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Article abstract

Partnership is one of the mechanisms of scientific development, and scientific collaboration or co-authorship is considered a key element in the progress of science. This study is a survey with a scientometric approach focusing on the field of e-learning products over 10 years. In an Advanced Search of the Web of Science, the following search formula was used: TS=(“m-learning” OR “mlearning” OR “mobile learning” OR “online learning” OR “virtual learning” OR “distance learning” OR “electronic learning”). The study was limited to 2005-2014, and the document type was limited to paper. A total of 4292 documents were found, to which 12362 authors contributed. The articles were evaluated individually and their information was entered into Microsoft Office Excel 2007 for analysis using the collaborative coefficient formula. In the Computers and Education journal, articles with two authors are the most frequent. The United States, with the highest production of articles in the field of e-learning, tends to produce articles with two authors. In 2014, the most productive year, articles with three authors were more frequent. The highest collaborative coefficient is in 2005 and 2014. Our findings show that despite the need for research activities as a team, the authors in the field of e-learning tend to publish their papers alone or in a team of two.

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# A Survey of the Collaboration Rate of Authors in the E-Learning Subject Area over a 10-Year Period (2005-2014) Using Web of Science

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## Abstract

Partnership is one of the mechanisms of scientific development, and scientific collaboration or co-authorship is considered a key element in the progress of science. This study is a survey with a scientometric approach focusing on the field of e-learning products over 10 years. In an Advanced Search of the Web of Science, the following search formula was used: TS=("m-learning" OR "mlearning" OR "mobile learning" OR "online learning" OR "virtual learning" OR "distance learning" OR "electronic learning"). The study was limited to 2005-2014, and the document type was limited to paper. A total of 4292 documents were found, to which 12362 authors contributed. The articles were evaluated individually and their information was entered into Microsoft Office Excel 2007 for analysis using the collaborative coefficient formula. In the Computers and Education journal, articles with two authors are the most frequent. The United States, with the highest production of articles in the field of e-learning, tends to produce articles with two authors. In 2014, the most productive year, articles with three authors were more frequent. The highest collaborative coefficient is in 2005 and 2014. Our findings show that despite the need for research activities as a team, the authors in the field of e-learning tend to publish their papers alone or in a team of two.

*Keywords:* e-learning, collaboration, authors, collaborative coefficient, Web of Science

## Introduction

Various areas of science, and researchers at the national and international levels, emphasize scientific collaboration among authors (Glänzel & Schubert, 2001; Sonnenwald, 2007). The growth of scientific collaboration shows individual mobility and a collective attitude to solving scientific problems (Glänzel & Schubert, 2001; Leydesdorff & Wanger, 2008). Therefore, in recent years we find many scientific papers and reports in the literature that are the result of the cooperation of multiple authors (Andrés, 2009);

moreover, according to Laband and Tollison (2000), academic work increasingly involves teamwork (Posner, 2001).

With the development of interdisciplinary sciences that have created scientific dynamism and growth in recent decades, the possibility working as an individual scholar has been reduced. No one person can be an expert in all areas of research. This is why partnership is one of the mechanisms of scientific development, and scientific collaboration leading to co-authorship is considered a key element in the progress of science. In collaborative activities, researchers share their ideas to increase the quality of their research and to use each other's specialized skills and benefit from the synergy of teamwork. (Stefano, Fuccella, Vitale, & Zaccarin, 2013). Given this trend, the study of the collaboration rate of authors has become an interesting topic in scientometrics. Scientometrics, one of the methods for the evaluation of scientific activities, studies scientific development in various areas of human knowledge. Scientometrics can evaluate scientists' degree of collaboration in scientific publications (Asadzandi, Shahbodaghi, Sajjadi, Kamkarhaghghi, & Hemmat, 2012).

E-learning is an interdisciplinary field of science. Its integration into education could be effective in addressing some educational challenges (Albarrak, 2011). Scientific collaboration among different disciplines would be essential for the success of an e-learning system.

This method of training functions as a complement to traditional training methods or, in some cases, has replaced them (Khan & Badii, 2012). Therefore, studying and reviewing the status of this area in terms of research production, authorship, country and organization of research, or scientometric studies in general is necessary, because scientometric studies can provide a perspective on the status of a scientific discipline for policy makers, planners and researchers.

A review of the literature shows that in the fields of library and information science (Hart, 2000), history and philosophy (Osca-Lluch, Velasco, López, & Haba, 2009), laser science (Garg & Padhi, 2001), management (Acedo, Barroso, Casanueva, & Galán, 2006), pharmacy (Osareh, Serati Shirazi, & Khademi, 2014) and accounting, psychology, management, and economics (Hariri & Nikzad, 2011), biology, physics, and mathematics (Newman, 2004), physiology and pharmacology, molecular, cellular, and genetic biology studies and medicine (Olmeda-Gómez, Perianes-Rodríguez, Ovalle-Perandones, & Moya-Anegón, 2008), sociology (Moody, 2004) and economics (Krichel & Bakkalbasi, 2006) have been conducted to determine the rate of co-authorship; therefore, in this study we decided to assess the collaboration rate of authors in the e-learning subject area in a 10-year period (2005-2014) through the Web of Science.

## Material and Methods

This study is a survey with a scientometric approach focusing on the field of e-learning literature over 10-years (2005-2014). To retrieve all publications from this area of scholarship it was necessary to find the right formula for searches. Therefore, first of all, the UNESCO and ERIC thesauri were used to retrieve equivalent terms for electronic learning. Then, in the Advanced Search of the Web of Science, the following search formula was used: TS=("m-learning" OR "mlearning" OR "mobile learning" OR "online

learning" OR "virtual learning" OR "distance learning" OR "electronic learning"), the results were limited to 2005-2014, and the document type was limited to paper. A total of 4292 documents was found, to which 12362 authors contributed. The articles were evaluated individually in terms and their information that was entered in Microsoft Office Excel 2007 for analysis. In this study, the following formula was used to calculate the collaboration coefficient:

$$cc = 1 - \frac{\sum_{j=1}^k 1 \left(\frac{1}{j}\right) f_j}{N}$$

$f_j$  = number of articles with  $j$  authors

$j$  = articles (1 author, 2 authors, 3 authors, 4 authors, and more than 4 authors)

$N$  = number of articles

$K$  = The greatest number of authors in a paper (Ajiferuke, Burell, & Tague, 1988)

## Results

Table 1

### *Collaboration Rate of Prolific Authors in E-learning*

	<b>Number of authors per article</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>&gt;4</b>	<b>Total</b>
	<b>Name of prolific author</b>						
1	Hwang GJ	1	1	8	12	3	<b>25</b>
2	Kinshuk	0	2	5	7	5	<b>19</b>
3	Lin FJ	0	1	5	7	5	<b>18</b>
4	Huang YM	0	2	6	7	3	<b>18</b>
5	Chen NS	0	2	4	6	4	<b>16</b>
6	Looi CK	0	3	3	2	7	<b>15</b>
7	Richardson JTE	9	1	4	0	0	<b>14</b>
8	Wong LH	0	3	2	1	5	<b>11</b>
9	Van Der Schaar M	0	6	2	2	1	<b>11</b>

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10	Shea P	0	6	0	1	4	<b>11</b>
11	<b>Total</b>	10	27	39	45	37	<b>158</b>

In Table 1, the authors are sorted according to their number of publications. The rate of collaboration among prolific writers in the field of e-learning is bold and significant; few articles are single-authored, while the number of articles with four or more authors is remarkable. According to the table, Hwang, with 12 four-author articles and 8 three-author articles, is ranked in first place for author collaboration, while Richardson, with 9 single-authored articles, 1 two-author article and 4 three-author articles, is in last position. This table clearly shows that authors in this area are keen to write scientific papers as a team.

Table 2

*Collaboration Rate of Authors Publishing in Prolific E-learning Journals*

	<b>Number of authors per article</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>&gt;4</b>	Total
	<b>Name of journal</b>						
1	<i>Computers and Education</i>	27	68	72	38	34	<b>239</b>
2	<i>International Review of Research in Open and Distributed Learning</i>	50	61	52	14	5	<b>182</b>
3	<i>Educational Technology &amp; Society</i>	29	41	28	17	26	<b>139</b>
4	<i>British Journal of Educational Technology</i>	17	33	19	5	8	<b>82</b>
5	<i>Computers in Human Behavior</i>	13	27	21	10	11	<b>79</b>
6	<b>Total</b>	136	230	192	84	84	<b>721</b>

Table 2 shows five journals that publish many articles in the field of e-learning. The *Computers and Education* journal, with 239 articles related to e-learning, is a prolific journal with a noticeable number of articles with three authors. However, in general, the co-authorship status of these journals shows that articles with two authors are the most frequent.

Table 3

*Collaboration Rate of Authors from Countries Prolific in E-learning Publication*

	<b>Number of authors per article</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>&gt;4</b>	<b>Total</b>
	<b>Name of country</b>						
1	USA	192	377	305	197	262	<b>1333</b>
2	England	97	115	106	64	69	<b>451</b>
3	Taiwan	71	105	82	73	45	<b>376</b>
4	People's Republic of China	23	68	93	85	60	<b>329</b>
5	Canada	40	52	62	43	55	<b>252</b>
6	Spain	23	42	60	41	69	<b>235</b>
7	Australia	36	68	53	29	46	<b>232</b>
8	Germany	12	20	37	26	33	<b>128</b>
9	Turkey	35	44	29	10	6	<b>124</b>
10	South Korea	9	33	38	15	5	<b>100</b>
11	<b>Total</b>	<b>538</b>	<b>924</b>	<b>865</b>	<b>583</b>	<b>650</b>	<b>3560</b>

According to Table 3, scholars in the United States, with the highest production in the field of e-learning, have a tendency to write articles with two authors. Table 3 clearly demonstrates that writers prefer to work in teams of two or three members.

Table 4

*Collaboration Rate of Authors at Institutions Prolific in E-learning Publication*

	<b>Number of authors per article</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>&gt;4</b>	<b>Total</b>
	<b>Name of institution</b>						
1	University of California System	5	29	30	10	26	<b>100</b>
2	Florida State University System	15	29	19	13	12	<b>88</b>

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3	Open University	23	20	18	9	9	<b>79</b>
4	National Institute of Education, Nanyang Technological University (NIE/NTU)	3	17	18	21	13	<b>72</b>
5	University of London	11	23	11	8	15	<b>68</b>
6	National Central University (Taiwan)	1	9	13	14	14	<b>51</b>
7	<b>Total</b>	<b>58</b>	<b>127</b>	<b>109</b>	<b>75</b>	<b>89</b>	<b>458</b>

In Table 4, institutions producing more than 50 e-learning publications were identified and the articles they published were investigated in terms of co-authorship. The results show that among 458 publications produced at these 7 institutions, similar to the findings by country of origin, articles with two authors were more frequent.

Table 5

*Number of Authors per Publication, by Year*

	<b>Year</b>	<b>Number of publications</b>	<b>Number of authors</b>	<b>Authors per publication</b>
1	2005	280	775	<b>2.76</b>
2	2006	242	709	<b>2.92</b>
3	2007	273	727	<b>2.66</b>
4	2008	368	996	<b>2.70</b>
5	2009	418	1146	<b>2.74</b>
6	2010	428	1215	<b>2.83</b>
7	2011	501	1433	<b>2.86</b>
8	2012	564	1687	<b>2.99</b>
9	2013	570	1744	<b>3.05</b>
10	2014	648	1930	<b>2.97</b>
	<b>Total</b>	<b>4292</b>	<b>12,362</b>	<b>28.48</b>

A total of 4292 articles with 12,362 authors were retrieved in the period of 10-years. The highest number of documents was in 2014 (n=648) and the lowest in 2006 (n=242). In terms of the number of authors, the year 2014 with 1930 authors had the highest number of authors, followed by the year 2013 with 1744 authors. On the other hand, the lowest rate was observed in 2006 with 709 authors. In terms of the number of authors per publication, the year 2013 had the highest ratio of 3.05, while almost similar values are recorded for all years in the survey.

Table 6

*Collaboration Rate of Authors, by Year*

	<b>Authors per publication</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>&gt;4</b>	<b>total</b>
	<b>Year of publication</b>						
1	2005	52	78	78	35	37	<b>280</b>
2	2006	38	74	63	33	34	<b>242</b>
3	2007	70	71	50	42	40	<b>273</b>
4	2008	73	109	93	44	49	<b>368</b>
5	2009	76	123	109	57	52	<b>418</b>
6	2010	74	132	93	66	63	<b>428</b>
7	2011	96	131	127	69	78	<b>501</b>
8	2012	100	136	134	80	114	<b>564</b>
9	2013	83	142	139	100	106	<b>570</b>
10	2014	89	143	187	110	119	<b>648</b>
11	<b>Total</b>	754	1136	1072	632	691	<b>4292</b>

According to Table 6, in 2014, the most productive year in the field of e-learning, articles with three authors were more frequent than other articles, but in 2013 most articles had two authors. In general, Table 6 shows that in e-learning areas, authors tend to work in teams of two.

For calculating collaborative coefficient, we used the CC index, which shows the degree of collaboration among authors. Whatever this index moves toward 1, it shows more collaboration; when it moves toward 0, it shows lower collaboration and a tendency to single-author articles.



Table 7

*Collaborative Coefficient in the E-learning Area, 2005-2014*

	<b>Year</b>	<b>CC</b>
1	2005	<b>0.20</b>
2	2006	<b>0.18</b>
3	2007	<b>0.17</b>
4	2008	<b>0.17</b>
5	2009	<b>0.18</b>
6	2010	<b>0.18</b>
7	2011	<b>0.18</b>
8	2012	<b>0.17</b>
9	2013	<b>0.15</b>
10	2014	<b>0.20</b>
11	<b>Average</b>	<b>0.17</b>

As seen in Table 7, the greatest amount of CC is in 2005 and 2014, although the collaborative coefficient is quite similar in the remaining years. According to the CC, it can be concluded that willingness to cooperate among the authors in the e-learning area is low; they are more inclined to single- or two-author articles.

## Conclusion

This study investigated the collaboration of authors publishing in the field of e-learning and calculated the collaborative coefficient for the first time. The total number of publications was 4292 and the total number of authors who participated in these articles was 12,362. A survey of the status of co-authorship between prolific researchers showed that they were interested in preparing articles in groups, so the number of articles with four authors had a high rank compared to articles with different numbers of authors. This indicates that there is a spirit of teamwork among influential authors in the field of e-learning.

Assessing the 25 articles of G. Hwang, the most prolific author in the field, revealed that he had collaborated with researchers of the fields of computer science, library science and education. Also, there have been more than four coauthors in articles that Hwang has published since 2012. This may show the

power of interdisciplinary research. However, evaluation of the status of participation of authors in high-producing journals showed a significantly higher number of articles with two authors, as compared to articles with three or four authors. Of course, in the *Computers and Education* journal, the most prolific journal in this area with 239 articles, the number of articles with three authors was very high compared to articles published in other journals from 2005 through 2014. Reviewing the journal articles shows a trend towards publishing interdisciplinary ones since 2010.

Our data as organized by country of authors showed that the United States of America (1333 publications) was the most prolific country and the data revealed that they tended to publish their articles in two-member teams; this situation was also repeated for other prolific countries. Single or double authored articles could be considered a threat for promotion of the science of e-learning. For example, South Korea is among the 10 most prolific countries in the literature of e-learning, but in that country there seems to be less interdisciplinary collaboration in published articles. However, establishing an atmosphere of collaborative research, both nationally and internationally, is essential.

Our study of the authors' institutional affiliations showed that the University of California was in the first place among prolific institutions in this period with 100 articles; the data for this institution also indicated a high number of articles with two authors, similar to the previously mentioned result for the United States as a whole. As mentioned earlier, willingness to undertake scientific collaboration depends on not only individual characteristics, but also on rules and regulations. Organizations can emphasize and support interdisciplinary researches in order to progress in the field and develop new concepts.

Scientific production in the 10-year period covered by our study showed that the year 2014, with 648 publications and 1930 authors, was the most prolific year. Moreover, the results showed that the average number of authors per publication in each year except 2013 (it is more than average and Plus or minus two standard deviations) was relatively the same. In the most years, articles with two authors were significantly more frequent but in two years, the trend has changed, in 2005 articles with three authors were equal to articles with two authors and in 2014 articles with three authors are considerably higher. Findings indicate that this emerging field of science needs time to be established as an interdisciplinary one which could be applicable to achieving educational objectives in any other field.

The calculated collaborative coefficient (CC) in the field of e-learning showed an almost constant value during these 10-years, and the mean CC (0.17) showed that the coefficient of collaboration was very low in this field. This low coefficient could be considered a threat which leads to low quality of publications, absence of articles in reputable databases, ineffectiveness of research, failure of the field to stay up to date, researchers' isolation and, finally, loss of opportunity to build new concepts and research projects (Hariri & Nikzad, 2011).

Our findings show that, despite the need to conduct research activities as a team in order to increase the quality of the research, the authors in the field of e-learning tend to publish their papers alone or in teams of two. If this situation continues, it can have negative effects such as a decline in the quality of articles, shortcomings in knowledge sharing and diffusion on a global level, and isolation of researchers in this field.

Our results can be useful to institutions, journals, nations, and policy makers in this field by drawing their attention to co-authorship at national and international levels. Through considering motivational mechanisms such as incentives, or allocating more points for articles with more scientific collaboration between authors, effective steps can be taken towards improving the status of this area. However, according to our analysis of articles on e-learning in the Web of Science from 2012 onwards, there is an upward trend in scientific collaboration in our field, and there is hope that, due to our entry into the digital age and the nature of the field of e-learning, researchers have understood the need for scientific collaboration.

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