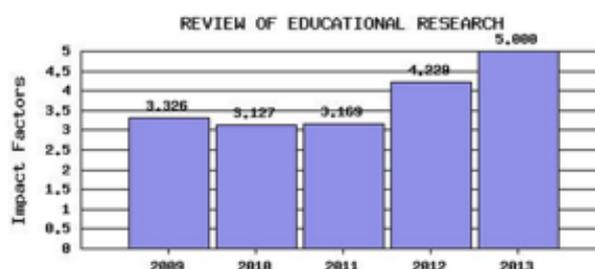


Figure 4 – FI trend of the Review of Education Research
Source: Journal Citation Reports (2015)

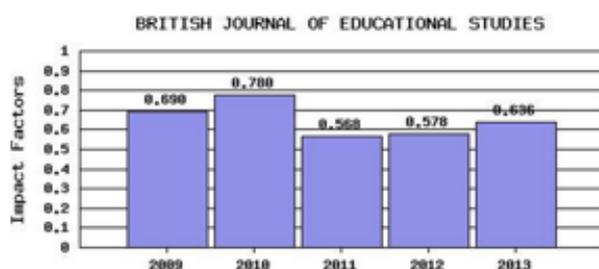


Figure 5 – FI trend of British J. of Ed. Stud. Source:
Journal Citation Reports (2015)

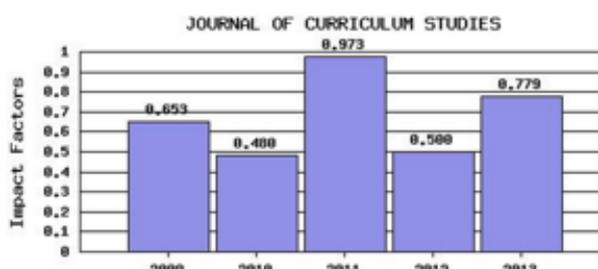


Figure 6 – FI trend of the Journal of Curric. Stud.
Source: Journal Citation Reports (2015)

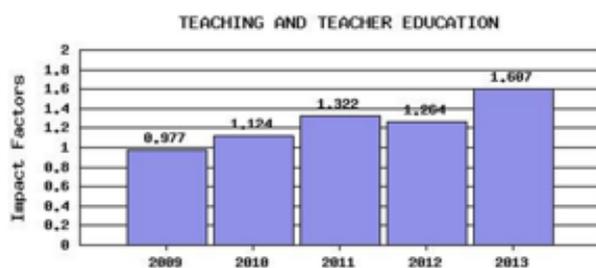


Figure 7 – FI trend of Teaching and T. Educ. Source:
Journal Citation Reports (2015)



Figure 8 – FI trend of American Ed. R. Journal Source:
Journal Citation Reports (2015)

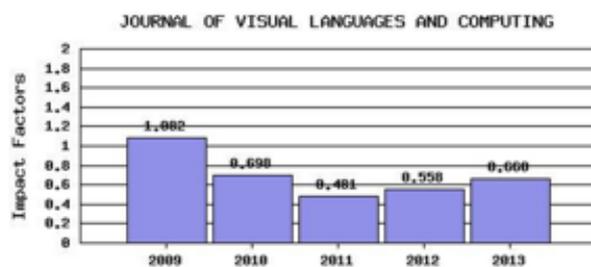


Figure 9 – FI trend of the Journal of Visual L. Comp.
Source: Journal Citation Reports (2015)

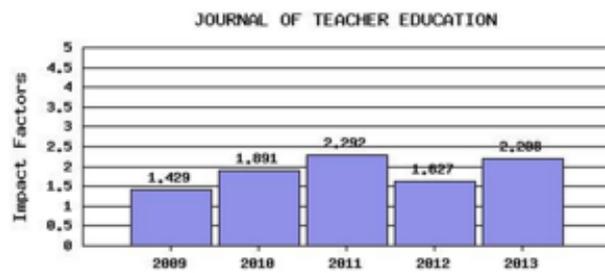


Figure 10 – FI trend of the Journal of Teach. Education.
Source: Journal Citation Reports (2015)

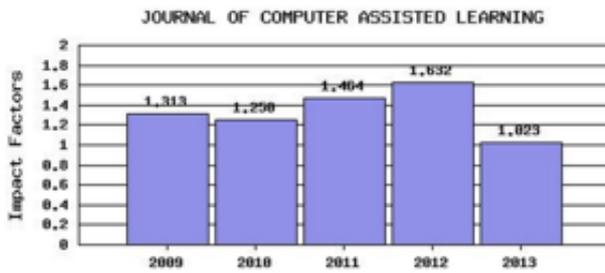


Figure 11 – FI trend of the Journal of Comp. A. Learn.
Source: Journal Citation Reports (2015)

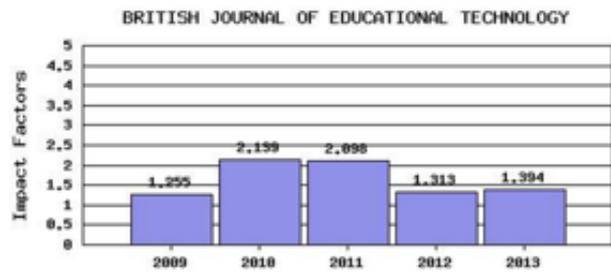


Figure 12 – FI trend of British J.of Educ. Tech.
Source: Journal Citation Reports (2015)

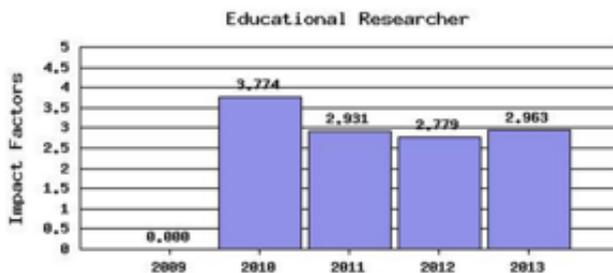


Figure 13 – FI trend of Educational Researcher.
Source: Journal Citation Reports (2015)

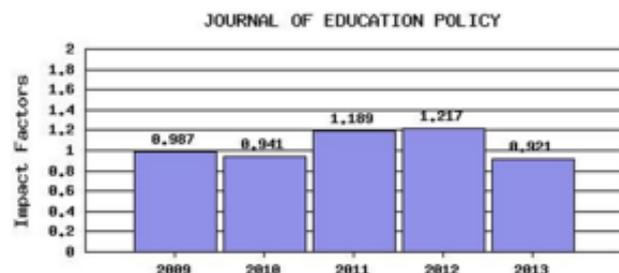


Figure 14 – FI trend of the Journal of Educ. Policy.
Source: Journal Citation Reports (2015)

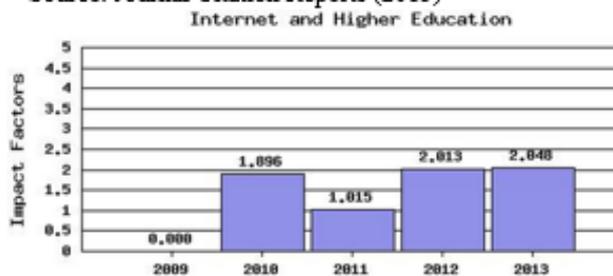


Figure 15 – FI trend of Internet and H. Education.
Source: Journal Citation Reports (2015)

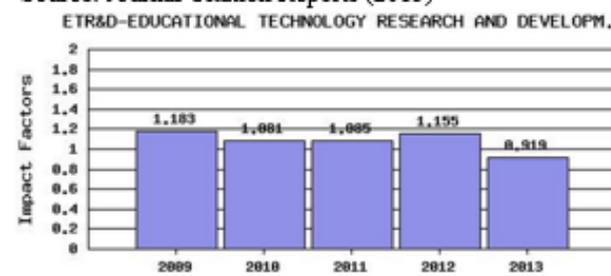


Figure 16 – FI trend ETR & D.
Source: Journal Citation Reports (2015)

By the if's evaluation among the journals trends possible to invert the trends in publications the the importance of a journal, as states in Figure 17. It is possible to see the alternation of positions in most journals, specially Review of Education Research, which in the years 2009, 2011 and 2013 was leading the IF, having an average in the period of 3770. Computer & Education had a progressive rise in the years 2009 and 2013, with a significant decrease in 2013, but even so it has a relevant position compared to other journals, having an average of IF of 2450 in the years 2009 to 2013. Educational Researcher in 2010 was the first place but lost this position in the years 2011 and 2012, having a minor increase in 2013.

Impact factor of journals.

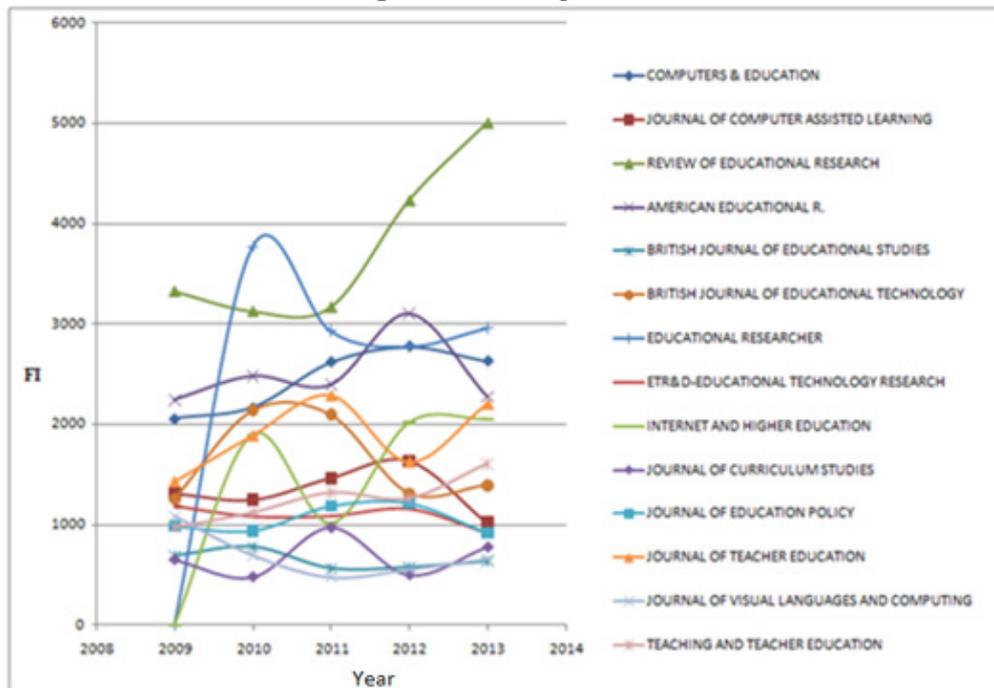


Figure 17 – FI relationship between Periodicals.
Source: Journal Citation Reports (2015).

Also it is important to state that 11 journals kept the hits from 650 to 3000 IF, keeping such values of IF in journals category. Besides that, there has been a rise in the annual average of IF in the analyzed period, what shows an increase in academic production on the studied topic.

Regarding publications by country, 60% of the articles were published in United Kingdom, 32% in USA, and 8% in Turkey, what reinforces the amount of publications on the topic involving technology and education as didactic tool in English language, with most publications in both United Kingdom and USA. The main institutions are located in United Kingdom as well, as we can see in Table 5.

TABLE 5
Articles by country of origin periodicals

Country	Count	% de 25
England	15	60
USA	8	32
Turkey	2	8

Source: ISI Web of Science(2015)

It was also observed that 64% of the articles were published in journals specialized in Education área, such Education & Education Research, 28% in Computer Science journals like, Computer Science and Education & Education Research and 8% in the journal Computer Science, as we can see in Table 6.

TABLE 6
Articles by research area of journals

Research Areas	Count	% de 25
Education & Educational Research	16	64
Computer Science; Education & Educational Research	7	28
Computer Science	2	8

Source: ISI Web of Science(2015)

As for institutions and research, it is possible to see that articles production is spread among 25 institutions related to the work activities of the authors, as we can see in Table 7.

TABLE 7
Teaching and research institution

Institution	Country
Afyon Kocatepe University	Turquia
Boston College	EUA
Brunel University	Inglaterra
Georgia Institute of Technology	EUA
Ghent University	Bélgica
Indiana University Bloomington	EUA
Miami University	EUA
Michigan State University	EUA
Newcastle University - UK	Inglaterra
Sheffield Hallam University	Inglaterra
University of Birmingham	Inglaterra
University of Cambridge	Inglaterra
University of Edinburgh	Escócia
University of Glasgow	Escócia
University of Hawaii	EUA
University of Illinois Chicago	EUA
University of Massachusetts Lowell	EUA
University of Minnesota Twin Cities	EUA
University of Northern Colorado	EUA
University of Tennessee	EUA
University of Twente	Holanda
University of Utah	EUA
University of Washington	EUA
Virginia Polytechnic Institute	EUA
Yuzuncu Yil University	Turquia

Fonte: ISI Web of Science(2015)

Source: ISI Web of Science(2015)

The amount of publications is directly related to institutions and authors, what can be seen in tables 7 and 8. It was also observed that 56% of the articles are related to institutions and research in USA, what reveals a relevant research status in such country, despite the amount of publications in English Journals (see table 5), responsible for 60% of the publications. This data confirms relevance of English journals the the preference of the authors by them apart from nationality, that means authors from different nationalities prefer to have their articles published in English journals.

It was also confirmed that 20% of the articles are related to authors working in England, 8% in institutions located in Scotland, 8% of institutions in Turkey, 4% in Belgium and 4% in Netherlands.

The evaluation of relationship between country of origin (table 5) and institutions origin (table 7) reinforces the perception of journals by country, once the authors related to institutions from other countries prefer having their articles published in United Kingdom.

Table 10 – Authors list.

Authors			
Abowd, GD	Hannafin, MJ	Miller, J	Smith, HJ
Alkan, Mehmet Ali	Hargreaves, DH	Mishra, Punya	Smith, R
Bebell, D	Herman, James	Motiwalla, Luvai F.	Stasko, JT
Brown, MI	Hermans, R.	Niederhauser, DS	Stoddart, T
Coldron, J	Higgins, S	O'Connor, K	Tondeur, J.
Cole, Melissa	Hill, JR	O'Dwyer, L	Valcke, M.
Dickey, MD	Hughes, Joan E.	Pelgrum, WJ	van Braak, J.
Dillon, A	Hundhausen, CD	Pellegrino, James W.	Wall, K
Douglas, SA	Kecebas, Ali	Robelia, Beth	Webb, Marsena
Draper, SW	Kim, Hyung Nam	Roblyer, M. D.	Windschitl, M
Gabbard, R	Koehler, Matthew J.	Russell, M	Witty, James Vince
Greenhow, Christine	Lawless, Kimberly A.	Sahl, K	Yahya, Kurnia
Grek, Sotiria	McDaniel, Michelle	Sharples, M	Yesilyurt, Mustafa

Source: ISI Web of Science

In order to have an overview of such key words, all terms and words were provided in a word cloud, using the application Wordle (www.wordle.net) In the cloud, the most used words are outlined in different sizes, as we can see in Figure 18.

is the mother language.

Regarding the research questions, most of the articles relate the concept of Educational Technology and Didactic Tool having as concern in the proper use of technological resources and the efficacy in the learning process, as well as the results obtained to meet such efficacy.

The great technological diversity reveals the range of application of such tools in educational area, what renders more importance to studies on the use, application and adjustments of such technologies, aiming educational efficiency and efficacy, opening oportunities to development of specific tools to meet the segment of educational needs. This is evident when we see articles related to technology as a resource or a tool to meet a pedagogical issue, what can be actually observed in the selected articles, 64% of them were published in the area of Education and Education Research, 28% in journals specialized in Computer Science and Education and 8% only in Computer Science domain.

From the main concept involving Educational Technogy and Didactic Tool, it can be observed that in recent articles there is a trend of research in the behavior of the teacher in relation to such technologies, besides the studies centered in cooperation learning by technological devices, as well as online learning inclusion politics and development of educational technologies and its role in educational process.

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