

# A Bibliometric Study of E-Learning Literature on SSCI Database

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**Abstract.** This paper investigates the publishing trends of e-learning literature catalogued in SSCI database during 1967-2009. Our findings indicate that (1) the quantity of recent research on e-learning is expanding remarkably; (2) the frequency indexes of authors productivity do not appear to abide by Lotka's Law; (3) most research papers on e-learning are generated by multiple authorship; and (4) applications of e-learning have most found in research areas such as Education & Educational Research, Information Science & Library Science, and Computer Science/Interdisciplinary Applications. Finally, future directions of research on e-learning are considered. Moreover, according to Bradford's Law, the three zone ratio comparisons almost equal as 1 : 8 : 82, which means the data does match Bradford's Law. And the seven core journals in e-learning are identified and analyzed.

**Keywords:** E-learning, Lotka, Bradford, author productivity, bibliometrics.

## 1 Introduction

Since the first scholarly paper in electronic-learning, or e-learning, appeared in 1967<sup>1</sup>, and according to SSCI database explorations of the possibilities of e-learning have seen a vigorous development, especially in the last fifteen years owing to the Information and Communication Technology (ICT). Kruse (2004) analyzed developments in ICT-based E-learning through 1996 to 2002 and argued that e-learning started from 1996 and reached its peak in 2000. Around 2002, it returned to previous level. ICT-based E-learning leads the development of knowledge management to the community of Management and Business Administration. (Huang and Yang, 2009; Garcia, 2009) Researches that provide practicable e-learning options to narrow the digital divide are also discussed from the viewpoint of sociology and social science. (Friedman and Deek, 2003; Laschewski, 2008; Mutula, 2008).

Aiming to arrive at a better understanding of the quantitative characteristics of recorded information such as the research institutions and subject areas of e-learning literatures on social science, this paper employs a bibliometric methodology towards a

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<sup>1</sup> According to SSCI database, we found one retrieved record "[Anon] (1967), New Electronic Learning Center. Educational Technology 7(3): 16-17." The author is anonymous.

literature review concerning its patterns of productivity and publishing trends. Last but not least, applying Lotka's law and Bradford's law to analyze author productivity and core journals in this field (within 1967 and 2009) respectively, will lead to discovery in literature features and research tendency in the future.

## 2 Description of E-Learning

The term e-learning has several definitions. Some refer to e-learning as either packaged content pieces or technical infrastructures; some consider it to be asynchronous to autonomous learning; while still others view e-learning as a synchrony for collaborative learning. It is generally agreed, however, that e-learning is an approach to learning. The e-learning group of National Center for Supercomputing Applications (NCSA) provides a general definition:

According to Rosenberg (2001), E-learning refers to the use of Internet technologies to deliver a broad array of solutions that enhance knowledge and performance. It is based on three fundamental criteria:

1. E-learning is networked, which makes it capable of instant updating, storage / retrieval, distribution and sharing of instruction or information.
2. It is delivered to the end user via a computer using a standard Internet technology.
3. It focuses on the broadest view of learning-learning solutions that go beyond the traditional paradigms of training.

Chute, Thompson & Hancock (1999) point out that e-learning has the following characteristics, for which it will become an indispensable vehicle of education:

- A fast, efficient dissemination to all areas of learning methods.
- High benefit-cost ratio, because they can provide higher-quality courses and to reduce travel.
- For busier people, if enough incentives and will enhance the rate of course.
- Information or knowledge acquisitions are the latest, but also the use of a faster-to-work.
- Courses can be shorter or longer periods, for learners to provide a more flexible and diversified.
- To increase the number of learning rather than being limited by space and cost.
- To consult experts in the field, and more, and quickly find the answer.

American Society for Training Development (ASTD) defines e-learning as the intermediate of transferring information through electronic means to assist learning. In brief, e-learning involves the use of technologies to enhance learning. Keegan (1990) defines e-learning as a teaching method whereby the teacher employs ICT, digital learning materials, along with pedagogical theories, to facilitate and support learning. E-learning may also be considered as a learning activity, which is based on on-line communication. Learners can browse through the materials, conduct discussions, perform in tests, or do exercises after logging onto the system.

The definition of e-learning in the national program is defined as an instructional and learning approach, which makes it possible for students to learn better and for teachers to teach more effectively, in contrast with traditional classroom settings. In

general, e-learning has several advantages, including: (1) it reduces the costs of teaching and training in organizations such as schools, government departments, businesses, and private institutions; (2) it stimulates learners' motivations to learning; (3) it provides opportunities for interactive and flexible learning (Hwang, 2003). On account of these benefits of e-learning, an increasing number of countries allocate funds and resources to encourage research in e-learning. In Europe, the Commission of the European Communities (2001) published the guidelines of an e-learning policy. The E-learning Action Plan-Designing tomorrow's education; The Secretary of Commerce in the United States (2002) made a report entitled "2020 Visions-Transforming Education and Training through Advanced Technologies". The government of Taiwan (2002) also initiated a five-year e-learning project called National Science and Technology Program and allocated four billion NT dollars to promote e-learning in Taiwan.

### 3 Research Findings and Discussion

Our research utilizes the data from the Social Sciences Citation Index (SSCI) of Web of Science created by the Institute for Scientific Information (ISI). An empirical retrieval method was operated using "e-learning", "distance learning", "digital learning",

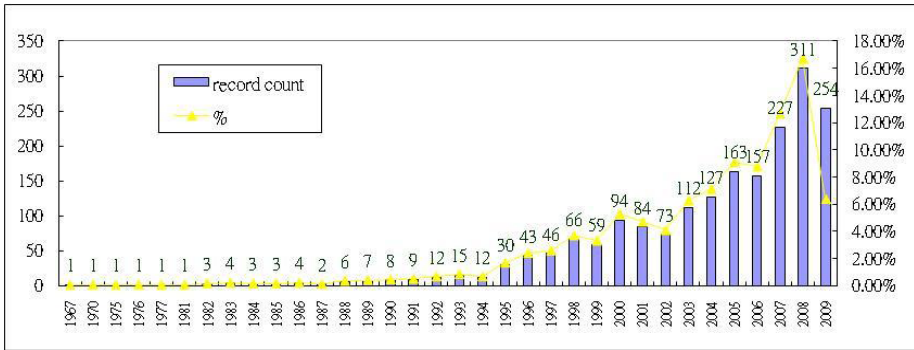


Fig. 1. Number of published papers in e-learning

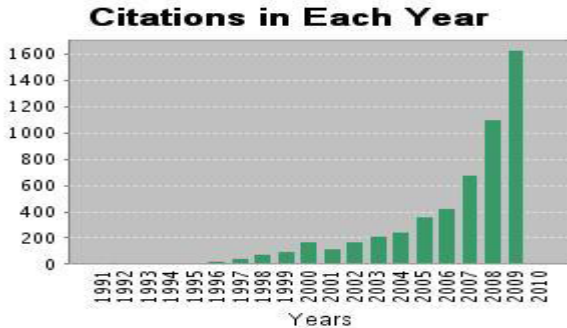


Fig. 2. Citation in each year (Source: SSCI database)

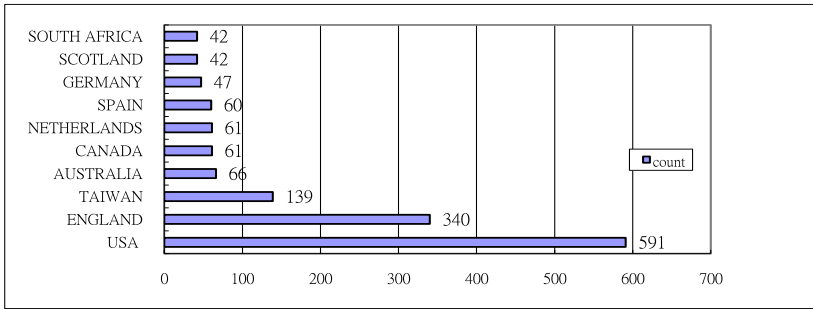


Fig. 3. Distribution of Top 10 productive country

or "electronic learning" to retrieve data. A total of 1,944 papers in e-learning published during 1967-2009 were found. Figure 1 and 2 indicate the growth of the number of academic papers and their annual citations. The results appear to suggest that the number of papers about e-learning has distinctively increased since 1995, and that citations of papers in e-learning are also on the increase each year. It appears that e-learning has received much attention from researchers, which leads to a rapid growth of related papers and citations, as illustrated in Figure 1 and 2. According to the numerical data, a large amount of research papers published during 2004-2009 have been catalogued in the SSCI database, with the distribution rate of 163(9.12%), 157(8.78%), 227(12.7%), 311(16.72%), and 254(13.07%) respectively, against the total number of papers indexed.

With regard to the distribution of nationalities of the 1,632 papers indexed for this research, top-rated nations with the most publications catalogued in SSCI database during 1967-2009 are elicited, as illustrated in Figure 3. According to the statistics, the United States outnumbers all the other nations in terms of number of papers, with a total of 591 papers (30.4%) retrieved. It is then followed by England (340 papers; 17.49%), Taiwan (139 papers; 7.15%), Australia (66 papers; 3.4%), and Canada (61 papers; 3.14%).

Table 1. The top ranking institutions with record counts greater than or equal twelve

Institution Name	Count	%	Country
Open Univ	79	4.06%	England
Natl Cheng Kung Univ	19	0.98%	Taiwan
Univ Sheffield	19	0.98%	England
Univ N Carolina	18	0.93%	USA
Natl Chiao Tung Univ	17	0.87%	Taiwan
Natl Cent Univ	15	0.77%	Taiwan
Univ Illinois	13	0.67%	USA
Univ S Africa	13	0.67%	South Africa
Open Univ Netherlands	12	0.62%	Netherlands
Univ Pretoria	12	0.62%	South Africa

Table 1 offers a closer look at the distribution of academic institutions by which the indexed papers were submitted. It is observed that, among the 13 institutions whose record counts of indexed papers are greater than nine, 9 are located in USA, followed by England and Germany. Based on the published studies related to e-learning, USA is the most productive country. Taiwan is also among the top ten. (25, 3.15%). And its institution National Chengchi University ranks No.4, holds 12 published papers as that of Harvard University (USA), Santa Fe Institution (USA) and University Groningen (Netherlands).

Table 2 offer an investigation into the authors who have written more than six papers related to e-learning research. The top 3 authors are Richardson, J.T.E. (13, England), Barker, P (12, England), Deeson, E (10, England), and Koper, R (10, Netherlands). Table 2 shows that the research in computer science and Education related to e-learning are the mainstream.

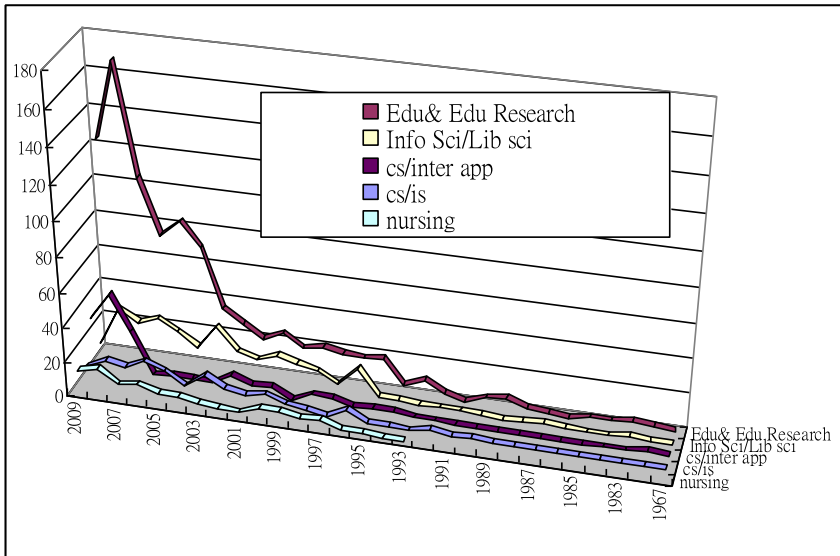
With a view to provide insights into the future directions of e-learning research, the discussion now turns to the applications of electronic learning. Table 3 shows the top 10 subject areas in which e-learning are most widely utilized based on our retrieval runs of SSCI database. Among all the subject matters listed here, education & educational research take the lead with 878 papers (45.16%) against the total of 1,944papers retrieved. Information science & library science ensues, with 301 papers recorded (15.48%). This is then followed by Computer Science/Interdisciplinary Applications,

**Table 2.** The top ranking of published papers in e-learning based on authors

Author	Count	%	Comprising % of country	Country	Institution	Subject area
Richardson, JTE	13	0.67%	2.20%	England	Open Univ	Education
Barker, P	12	0.62%	2.03%	England	Univ Teesside	Info Sci & Lib Sci
Deeson, E	10	0.51%	1.69%	England	Blackwell Publ Ltd	Education
Koper, R	10	0.51%	16.4%	Netherlands	Open Univ	Education
Chen, CM	9	0.46%	6.47%	Taiwan	Natl Chengchi Univ	Info Sci & Lib Sci
Huang, YM	7	0.36%	5.04%	Taiwan	Natl Cheng Kung Uni	Eng Sci
Tseng, SS	7	0.36%	5.04%	Taiwan	Natl Chiao Tung Univ	Comp Sci
Amandi, A	6	0.31%	75%	Argentina	Unicen Univ	Comp Sci
Barron, T	6	0.36%	1.02%	USA	Univ Rochester	Comp Sci
Chen, GD	6	0.31%	4.32%	Taiwan	Natl Cent Univ	Comp Sci
Du Preez, M	6	0.31%	14.3%	South Africa	Univ S Africa	Info Sci & Lib Sci
Galagan, PA	6	0.31%	1.02%	USA	Amer Soc Training Development	Business
Liaw, SS	6	0.31%	4.32%	Taiwan	China Med Univ	Education
Price, B	6	0.31%	1.02%	England	RCN Inst	Info Sci & Lib Sci
Sun, PC	6	0.31%	4.32%	Taiwan	Natl Kaohsiung Normal Univ	Comp Sci
Tattersall, C	6	0.31%	9.84%	Netherlands	Open Univ	Education

**Table 3.** The top ranking of published papers in e-learning based on subject areas

Rank	Subject Area	Count	%
1	Education & Educational Research	878	45.16%
2	Information Science & Library Science	301	15.48%
3	Computer Science/Interdisciplinary Applications	176	9.05%
4	Computer Science/Information Systems	138	7.10%
5	Nursing	111	5.71%
6	Psychology, Multidisciplinary	79	4.06%
7	Business	75	3.86%
8	Management	61	3.14%
9	Education, Scientific Disciplines	54	2.78%
10	Communication	50	2.57%



**Fig. 4.** Yearly Distribution of Top 5 Subject Areas

with 176 papers (9.05%) related to e-learning. Referring to Figure 4, Education & Educational Research is growing fast after 2000, while Information Science & Library Science and Computer Science/Interdisciplinary Applications are gradually growing.

To summarize, a vigorous development in e-learning literature is observed, based on our retrieval run over the SSCI database. The top five nations with the most papers in e-learning are the US, England, Taiwan, Canada, and Netherlands. In addition to our bibliometric data, which suggest the quantitative growth of research in e-learning, efforts have been made to further promote the development of this emerging field. The United Nations, for instance, has called for a massive investment in e-learning from governments, especially developed countries – on the ground that such efforts may contribute to a better understanding of nature, society, and related areas of interests, which will then empower the knowledge of the mankind in the near future.

#### 4 Bradford's Law and Journal Literature

Samuel C. Bradford in 1934 introduced Bradford's Law which is a pattern to estimates the exponentially diminishing returns of extending a search for references in

**Table 4.** The distribution of [E-Learning](#) journals

	No. of articles (A)	No. of journal (B)	Accumulated Journals (C)	(D) = (A)*(B)	(E) = Accumulated (D)	Log (acc. Journals)
(A) Core	159	1	1	159	151	2.1790
	152	1	2	152	303	2.4814
	131	1	3	131	434	2.6375
	58	2	5	116	550	2.7404
	41	1	6	41	591	2.7716
	33	1	7	33	624	2.7952
(B) Relevant	30	1	8	30	654	2.8156
	29	1	9	29	683	2.8344
	27	1	10	27	710	2.8513
	23	1	11	23	733	2.8651
	21	2	13	42	775	2.8893
	19	1	14	19	794	2.8998
	17	2	16	34	828	2.9180
	16	1	17	16	844	2.9263
	15	1	18	15	859	2.9340
	12	3	21	36	895	2.9518
	11	4	25	44	939	2.9727
	10	4	29	40	979	2.9908
	9	10	39	90	1069	3.0290
	8	2	41	16	1085	3.0354
	7	5	46	35	1120	3.0492
	6	13	59	78	1198	3.0785
(C) marginal	5	13	72	65	1263	3.1014
	4	23	95	92	1355	3.1319
	3	41	136	123	1478	3.1697
	2	85	221	170	1648	3.2170
	1	296	517	296	1944	3.2887

science journals. The law principle impose a formulation that if journals in a field are sorted by number of articles into three groups, each group approximate to one-third of all articles, then the number of journals in each group will be proportional to 1:n: n<sup>2</sup>. (Tsai, 2003)

The 1,944 publish papers in this study distributed in 517 journals. Table 4 provides the number of publish paper each journal and other information ranking by the number of publish paper according to the zoning of Bradford Law. Table 5 also provides the ratio comparisons of 3 zones, that is ratio of published paper each zone of zone A, B, C, 7:53:458. It almost equal to 7:56:448 as 1 : 8 : 8<sup>2</sup>. That is, A: B: C = 1: n: n<sup>2</sup>. The result matches the explanations of Bradford Law.

Table 6 shows the core journals in E-Learning. The number one journal, British Journal of Educational Technology has 159 published papers (8.18%), greater than the number of publish paper of number two journal, Computers & Education (152, 7.82%). It is also observed that the main subject areas of the five journals are Education and Education Technology.

### 5 Lotka’s Law and Author Productivity

Lotka's law of scientific productivity of authors is a good example with respect to such empirical laws. Lotka deduced an inverse square law relating the authors of

**Table 5.** The literature brief distribution in [E-Learning](#) based on journal

	(1) No. of journal	(2) No. of articles	(3) Range of No. of articles	(4) Average articles
A	7	24	33~159	3
B	52	376	6~30	7
C	458	1041	1~5	2

**Table 6.** The seven core journal titles and their statistics in E-Learning

Title	Count	%	Acc. %
British Journal Of Educational Technology	159	8.18 %	8.70 %
Computers & Education	152	7.82 %	16.5 %
Educational Technology & Society	131	6.74 %	23.2 %
Journal Of Computer Assisted Learning	58	2.98 %	26.2 %
Training & Development	58	2.98 %	29.2 %
Electronic Library	41	2.11 %	31.3 %
Etr&D-Educational Technology Research And Development	33	1.70 %	33.0 %



**Table 7.** Author distribution of Lotka's Law

Record count	% of author(s)	Accumulated % of Author(s) Sn (X)	Expected % of author(s)	Accumulated Expected % of author(s) Fo (X)	Absolute Value  Fo (X)-Sn (X)
1	0.8858	0.8858	0.8651	0.8651	<b>0.0207</b>
2	0.0816	0.9674	0.0888	0.9539	0.0134
3	0.0213	0.9887	0.0235	0.9774	0.0113
4	0.0057	0.9944	0.0091	0.9865	0.0078
5	0.0014	0.9957	0.0044	0.9909	0.0048
6	0.0024	0.9981	0.0024	0.9933	0.0048
7	0.0005	0.9987	0.0015	0.9948	0.0039
9	0.0003	0.9990	0.0006	0.9954	0.0035
10	0.0005	0.9995	0.0005	0.9959	0.0036
12	0.0003	0.9998	0.0002	0.9961	0.0037
13	0.0003	1.0000	0.0002	0.9963	0.0037

published papers to the amount of papers written by each author in 1926. The data represented in the decennial index of Chemical Abstracts specifically and the Auerbach's *Geschichtstafeln der Physik* as the name index, Lotka plots the number of authors against the number of contributions contributed by each author on a logarithmic scale. Lotka dictated these points are closely scattered around a straight line having a depth slope of approximately negative two. This empirical observation as Lotka concludes provided the following equation (Chung and Cox, 1990).

$$a_n = a_1/n^c, n = 1, 2, 3, \dots \quad (1)$$

Where

- $a_n$  = the number of authors publishing  $n$  papers,
- $a_1$  = the number of authors publishing one paper, and
- $c$  = a constant. (in Lotka's case,  $c = 2$ )

Taking the log of both sides of (1), we obtain

$$\log(a_n) = \log(a_1) - c \log(n). \quad (2)$$

In the computation of the "best empirical value", the constant  $c$  for data related to e-learning by fitting a line to the empirical frequency distribution. The regression results show that  $c = 3.28$ . If the estimated  $a_1$  is 0.8651, then the equation (1) will be stated as follows:

$$a_n = 0.8651 / n^{3.28}$$

It is possible to check whether e-learning literature matches the Lotka's Law by K-S statistical test. According to K-S test, as demonstrated in Table 7, as if  $D_{max} = 0.0407$  and the sampling number is bigger than 35, then the threshold value will be  $1.63/3703^{1/2} = 0.02679$ , while the number of accumulated authors will be 3703.

Although the fact that  $D_{max}$  is less than the threshold value, the result matched the generalized Lotka's law, which indicates that the Lotka's law is author productivity distribution data related to e-learning literature.

## 6 Conclusion

E-learning is one of fastest growing field of research in recent years. Having analyzed the characteristics of literature on e-learning as well as author productivity distribution, one may expect that the number of research papers in this area will continue to increase. The main research institutions which have yielded the most publications of e-learning papers are located in the US, England, and Taiwan. Our research findings also suggest that there is a centralization tendency of institution distribution in both England and Taiwan. The frequency indexes of author productivity distribution abide by Lotka's Law. Applications of e-learning are most active in the fields of Education & Educational Research, Information Science & Library Science, and Computer Science/Interdisciplinary Applications. It is also observed in our research that e-learning papers are usually generated by multiple authorships. Moreover, according to Bradford's Law, the three zone ratio comparisons almost equal as  $1 : 8 : 8^2$ , that means the data does match Bradford's Law. And, the seven core journals in E-Learning are identified and analyzed. The effects of perceived issues for the potential of e-learning are worthy to study further.

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