

MAPPING OF DIGITAL LEARNING RESEARCH OUTPUT: A SCIENTOMETRIC ANALYSIS

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ABSTRACT

An analysis of 6493 publications published by scientists on Digital Learning during 1989-2015 and received 56748 citations that the publication output in the Global Research Publications. The highest numbers of papers were published in the year of 2015 with 964 records and followed by 2013 with 673 records there were contributions. Overall, 17228 authors preferred 2235 journal and 4191 Institutions are involved the research in this areas.

Keywords: Digital Learning; E-Learning; Scientometrics

Introduction

The history of human life has related to Digital learning. It was causes to the key development in the rise of sedentary human civilization. In recent years, a remarkable shift in learning practices has occurred due to the development of new technologies. The role of an online educator or trainer entails not just creating great learning experiences, but also measuring their effectiveness. Most of the educators are satisfied with delivering a great class. They tend to overlook some of the most crucial aspects of educating learners, which are evaluating themselves and their instructional approach constantly. Learning journey is inextricably linked to instructor effectiveness, which can be measured in terms of learner engagement, which in turn is influenced by factors, such as course completion rate, overall content consumption, dropout rate, to name a few. Educators need to be constantly aware of these factors in order to ensure optimal learning outcomes. It allows educators and trainers to ensure the success of learners and that of their online teaching or training programme.

What is Digital Learning?

Digital learning is any instructional practice that is effectively using technology to strengthen the student learning experience. Another words means Digital learning is more than just providing students with a laptop. Digital learning requires a combination of technology, digital content and instruction.

Technology: Technology is the mechanism that delivers content. It facilitates how students receive content. It includes Internet access and hardware, which can be any Internet access device – from a desktop to a laptop to an iPad to a smartphone. Technology is the tool, not the instruction.

Digital Content: Digital content is the high quality academic material which is delivered through technology. It is what students learn. It ranges from new engaging, interactive and adaptive

software to classic literature to video lectures to games. It isn't simply a PDF of text or a PowerPoint presentation.

Instruction: Educators are essential to digital learning. Technology may change the role of the teacher but it will never eliminate the need for a teacher. With digital learning, teachers will be able to provide the personalized guidance and assistance to ensure students learn and stay on track – throughout the year and year after year – to graduate from high school. Teachers may be the guide on the side, not the sage on the stage.

Scientometric analysis

Scientometrics is the study of measuring and analysing science technology and innovation. Major research issues include the measurement of impact, reference sets of articles to investigate the impact of journals and institutes, understanding of scientific citations, mapping scientific fields and the production of indicators for use in policy and management contexts.

Definitions -Scientometrics

- The study of quantitative aspects of science as a discipline or economic activity
- Part of sociology of science and has application to science policy - making
- It involves quantitative studies of scientific activities, among others, publication, and so overlaps bibliometrics to some extent (Tague - Sutcliffe, 1992)

Objectives of the Study

The main objectives of the study was used to Mapping of Digital learning Research Output: A Scientometric Analysis with special reference to research activities at global level:

- To identify and analyze the rate of growth of research productivity;
- To examine the Year wise distribution of publications;
- To note the Document wise distribution of publications;
- To analyze the authorship pattern and examine the extent of research collaboration
- To identify Journal wise distribution of publications;
- To assess the Institution wise research concentration;
- To identify Country – wise Distribution of Publications;
- To identify the word wise distribution of publications.
- To test the law of metrics.

Statement of the Problem

Scientists can receive professional recognition and esteem as well as promotion, advancement, and funding for future research through publications. Publication is so central to productivity in research that the work becomes ‘a work’ only when it takes a conventional, physical (that is published) form, which can be received, assessed and acknowledged by the professionals. It could be seen clearly from the above discussion that Bibliometrics and Scientometric analysis is an important tool in analyzing any science and social science discipline. By keeping this view in mind, the researcher intends to undertake the study on “Mapping of Digital Learning Research Output: A Scientometric Study”.

Methodology

The present study aims at analyzing the research output of Researchers in the field of Digital Learning. It brings into focus the distribution of research output by following categories such as related growth of output and doubling time, authorship pattern, language of publications, forms of publications, country affiliations, and core journals etc. Besides statistical tools like trend analysis, correlation analyses and time series analyses were used to predict the future in digital learning research. The data were downloaded from web of science database during the period of 1989-2015 and tabulated using ‘ histcite’ software and analyzed for the study. Histcite is a software package used for Scientometric analysis and information visualization. The study explores the research concentration in digital learning and journal priority in publishing digital learning articles.

Tools and Techniques used

Digital learning is used in the present study. The total of 6493 records was published in Digital Learning research in global level. The research output was analyzed using various scientometric indicators. This software is designed to assist a user in analyzing bibliographic data, or any data of a textual nature formatted in a similar manner.

Application of Statistical Tools are used

In this study, the following bibliometric/scientometric indicators and statistical techniques/tools were employed while analysing the data on Digital Learning research output collected from the Web of Science.

- Relative Growth Rate (RGR)
- Doubling Time (Dt)
- Author Productivity

- Degree of Collaboration
- Bibliometric Laws

Year Wise Distribution of Publications

In the present study the research output on Digital Learning publication is taken as a tool to evaluate the performance at various levels. To analyze the year wise publication of the data has been presented in Table-1. The table depicts the research output in the global level. From the below table, it could clearly see that during the period 1989–2015 a total of 6493 publications were published. Table 1 clearly shows that during the period 1989- 2015 a total of 6493 publications were published at global level. The highest number of publication is 964 in 2015 with 266 Citations and followed by 673 papers in 2013 and 648 papers in 2014.

Table 1 shows Yearly wise distribution of publications during 1989-2015

#	Year	Records	%	TLCS	TGCS
1	1989	2	0.0	1	5
2	1990	2	0.0	0	5
3	1991	32	0.5	20	234
4	1992	35	0.5	2	739
5	1993	42	0.6	16	549
6	1994	52	0.8	18	795
7	1995	56	0.9	34	1560
8	1996	80	1.2	21	1406
9	1997	80	1.2	32	781
10	1998	88	1.4	20	1334
11	1999	95	1.5	36	1474
12	2000	123	1.9	70	2856
13	2001	127	2.0	53	1856
14	2002	126	1.9	46	3543
15	2003	164	2.5	85	3011
16	2004	189	2.9	138	2754
17	2005	242	3.7	133	3166
18	2006	245	3.8	159	3430
19	2007	245	3.8	162	2892
20	2008	353	5.5	387	4887
21	2009	378	5.8	300	4322
22	2010	420	6.5	340	4504
23	2011	488	7.5	246	3597
24	2012	544	8.4	192	3290
25	2013	673	10.4	149	2378
26	2014	648	10.0	102	1114
27	2015	964	14.5	12	266
	Total	6493		2774	

*TLCS – Total Local Citation Score ** TGCS – Total Global Citation Score

Table 2 shows the doubling time

S.No.	Publication Year	Records	Log W1	Log W2	R(a)	Mean R(a) 1-2	Doubling time	Mean Dt R(a) 1-2
1	1989	2	-	0.69	-		-	
2	1990	2	0.69	0.69	0.00		0.00	
3	1991	32	0.69	3.47	2.77		0.00	
4	1992	35	3.47	3.56	0.09		0.25	
5	1993	42	3.56	3.74	0.18		7.73	
6	1994	52	3.74	3.95	0.21		3.80	
7	1995	56	3.95	4.03	0.07		3.24	
8	1996	80	4.03	4.38	0.36		9.35	
9	1997	80	4.38	4.38	0.00		1.94	
10	1998	88	4.38	4.48	0.10		0.00	
11	1999	95	4.48	4.55	0.08		7.27	
12	2000	123	4.55	4.81	0.26		9.05	
13	2001	127	4.81	4.84	0.03		2.68	
14	2002	126	4.84	4.84	0.01	0.32	21.65	5.15
15	2003	164	4.84	5.10	0.26		87.66	
16	2004	189	5.10	5.24	0.14		2.63	
17	2005	242	5.24	5.49	0.25		4.88	
18	2006	245	5.49	5.50	0.01		2.80	
19	2007	245	5.50	5.50	0.00		56.25	
20	2008	353	5.50	5.87	0.37		0.00	
21	2009	378	5.87	5.93	0.07		1.90	
22	2010	420	5.93	6.04	0.11		10.13	
23	2011	488	6.04	6.19	0.15		6.58	
24	2012	544	6.19	6.30	0.11		4.62	
25	2013	673	6.30	6.51	0.21		6.38	
26	2014	648	6.51	6.47	0.04		3.27	
27	2015	964	6.47	6.87	0.40	0.16	18.31	15.81
Total		6493	Mean R (a) 0.24		10.5 years			

Table 2 clearly shows that doubling time in number of publication was observed during the period 1989- 2015, a total of 6493 publications, were published at global level. The highest number of publications in the year of 2015 with 964 records and followed by 2013 with 673 records. The least publication in the year 1989 and 1990 with only 2 records and doubling time in number of publication was observed Mean R(a) is 0.24 in 10.5 years. It denotes that the Doubling time for the research output in digital learning is 10.5 years for the study period.

TABLE 3 shows exponential growth rate of publications

S.No.	Publication Year	Records	Exponential Growth Rate	Mean	S.D	V	C. V.
1	1989	2	0.00	2002	5.71	32.63	0.29
2	1990	2	1.00				
3	1991	32	16.00				
4	1992	35	1.09				
5	1993	42	1.20				
6	1994	52	1.24				
7	1995	56	1.08				
8	1996	80	1.43				
9	1997	80	1.00				
10	1998	88	1.10				
11	1999	95	1.08				
12	2000	123	1.29				
13	2001	127	1.03				
14	2002	126	0.99				
15	2003	164	1.30				
16	2004	189	1.15				
17	2005	242	1.28				
18	2006	245	1.01				
19	2007	245	1.00				
20	2008	353	1.44				
21	2009	378	1.07				
22	2010	420	1.11				
23	2011	488	1.16				
24	2012	544	1.11				
25	2013	673	1.24				
26	2014	648	0.96				
27	2015	964	1.49				
			44.87(1.66)				

The above Table 3 reveals the Exponential Growth rate of over all publications on Digital Learning during twenty seven years. An exponential growth rate in number of publication was observed during 1989 to 2015. The highest growth rate (16 %) was found during 1992 with 32 publications followed by (1.49 %) with 965 publications during 2015, during 2008 (1.44 %) with 353 publications, at 1996 (1.43 %) with 80 publications, 1.30 percents during 2003, 1.29 percents at 2000, 1.28 percents at 2005, 1.24 percents at 1994, 1.24 percents at 2013, 1.20 percents at 1993, 1.16 percents at 2011, 1.15 percents at 2004, 1.11 percents at 2010 and 2012. 1.10 percents at 1988, 1.09 percents at 1992, 1.08 percents at 1999 and 1995. 1.07 percents at 2009, 1.03 percents at 2001, 1.01 percents at 2006, only one percents at 1990, 1996 and 2007, 0.99 percents at 2002, and 0.96 percents at 2014. The average exponential growth rate is 1.66 during the sample periods. The table also calculated

the value of 2002 with Mean, Standard Deviation value is 5.71, Variance is 32.63 and Co-efficient of variance is 0.29.

Ranking of Authors based on Publications with Citation Scores

Table 4 indicates ranking of authors based on number of publications. Author Hwang GJ published highest number of articles for the study period with 26 records and 681 Global Citation Scores; next author Huang YM and Tsai CC published next highest number of articles for the study period with 14 records. Chen NS published 13 records. Li J published 12 records.

Table 4 Author wise distributions of the publications

S.No.	Author	Records	Percent	TLCS	TGCS	TLCR
1	Hwang GJ	26	0.4	139	681	132
2	Huang YM	14	0.2	12	149	25
3	Tsai CC	14	0.2	48	304	34
4	Chen NS	13	0.2	18	121	31
5	Li J	12	0.2	7	258	9
6	Chu HC	11	0.2	74	363	50
7	Lin FJ	11	0.2	9	146	9
8	Chen CM	10	0.2	17	139	27
9	Li Q	10	0.2	1	152	6
10	Longo G	10	0.2	10	85	20
11	Selwyn N	10	0.2	10	54	7
12	Gil-Solla A	9	0.1	0	83	1
13	Indiveri G	9	0.1	29	321	19
14	Kim S	9	0.1	4	142	1
15	Nussbaum M	9	0.1	12	77	11
16	Pazos-Arias JJ	9	0.1	0	83	1
17	Sampson DG	9	0.1	2	27	4
18	Shih JL	9	0.1	16	99	38
19	Wang Y	9	0.1	1	71	9
20	Wilson TD	9	0.1	15	53	18
21	Brescia M	8	0.1	4	37	16
22	Brunner RJ	8	0.1	47	183	46
23	Card HC	8	0.1	16	91	22
24	Chang CC	8	0.1	1	12	11
25	Churchill D	8	0.1	11	80	8

It is found from the analysis that LOTKAS law may not be applicable with regard to author productivity in proliferation of research in Mapping of research output in Digital learning as the research papers equally distributed by a large number of authors. It also shows that author Hwang GJ has got highest 681 global citations against 26 publications, followed by the author Chu HC with 363 global citations against 11 publications and third

one is with more citations by Indiveri G having 321 global citations for 9 publications. Among the top 25 authors, author Hwang GJ has append 132 references for its 26 publications which is followed by the authors Brunner RJ with 46 cited references. There are only one author having more than 500 global citations and three authors having more than 300 global citations.

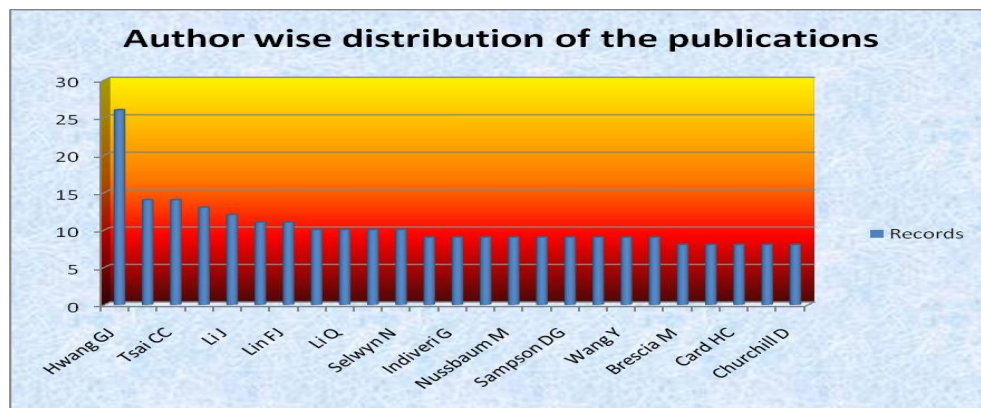


Figure 1 Shows author wise distribution of publicaions

Table 5 shows that Author wise distributions of publications

Year	One	Two	Three	Four	Five	Six	Seven	Eight	Nine	>10	Total
1989	00 (0.0)	01 (0.02)	00 (0.0)	01 (0.02)	00 (0.0)	00 (0.0)	00 (0.0)	00 (0.0)	00 (0.0)	0 (0.0)	2 (0.03)
1990	01 (0.02)	01 (0.02)	00 (0.0)	00 (0.0)	00 (0.0)	00 (0.0)	00 (0.0)	00 (0.0)	00 (0.0)	0 (0.0)	2 (0.03)
1991	13 (0.20)	11 (0.17)	03 (0.05)	03 (0.05)	01 (0.02)	00 (0.0)	01 (0.02)	00 (0.0)	00 (0.0)	0 (0.0)	32 (0.49)
1992	06 (0.09)	11 (0.17)	06 (0.09)	05 (0.08)	03 (0.05)	02 (0.03)	01 (0.02)	00 (0.0)	01 (0.02)	0 (0.0)	35 (0.54)
1993	13 (0.20)	10 (0.15)	06 (0.09)	04 (0.06)	05 (0.08)	02 (0.03)	00 (0.0)	00 (0.0)	01 (0.02)	1 (0.02)	42 (0.65)
1994	07 (0.11)	20 (0.31)	12 (0.19)	05 (0.08)	04 (0.06)	02 (0.03)	00 (0.0)	01 (0.02)	00 (0.0)	1 (0.02)	52 (0.80)
1995	09 (0.14)	19 (0.29)	17 (0.26)	06 (0.09)	02 (0.03)	00 (0.0)	01 (0.02)	01 (0.02)	00 (0.0)	1 (0.02)	56 (0.86)
1996	22 (0.34)	18 (0.28)	22 (0.34)	07 (0.11)	05 (0.08)	03 (0.05)	01 (0.02)	01 (0.02)	01 (0.02)	0 (0.0)	80 (1.23)
1997	23 (0.36)	21 (0.32)	12 (0.19)	08 (0.12)	05 (0.08)	05 (0.08)	01 (0.02)	02 (0.03)	00 (0.0)	3 (0.05)	80 (1.23)
1998	27 (0.42)	26 (0.40)	15 (0.23)	09 (0.14)	05 (0.08)	03 (0.05)	02 (0.03)	00 (0.0)	01 (0.02)	0 (0.0)	88 (1.36)
1999	29 (0.45)	15 (0.23)	26 (0.40)	09 (0.14)	08 (0.12)	02 (0.03)	05 (0.08)	00 (0.0)	00 (0.0)	1 (0.02)	95 (1.46)
2000	29 (0.45)	36 (0.56)	21 (0.32)	17 (0.26)	10 (0.15)	04 (0.06)	03 (0.05)	01 (0.02)	01 (0.02)	1 (0.02)	123 (1.89)
2001	43 (0.67)	31 (0.48)	20 (0.31)	19 (0.29)	05 (0.08)	03 (0.05)	02 (0.03)	01 (0.02)	02 (0.03)	1 (0.02)	127 (1.96)
2002	37 (0.57)	24 (0.37)	27 (0.42)	22 (0.34)	06 (0.09)	04 (0.06)	01 (0.02)	01 (0.02)	02 (0.03)	2 (0.03)	126 (1.94)
2003	44 (0.68)	47 (0.73)	25 (0.39)	24 (0.37)	11 (0.17)	05 (0.08)	03 (0.05)	02 (0.03)	01 (0.02)	2 (0.03)	164 (2.53)
2004	30	48	50	23	11	08	05	05	04	5	189

	(0.46)	(0.74)	(0.77)	(0.36)	(0.17)	(0.12)	(0.08)	(0.08)	(0.06)	(0.08)	(2.91)
2005	51 (0.79)	56 (0.87)	53 (0.82)	37 (0.57)	16 (0.25)	14 (0.22)	04 (0.06)	06 (0.09)	01 (0.02)	4 (0.06)	242 (3.73)
2006	37 (0.57)	63 (0.97)	62 (0.96)	35 (0.54)	16 (0.25)	13 (0.20)	10 (0.15)	04 (0.06)	01 (0.02)	4 (0.06)	245 (3.77)
2007	51 (0.79)	58 (0.90)	46 (0.71)	28 (0.43)	27 (0.42)	12 (0.19)	09 (0.14)	06 (0.09)	02 (0.03)	6 (0.09)	245 (3.77)
2008	83 (1.28)	101 (1.56)	65 (1.01)	41 (0.63)	30 (0.46)	13 (0.20)	07 (0.11)	04 (0.06)	04 (0.06)	5 (0.08)	353 (5.44)
2009	89 (1.38)	102 (1.58)	82 (1.27)	43 (0.67)	24 (0.37)	19 (0.29)	08 (0.12)	05 (0.08)	04 (0.06)	2 (0.03)	378 (5.82)
2010	85 (1.31)	113 (1.75)	97 (1.50)	51 (0.79)	26 (0.40)	12 (0.19)	12 (0.19)	07 (0.11)	04 (0.06)	13 (0.20)	420 (6.47)
2011	130 (2.01)	112 (1.73)	101 (1.56)	71 (1.10)	33 (0.51)	20 (0.31)	08 (0.12)	01 (0.02)	05 (0.08)	7 (0.11)	488 (7.52)
2012	128 (1.98)	135 (2.09)	115 (1.78)	82 (1.27)	38 (0.59)	17 (0.26)	13 (0.20)	09 (0.14)	01 (0.02)	6 (0.09)	544 (8.38)
2013	109 (1.69)	173 (2.68)	144 (2.23)	97 (1.48)	68 (1.04)	36 (0.54)	10 (0.15)	11 (0.17)	10 (0.15)	15 (0.23)	673 (10.37)
2014	115 (1.78)	148 (2.29)	127 (1.96)	115 (1.78)	60 (0.93)	35 (0.54)	18 (0.23)	10 (0.15)	06 (0.09)	14 (0.22)	648 (9.98)
2015	171 (2.54)	243 (3.67)	211 (3.20)	138 (2.13)	74 (1.08)	48 (0.73)	30 (0.45)	14 (0.22)	11 (0.15)	24 (0.37)	964 (14.85)
Total	1382 (21.27)	1643 (25.32)	1365 (21.05)	900 (13.90)	493 (7.55)	282 (4.33)	155 (2.38)	92 (1.42)	63 (0.96)	118 (1.82)	6493 (100)

Table 5 shows that the highest number of the publications with 1643 in two author productivity and followed by the one and three author's with 1382 and 1365 records of the publications.

Table 6 Shows that Authorship pattern of Digital Learning Literature

Authorship Pattern	No. of Contribution	Percentage of Authors	Cumulative Percentage
1	1382	21.28	21.28
2	1643	25.30	46.58
3	1365	21.02	67.60
4	900	13.86	81.46
5	493	7.59	89.05
6	282	4.34	93.39
7	155	2.39	94.78
8	92	1.42	97.20
9	63	0.97	98.17
10	118	1.83	100
Total	6493	100	

The authorship pattern shows that the collaboration trend is dominant as only 21.28 percent are contributed by single authors. The highest productivity of publications output (25.3%) from two authors. This is followed by three authors' contribution (21.02%).

Table 7 Showing Year wise Distribution of Degree of Collaboration

Year	Single Authors		Multiple Authors		Total	Degree of Collaboration
	No. of Output	%	No. of Output	%		
1989	0	0.00	2	0.03	2 (0.03)	0.00
1990	1	0.02	1	0.02	2 (0.03)	0.00
1991	13	0.20	19	0.29	3 (0.49)	0.00
1992	6	0.09	29	0.45	35(0.54)	0.00
1993	13	0.20	29	0.45	42(0.65)	0.00
1994	7	0.11	45	0.69	52(0.80)	0.01
1995	9	0.14	47	0.72	56(0.86)	0.01
1996	22	0.34	58	0.89	80(1.23)	0.01
1997	23	0.35	57	0.88	80(1.23)	0.01
1998	27	0.42	61	0.94	88(1.36)	0.01
1999	29	0.45	66	1.02	95(1.46)	0.01
2000	29	0.45	94	1.45	123(1.89)	0.01
2001	43	0.66	84	1.29	127(1.96)	0.01
2002	37	0.57	89	1.37	126(1.94)	0.01
2003	44	0.68	120	1.85	164(2.53)	0.02
2004	30	0.46	159	2.45	189(2.91)	0.02
2005	51	0.79	191	2.94	242(3.73)	0.03
2006	37	0.57	208	3.20	245(3.77)	0.03
2007	51	0.79	194	2.99	245 (3.77)	0.03
2008	83	1.28	270	4.16	353(5.44)	0.04
2009	89	1.37	289	4.45	378(5.82)	0.04
2010	85	1.31	335	5.16	420(6.47)	0.05
2011	130	2.00	358	5.51	488(7.52)	0.06
2012	128	1.97	416	6.41	544(8.38)	0.06
2013	109	1.68	564	8.69	673(10.37)	0.09
2014	115	1.77	533	8.21	648(9.98)	0.08
2015	171	2.63	793	12.21	964 (14.85)	0.12
	1382	21.28	5111	78.72	6493(100)	0.79

It is inferred from the table -7 that at the aggregate level, the degree of collaboration is of 0.79 during the study period 1989 to 2015 i.e, that is out of total 6493 literature published, 79% of them or published under the joint author of publications in “Digital Learning” research output. This brings out clearly the high level of prevalence of collaborative research in Digital Learning.

Lotka’s Law of Author Productivity

Generally author productivity is determined on the basis of number of papers contributed by digital learning in a specific field. It is quite relevant to study the impact of Lotka’s Law in examining the author productivity in digital learning research. Table presents the results of author productivity based on Lotka’s Law.

TABLE 8 LOTKA'S LAW OF AUTHOR PRODUCTIVITY

No. of authors	Observed Number of authors with 'n' or (an) or (f)	Observed percentage of authors $100 \times \frac{an}{a1}$	Expected number of authors $(an=\frac{an}{n^2})$ or (p)	Expected percentage of authors	$(F-P)^2/P$
1	1382	100.00	1382.00	100.00	0.00
2	1643	118.89	345.50	25.00	4872.67
3	1365	98.77	153.56	11.11	9557.44
4	900	65.12	86.38	6.25	7664.09
5	493	35.67	55.28	4.00	3465.97
6	282	20.41	38.39	2.78	1545.93
7	155	11.22	28.20	2.04	570.03
8	92	6.66	21.59	1.56	229.56
9	63	4.56	17.06	1.23	123.69
10	43	3.11	13.82	1.00	61.61
11	15	1.09	11.42	0.83	1.12
12	10	0.72	9.60	0.69	0.02
13	15	1.09	8.18	0.59	5.69
14	5	0.36	7.05	0.51	0.60
15	6	0.43	6.14	0.44	0.00
16	3	0.22	5.40	0.39	1.07
17	3	0.22	4.78	0.35	0.66
18	2	0.14	4.27	0.31	1.20
19	1	0.07	3.83	0.28	2.09
20	4	0.29	3.46	0.25	0.09
22	4	0.29	2.86	0.21	0.46
24	1	0.07	2.40	0.17	0.82
25	1	0.07	2.21	0.16	0.66
29	1	0.07	1.64	0.12	0.25
31	1	0.07	1.44	0.10	0.13
33	1	0.07	1.27	0.09	0.06
39	1	0.07	0.91	0.07	0.01
50	1	0.07	0.55	0.04	0.36
Total	6493	469.83	2219.18	X²	28106.27

Further the Lotka's Law is also tested with application of scientific productivity Chi-square model in relation to the number of authors who contributed n number of publications. It is observed from the Table that the calculated chi-square value (28106.27) is lesser than the table value at 0.05 level of significance. Therefore the growth of 'Digital Learning' do fit with the lower pattern and the analysis of quantum of productivity theoretically validated Lotka's findings. From the above analysis, it is inferred that Lotka's Inverse Square Law does not apply to the 'Digital Learning' research output studied. However it is to be

mentioned that Lotka's Law to be treated as general and theoretical estimate of productivity not as precise statistical distribution.

TABLE 9 JOURNAL WISE DISTRIBUTIONS OF THE PUBLICATIONS

S.No	Journal	Records	Percent	TLCS	TGCS	TLCR
1	Computers & Education	207	3.2	413	2804	288
2	Educational Technology & Society	104	1.6	60	596	133
3	British Journal of Educational Technology	85	1.3	166	863	55
4	Journal of Computer Assisted Learning	69	1.1	152	1219	67
5	Computers In Human Behavior	66	1.0	47	610	61
6	Electronic Library	55	0.8	39	245	43
7	IEEE Transactions On Education	51	0.8	46	381	14
8	Australasian Journal of Educational Technology	49	0.8	63	394	48
9	Learning Media And Technology	46	0.7	31	233	29
10	IEEE Transactions On Neural Networks	37	0.6	56	1457	16
11	International Journal of Engineering Education	36	0.6	6	102	14
12	Comunicar	34	0.5	6	52	8
13	ETR&D-Educational Technology Research and Development	34	0.5	45	348	53
14	Neurocomputing	34	0.5	5	130	12
15	Journal of Adolescent & Adult Literacy	33	0.5	3	32	17
16	Monthly Notices of The Royal Astronomical Society	33	0.5	52	315	65
17	Anatomical Sciences Education	31	0.5	32	195	67
18	Computer Applications in Engineering Education	29	0.4	8	102	13
19	Expert Systems With Applications	27	0.4	6	217	4
20	International Review of Research in Open and Distance Learning	26	0.4	3	34	14
21	Medical Teacher	25	0.4	25	449	15
22	Library Trends	24	0.4	18	139	1
23	Multimedia Tools and Applications	24	0.4	1	98	7
24	Journal of Universal	23	0.4	3	64	15

	Computer Science					
25	Program-Electronic Library and Information Systems	23	0.4	3	63	4

Ranking of the journals along with the country of origin based on the research output on Digital Learning during the study period has been presented in the Table.

There are 2235 journals contributed 6493 and above articles during the study period with the total ranking of 42. The highly productive journals up to the 5 ranks are as follows:

- “Computers & Education” (ISSN 0360-1315) ranked first in order published 207(3.2%) articles.
- “Educational Technology & Society” (ISSN 1436-4522) ranked second in order published 104 (1.6%) articles.
- “British Journal of Educational Technology” (ISSN 0007-1013) ranked first in order published 85 (1.3 %) articles.
- “Journal of Computer Assisted Learning” (ISSN 0266-4909) ranked first in order published 69 (1.1%) articles.
- “Computers in Human Behavior” (ISSN 0747-5632) ranked first in order published 66 (1.0%) articles.

RANKING OF JOURNALS

Journals, one of the primary sources of information are the vehicles of current output of knowledge. The number of journals of articles can be a measure of the growth in the field of knowledge.

TABLE 10 SHOWING RANKING OF JOURNALS ACCORDING TO BRADFORD’S DISTRIBUTION

Rank	No.JLs	Cum.No.of JLs	No. Cits	Total No.Cites	Cum. Of Cits	Log(n)	%of cits
1	1	1	207	207	207	0.00	3.19
2	1	2	104	104	311	0.69	1.60
3	1	3	85	85	396	1.10	1.31
4	1	4	69	69	465	1.39	1.06
5	1	5	66	66	531	1.61	1.02
6	1	6	55	55	586	1.79	0.85
7	1	7	51	51	637	1.95	0.79
8	1	8	49	49	735	2.08	0.75
9	1	9	46	46	772	2.20	0.71
10	1	10	37	37	769	2.30	0.57
11	1	11	36	36	805	2.40	0.55
12	3	14	34	102	907	2.48	1.57

13	2	16	33	66	973	2.56	1.02
14	1	17	31	31	1004	2.64	0.48
15	1	18	29	29	1033	2.71	0.45
16	1	19	27	27	1060	2.77	0.42
17	1	20	26	26	1086	2.83	0.40
18	1	21	25	25	1111	2.89	0.39
19	2	23	24	48	1159	2.94	0.74
20	4	27	23	92	1251	3.00	1.42
21	2	29	22	44	1295	3.04	0.68
22	2	31	21	42	1337	3.09	0.65
23	2	33	20	40	1377	3.14	0.62
24	3	36	19	57	1434	3.18	0.88
25	3	39	18	54	1488	3.22	0.83
26	8	47	17	136	1624	3.26	2.09
27	5	52	16	80	1703	3.30	1.23
28	7	59	15	105	1809	3.33	1.62
29	5	64	14	70	1879	3.37	1.08
30	10	74	13	130	2009	3.40	2.00
31	8	82	12	96	2105	3.43	1.48
32	16	98	11	176	2281	3.47	2.71
33	14	112	10	140	2421	3.50	2.16
34	17	129	9	153	2574	3.53	2.36
35	23	152	8	184	2758	3.56	2.83
36	31	183	7	217	2975	3.58	3.34
37	43	226	6	258	3233	3.61	3.97
38	62	288	5	310	3543	3.64	4.77
39	107	395	4	428	3971	3.66	6.59
40	165	560	3	495	4466	3.69	7.62
41	352	912	2	704	5170	3.71	10.84
42	1323	2235	1	1323	6493	3.74	20.38
	2235		1310	6493			100.00

TABLE 11 SHOWS THAT THE BRADFORD'S DISTRIBUTION OF JOURNALS

S.No.	Zones	No. of Journals	No. of Records	Multification factors
1	I	98	2281	-
2	II	462	2185	7.17
3	III	1675	2027	0.77
		2235	6493	7.94

Table -11 indicates that the first six journals covered more than one third of total articles published. The next fifty two journals covered another one third of the articles. Then remaining 2235 journals covered the last one third of the published articles. According to Bradford's distribution the relationship between the zone is $1:n:n^2$ visible the relationship in each zone of the present study.

The easy and interesting observation from the table is the number of journals in each zone. After Bradford's formulation, where as the observed number of journals in the three zones stands as 98: 462: 1675. This shows that core contributions are given by a very few journals, i.e., less than Bradford's formula and the final zone contains a very large number of journals, i.e., much more than the Bradford's formula.

COUNTRY WISE DISTRIBUTION OF THE PUBLICATIONS:

TABLE 12 COUNTRY WISE DISTRIBUTIONS OF PUBLICATIONS

S.No.	Country	Records	Percent	TLCS	TGCS
1	USA	1972	30.4	910	25444
2	UK	700	10.8	334	6385
3	Taiwan	363	5.6	341	2879
4	Peoples R China	348	5.4	108	2297
5	Canada	344	5.3	161	3677
6	Australia	343	5.3	290	2440
7	Spain	339	5.2	45	1429
8	Germany	280	4.3	79	2463
9	Italy	206	3.2	88	3241
10	Japan	177	2.7	56	1347
11	Netherlands	160	2.5	68	1441
12	France	140	2.2	30	1431
13	Brazil	122	1.9	13	213
14	South Korea	114	1.8	30	661
15	Singapore	105	1.6	56	895
16	India	87	1.3	10	350
17	Sweden	84	1.3	29	553
18	Belgium	81	1.2	31	1008
19	Turkey	76	1.2	8	575
20	Greece	74	1.1	78	790
21	Switzerland	72	1.1	44	1000
22	Finland	64	1.0	26	836
23	Norway	60	0.9	15	364
24	Austria	57	0.9	23	617
25	New Zealand	54	0.8	20	291

The above table indicates that among the country wise distribution of Digital Learning covered by the study tops USA with 1952 publications followed by UK with 700, Taiwan with 363, Peoples R China with 348 and Canada with 344 research publications respectively. First place goes to USA with 25444 Global citations of the publications. UK secured second rank in terms of GCS with 6385 more than 50 Countries were contributed the publications.

Document wise distribution of Publications**TABLE 13 shows that Document Wise Distribution of Publications**

S.No.	Document Type	Records	Percent	TLCS	TGCS
1	Article	5520	85.0	2364	45648
2	Article; Proceedings Paper	532	8.2	211	4722
3	Review	169	2.6	200	6386
4	Book Review	98	1.5	2	6
5	Editorial Material	92	1.4	16	339
6	Meeting Abstract	47	0.7	0	1
7	Letter	10	0.2	2	41
8	News Item	8	0.1	0	2
9	Note	5	0.1	0	3
10	Software Review	3	0.0	0	3
11	Article; Book Chapter	2	0.0	0	14
12	Editorial Material; Book Chapter	2	0.0	1	3
13	Reprint	2	0.0	0	7
14	Review; Book Chapter	2	0.0	0	27
15	Discussion	1	0.0	0	0

Table shows that the Document wise distributions of the publications. Through this analysis that more than half or three – fourth of the occupies in the article (5520) and rest of the publications covered by the other format. The Discussion is very least or only one publications of the documents.

Institution wise distribution of publications

The below table analysis indicates Institution-wise research productivity. It is noted that out of the 4191 records of the publication, Nanyang Technology University has the highest number of research publications 68 (1.62%) and Open University has second highest number of research publications 55 (1.31%) and University Illinois has third highest number of research publications with records 53 (1.26%) stands third and others.

TABLE 14 shows that Institution Wise Distribution of Publications

S.No.	Institutions	Records	% of 6493
1	Nanyang Technology University	68	1.62
2	Open University	55	1.31
3	University Illinois	53	1.26
4	National Centre University	52	1.24
5	Stanford University	50	1.19
6	National Taiwan University Science Technology	50	1.19
7	Harvard University	49	1.17
8	University Washington	44	1.05

9	University Toronto	44	1.05
10	University Wisconsin	43	1.03
11	Michigan State University	43	1.03
12	University Maryland	42	1.00
13	University Calif Los Angeles	41	0.98
14	National Cheng Kung University	39	0.93
15	MIT	37	0.88
16	University London	36	0.86
17	University British Columbia	35	0.84
18	Arizona State University	35	0.84
19	University Sydney	34	0.81
20	University Cambridge	34	0.81
21	University Michigan	33	0.79
22	University California Berkeley	32	0.76
23	University Arizona	32	0.76
24	University Oxford	31	0.74
25	Penn State University	31	0.74
	Total	1043	

Findings and Conclusion

Based on the analysis undertaken by the present study, the following findings are drawn.

- During the period (1989-2015) 6493 articles were published which are indexed in Web of Science. Overall, 17228 authors contributed in 2235 journals.
- The findings of global research productivity in Digital Learning with special reference have the highest publication as 964 in the year 2015 followed by 673 papers in 2013 with 648 papers in 2014.
- The authorship pattern of global research productivity on Digital Learning has identified that majority of papers are multi-authored.
- The study found that the total research output of the Digital Learning for the study period (1989 – 2015) published in 2235 journals. As the major portion of the research productivity covered by 2235 journals that are coincide with the theory of Bradford's Law of scattering of journals in research productivity.
- This study has highlighted quantitatively the contributions made by the Scientometric Mapping of Research output on Digital Learning researchers during 1989-2015 as reflected in Web of Science database covered only the peer reviewed journals.

Scientometric research has developed a body of theoretical knowledge and a group of techniques and applications based on the distribution of bibliographic data. Scientometric data provide precise and accurate observation. The researcher suggest that the Scientometrician is to

continue to develop the techniques which will be more reliable and useful for evaluation and prediction, because Scientometric data mirror the actual published results of the work of researchers.

References

- **Surulinathi, M, Balasubramani R and Kalisdha A (2013)** Continent wise Analysis of Green Computing Research: A Scientometric Study *Journal of Advances in Library and Information Science* 2(1), 39-44.
- **Surulinathi, M., Amsaveni, N., Maheswaran., and Srinivasaragavan, S (2007).** Scientometric Dimensions of Knowledge Management Research in India: A Study based on Scopus database, *Sri Lankan Journal of Librarianship and Information Management*, 2(2), 13-24.
- **Potter W.G. (1981)** "Lotka's Law Revised". *Library Trends*, 30(1), 1-39.
- www.helenogrady.co.in
- <https://en.wikipedia.org/wiki/Scientometrics>
- <http://digitallearning.eletsonline.com/2015/11/future-of-e-learning/>