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ABSTRACT

Information literacy has been an emerging topic for many fields in recent years, and this paper aims to evaluate the field of information literacy in the context of Library and Information Science (LIS). The evaluation will be conducted by using bibliometrics and scientific visualization techniques. A total of 2288 articles were retrieved that are indexed under topic information Literacy on web of science (Science Citation Index, Social Science Citation Index & Arts & Humanities Citation Index) were identified in order to achieve this objective. Search using the term 'information literacy'. Unify and standardize the data to make reliable evaluations. Evaluate publications, citation counts, their distribution to journals, documents, countries, etc. The findings of this study are important to reveal the pioneers and interdisciplinary of the field of information literacy. This is important for understanding the complexities of the issue and for evaluating the effectiveness of current campaigns.

Keywords -: Information Literacy, Bibliometric Study, Library Science, Information Science, Scientometric Study.

Introduction

Paul Zurkowski[1] first used the term 'Information literacy' (IL) in 1974 to mean being able to identify an information need and then being able to locate, evaluate, and use it effectively. After it became widely accepted, many countries put effort into improving information literacy abilities and adapting the concept to education. As these developments show, there has been an incremental awareness about information literacy over the course of time. Based on this, various models of information literacy have been developed and implemented, as well as standards such as the Information Literacy Competency Standards for higher Education (ILC). These are notable remarks in the field, and show that there is still more work to be done in this field.

Information literacy is the ability to harness the power of information and use it effectively. This requires a range of personal abilities such as critical thinking, problem solving, analysis, synthesis, organizing the knowledge, etc. Gaining these abilities helps personal development, self-confidence, lifelong learning, and social change as well. This study aims to improve the

understanding of information science by using bibliometrics to analyse the research papers and scientific visualizations of information .The questions addressed in this study are-

1. To know the growth of research articles based on topic "information literacy"
2. To know the top 10 manuscripts and prolific authors.
3. To know the authorship pattern followed by the research articles on given topic
4. To list out top publication titles on the research topic.
5. To study the keyword co-occurrence network in the topic of information literacy.
6. To know CAGR, RGR & Doubling Time of the literature.
7. To check whether the literature fits to Lotkas law of authorship distribution

Research Method -: A search in WoS database was carried out in the month of August 2022 to find topic indexed on Information Literacy. All indexed articles from web of science database which comes under category of Information Science & Library Science are filtered out. A refinement in search result is done for only research articles and other form of literature is excluded from the study. Further refinement is done for periods 2000 to 2010 & 2010 to 2021. The results are downloaded in bibtex form as well in excel format for analysis, bibliometric analysis was carried out with the help of bibliometrix-r package. In overall there are 2288 articles retrieved from the WoS database.

LITERAURE REVIEW

Here in Literature Review focus is on topics relevant to the study of information literacy. In present study the deep understanding and growth of literature on Information Literacy is the first attempt to study the related growth in two different time span to get deep and elaborated understanding of the growth of information literacy literature from bibliometric and scientometric view. The study also focuses on the growth of information literacy outputs from different parts of the world.

Islam et.al. (2022)[2] in their research article from "Library Philosophy and practice" e-journal ,examined the information literacy papers from bibliometric prospective from Scopus database of all forms of literature 2017-2021 and found that there are an average 3.91 citations per document and 0.8668 citations per year. They used Scopus database to retrieve the data. The keywords and author references were used for the study. They used VOS software to visualize data.

Pinto Maria et.al. (2019)[3] studied the literature on mobile information literacy period 2006-2017 and found that the number of articles on mobile information literacy increased from 3 to 5 per year. They used LISA, LISTA, ERIC, WoS and SCOPUS database for the study. The keywords and author references were used for the study.

 Kolle, S.R.(2017)[4] in his research paper studied the global literature on Information Literacy from Web of Science database from 2005 to 2014 and noticed that there is high amount of growth of literature but citation per article decreased during 2011 to 2014.Pinto m is the most productive author and Spain institution is with 28 articles ranked first.

Park, M. K., & Kim,H. J. (2011)[5], studied subtopics of information Literacy and their association with other areas, They used LISA database. They found terms Use Training, University Libraries, Students, and Academic Libraries etc. as high descriptor frequencies. Further they listed journals.

Nazim and Ahmad (2007)[6,] studied 607 library and information science journals from LISA database. They found USA is most productive country (51.2%) of the published literature and English language is most used language (88.3%). The most productive journal in the study was 'Journal of Documentation' and 'Journal of the American Society for Information Science and Technology'. There are 32 countries with total publications in the study.

Results and Discussion

A) Authorship Pattern & Degree of collaboration.

In overall there are 2288 articles indexed under the topic Information Literacy during the period .Authorship Pattern for documents in the two span of study are shown in Table 1. The overall authorship pattern shows that the Single authorship pattern (32.23%) is dominant for the research articles in information literacy field. For the time span we can observe that during 2010 to 2021 there is slight increase in two authored document 509(29.61%) i.e. single authorship pattern is quite declined as compared with the span of 2000 to 2010.In overall multi authored documents are more than single authored documents in number. The highest authored article for the time span 2000 to 2010 is 11 & for the time span 2011 to 2021 are 13.The overall multi authored papers are 1577 (67.48%) as compared with overall single authored 744(32.52%).

Table 1: Authorship distribution of research articles during the period.

Articles Authored	2000-2010	2011-2021	Overall(2000-2021)
1 Authored	255 (44.82%)	489 (28.45%)	744 (32.52%)
2 Authored	177 (31.11%)	509(29.61%)	686 (29.98%)
3 Authored	84 (14.76%)	344 (20.01%)	434 (18.97%)
4 Authored	30 (5.27%)	165 (9.60%)	198 (8.65%)
5 or more than >5	23(4.04%)	212 (12.33%)	241 (10.53%)
Total Articles	569 (100%)	1719(100%)	2288(100%)

Degree of collaboration-:

To calculate the degree of collaboration for two different spans here the formula used by *Subramanian's*[7] (1983) is applied. The formula is useful to calculate the extent of collaboration in research

C = Nm / Nm+Ns, where Nm is number of multiple authored papers & Ns is number of single authored papers

C= 314 / 314+255 = 0.5518   - (For Yr.2000-2010 span)

C= 1230 / 1230 + 489 = 0.7155   - (For Yr.2011-2021 span)

C= 1544 / 1544 + 744 = 0.6748   - (For overall span of year 2000-2021)

B) The overall scientific output of articles from 2000 to 2021. - following chart shows the overall scientific output of articles in information literacy topic year wise. In year initially there are 12 articles later years shows rapid growth in articles it was observed that in year 2016 a pick is observed with 197 articles output .The annual percentage growth rate is 14.17036%.

Fig.1: Publication numbers and non-cited publications by years
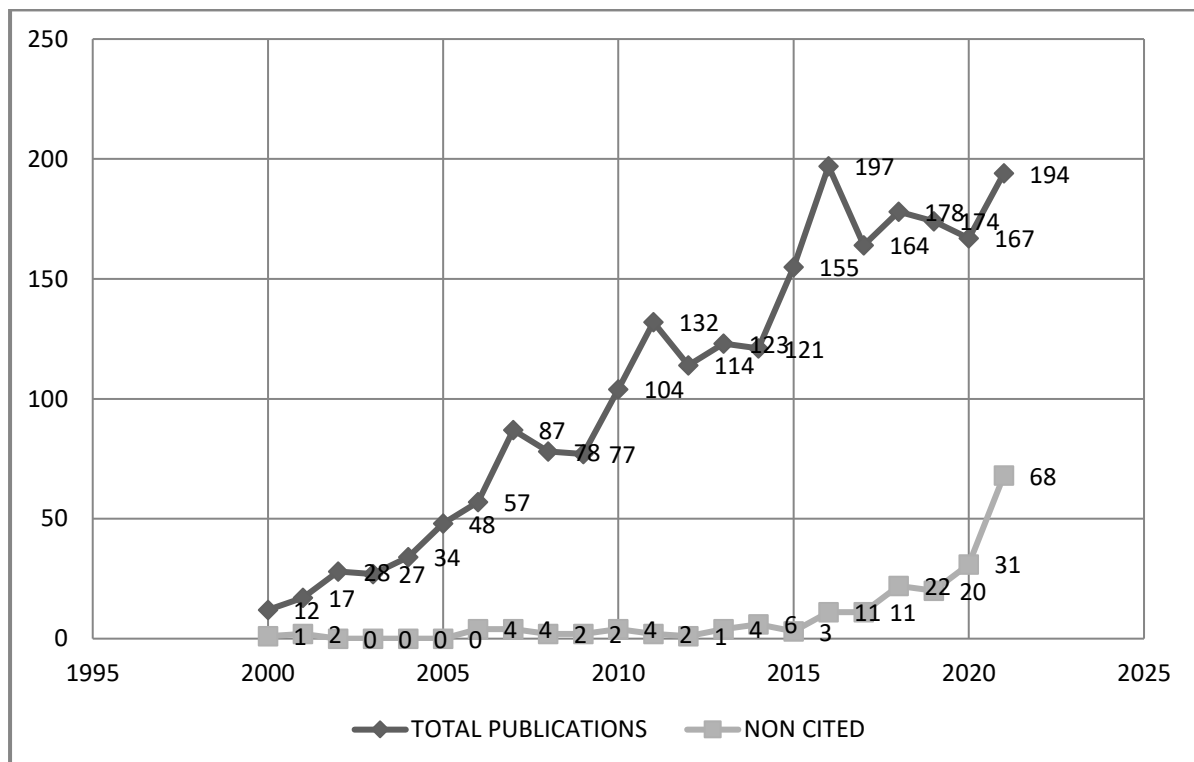
C) Some basic information about two span of data

Table 2: Basic information about articles, authors and sources

Information	Yr. Span 2000-2010	Yr. Span 2011-2021
Source (Journal, Books, etc.)	61	77
Total Articles	569	1719
Annual Growth Rate %	24.1	3.93
Document average age	15.3	5.54
Average Citation per doc.	27.1	10.71
Average citation per year per doc	1.701	1.559
References	14753	52957
International co-authorship %	5.272	13.9

D) Most Productive Authors -: Most productive top 10 authors based on their total article contributions are listed for two different spans as in Table 3

Table3: Most productive Authors based on contributions

Yr. Span 2000-2010		Yr. Span 2011-2021	
Authors	Articles	Authors	Articles
PINTO M	15	PINTO M	38
JULIEN H	08	LLOYD A	18
LLOYD A	08	FOURIE I	16
ARP L	06	SALES D	15
SALES D	06	JOULIEN H	13
WOODARD BS	06	FARNANDEZ-PASCUAL R	12
CRAWFORD J	05	BRUCE C	11
DOUCET AV	05	HICKS A	10
KOWN N	05	SPRING H	10
MANSOURIAN Y	05	GROSS M	09

E) Following Table 4 & 5 gives top 10 cites articles based on the citations received throughout the years for different spans of study.TC represents the total citations received for article.

Table 4: Top 10Manuscripts between years span 2000-2010 based on total citations received

Article Title	Author/s	Source	TC
1.Making sense of credibility on the web: Models for evaluating online information and recommendations for future research	Metzger, Miriam J (2007)	Journal of the American society for information science and technology	528
2. The dark side of information: overload, anxiety and other paradoxes and pathologies	Bawden, David & Robinson, Lyn (2009)	Journal of information science	481
3. The Google generation: the information behavior of the researcher of the future	Rowland's, Ian & others (2008)	ASlIB proceedings	287
4. Critical information literacy: Implications for instructional practice	Elmborg, J (2006)	Journal of academic librarianship	221
5. Information literacy as a sociotechnical practice	Tuominen, K, Savolainen, R & Talja, S (2005)	Library Quarterly	182
6. Conceptions of information literacy: new perspectives and implications	Webber, S; & Johnston, B (2000)	Journal of information science	173
7. Information grounds and the use of need-based services by immigrants in Queens, New York: A context-based, outcome evaluation approach	Fisher, KE,Durrance, JC& Hinton, MB (2004)	Journal of the American society for information science and technology	168
8. Bridging the digital divide: Reaching vulnerable populations	Chang, BL & others (2004)	Journal of the American Medical Informatics Association	165
9. A nonlinear model of information-seeking	Foster, A (2004)	Journal of the	143

behavior		American Society for Information Science and Technology	
10. Developing the information literacy self-efficacy scale	Kurbanoglu, S & others (2006)	Journal of documentation	140

From the above table we have maximum citation publication is "Journal of the American Society for Information Science and Technology" contributes more citable items which have maximum 3 articles from cited top 10 articles. It is observed that some Journals brought out special issues among them are "Canadian Journal of Information Science", "Library and Information Science Research" and "Information Technology for Development".

Table 5: Top 10 Manuscripts between years span 2011-2021 based on total citations received

Article Title	Author/s	Source	TC
1. Health Literacy Measurement: An Inventory and Descriptive Summary of 51 Instruments	Haun, Jolie N & others. (2014)	Journal of Health Communication	207
2. Reframing Information Literacy as a Meta literacy	Mackey, Thomas P. & Jacobson, Trudi E. (2011)	College & Research Libraries	189
3. Adopting evidence-based practice in clinical decision making: nurses' perceptions, knowledge, and barriers	Majid, Shaheen & others(2011)	Journal of the Medical Library Association	159
4. Availability and quality of mobile health app privacy policies	Sunyaev, Ali & others. (2015)	Journal of the American Medical Informatics Association	152
5. The Health Literacy Skills Framework	Squiers, Linda & others. (2012)	Journal of Health Communication	145
6. The digital divide and social inclusion among refugee migrants A case in regional Australia	Alam, Khorshed & Imran, Sophia. (2015)	Information Technology & People	139
7. What's Skill Got to Do With It?: Information Literacy Skills and Self-Views of Ability Among First-year College Students	Gross, Melissa & Latham, Don. (2012)	Journal of the American Society for Information Science and Technology	129
8. Connecting with new information landscapes: information literacy practices of refugees	Lloyd, Annemaree & others.(2013)	Journal of Documentation	121
9. Disparities in registration and use of an online patient portal among older adults: findings from the Lit Cog cohort	Smith, Samuel G & others.(2015)	Journal of the American Medical informatics Association	92
10. Incorporating Data Literacy into Information Literacy Programs: Core Competencies and Contents	Calzada Prado, J & Angel Marzal, M (2013)	LIBRI-International Journal of Library & Information Studies	89

From the above table we have maximum citation publication in 2011-2021 is for Journal of health Communication which contributes more citable articles, secondly Journal of the American Medical Informatics has two articles in cited top 10 articles. Journals like 'Reference Service Review', 'Library Quarterly', 'Serials Review', 'Journal of Librarianship & Information Science', 'Information Development', 'College & Research Libraries', 'Journal of Health Communications', 'Reference Service Review''ASLIB Journal of Information Management' etc. have brought their special issues.

F) Top 10 Country-: Top 10 countries of publication are calculated based on Author affiliation country. Table 6 gives top 10 countries in two spans of years.

Table 6: Top 10 country outputs based on Authors affiliation of the country.

Sr.No.	For Period Span Yr.2000-2010				For Period Span Yr.2011-2021			
	Country	Articles	SCP	MCP	Country	Articles	SCP	MCP
1	USA	258	251	07	USA	770	719	51
2	United Kingdom	67	61	06	United Kingdom	132	117	15
3	Australia	30	27	03	Australia	84	74	10
4	Canada	27	24	03	Spain	80	62	18
5	Spain	25	24	01	China	77	48	29
6	Brazil	14	14	00	Canada	72	64	08
7	China	11	10	01	South Africa	39	29	10
8	Nigeria	11	11	00	Brazil	37	34	03
9	South Africa	11	10	01	Sweden	36	31	05
10	Botswana	08	08	00	Finland	26	21	05

Here SCP stands for Single Country Publication i.e. publication with the same country author whereas MCP stands for Multi Country Publication i.e. with the other country collaboration of author. Here for the first span of years USA though has maximum documents its MCP ratio (2.71%) is less as compared with United Kingdom (8.96%).Almost all countries remain in top 10 condition in second span except country Nigeria & Botswana lost their place . Countries USA, United Kingdom & Australia maintained their top three positions in second span's MCP is (6.62%), while UK has MCP(11.36%) higher than USA in Yr.2011-2021.

G) Following table gives most relevant sources based on total article contributions during the time span.

Table 7: Most relevant sources based on number of articles coming from the sources.

Sr.No.	For Period Span Yr.2000-2010		For Period Span Yr.2011-2021	
	Journal Titles	Articles	Journal Titles	Articles
1	Journal of Academic Librarianship	64	Journal of Academic Librarianship	203
2	Portal-Libraries and The Academy	44	Journal of Health Communication	124
3	College & Research Libraries	38	Reference Service Review	99

4	Electronic Library	33	Journal of Documentation	98
5	Journal of Health Communication	29	Portal-Libraries and The Academy	96
6	Journal of Librarianship and Information Science	27	College & Research Libraries	89
7	Journal of Documentation	24	Journal of Librarianship and Information Science	83
8	Reference and User Services Quarterly.	24	Health Information And Libraries Journal	77
9	Library Trends	20	Journal Of The Medical Library Association	63
10	Library & Information Science Research	19	Library & Information Science Research	56

For the first period span from above table, "Journal of Academic Librarianship" stood first with 64 articles contributing on the theme. "Journal of Documentation" stood in both maximum citation and maximum contributing source table.

H) Most Relevant Keywords-: following table gives most relevant keywords during two span of study.

Table 8: Top 10 keywords used by authors based on keyword appearance in articles.

Sr.No	For Period Span Yr.2000-2010		For Period Span Yr.2000-2010	
	Author Keywords	Articles	Author Keywords	Articles
1	Information Literacy	90	Information Literacy	492
2	Information	21	Academic Libraries	105
3	Internet	20	Information	100
4	Literacy	19	Literacy	74
5	University Libraries	14	Library Instruction	72
6	Learning	13	Students	59
7	Librarians	13	Education	54
8	Information Retrieval	12	Libraries	51
9	Communication Technologies	11	Assessment	46
10	Worldwide Web	11	Higher Education	44

I) Keyword Co-occurrence Network -: Keyword co-occurrence network is constructed based on author's keyword and suggested relevant keywords appeared in articles. Here three clusters are observed overall time span.Colours represents different clusters and related keywords in cluster, while size of the keywords and its relevant weight is denoted by circles, In fig.2 behaviors, keywords like behavior, literacy, seeking, internet denoted in red color forms a basic cluster while education, impact, skill, library etc. denoted in blue forms other cluster & color green cluster at top denoting information, knowledge, communication, health literacy etc. keywords.

Fig.2: Keyword co-occurrence network 2000-2021.
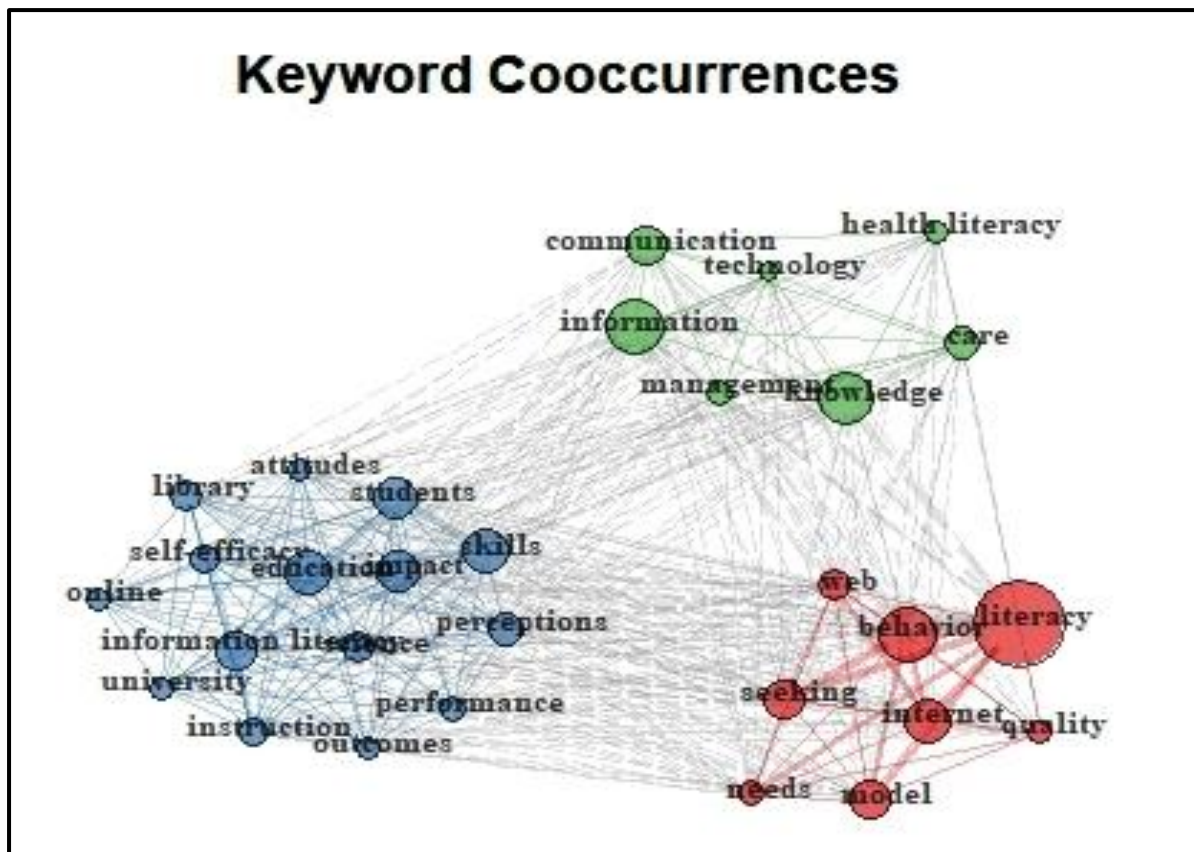
J) CAGR, RGR & Doubling Time (Dt)-;

From the total publication outputs we calculate Compound Annual Growth Rate (CAGR), Relative Growth Rate (RGR) and Doubling Time (Dt) for topic indexed under information literacy of WoS database is calculated as follows:

CAGR is calculated by the formula

$$CAGR(t_0 - \text{tn}) = \left(\frac{V(\text{to})}{V(\text{tn})}\right)^{1/\text{tn}-\text{t0}} - 1 \qquad \text{----- (1)}$$

Where V (t_0) = start value, V (t_n) = finish value and $t_n - t_0$ = number of years.

Therefore, CAGR = (1719 ÷ 569) $^{1/\,2021\text{-}2000}$ $\qquad$ - 1

$$= 10.57 \text{ \% CAGR}$$

RGR and doubling time (Dt) formula is used to measure the scientific output increase or decrease during the two periods of study. Relative growth rate (RGR) which is the measure of difference between natural logarithm of total number of publications at two points divided by time period. RGR and Doubling Time as suggested by Baskaran[8]

$$RGR = (1 - 2)^r = \frac{\text{in(W2)} - \text{in(W1)}}{\text{t2} - \text{t1}} \qquad \text{----- (2)}$$

Where, W_1= Total number of publications at initial time, W_2=Total number of publications at final and $t2 - t1$ = difference between the initial year and final year.

$$Doubling\ Time = Dt = \frac{0.693}{RGR} \quad \text{-----} (3)$$

Therefore we have values calculated are for RGR = 0.053 , Dt= 13.16, this means relative growth rate percentage of Information Literacy topic is 5.3% and doubling time is 13.16 which means 13 years.

K) Verification of Lotkas Law

Lotka's law states that the frequency of publications is inversely proportional to the square of the number of authors in a certain field. Law of the inverse square states that the frequency of publications by authors in a certain field is an inverse square law, where the number of authors publishing a certain number of articles is a sine curve. The sine curve describes the relationship between the number of authors publishing a certain number of articles, and the frequency of publications. The sine curve is an approximation of the actual relationship between the number of authors publishing a certain number of articles, and the frequency of publications.

Kolmogorov-Smirnov (K-S) test

K-S test, a goodness-of-fit statistical test is used to find out the significant difference between the observed and theoretical distribution of authors. Formula:

$$D= max\ [\ F_0(x) - Sn\ (x)] \quad \text{.....(4)}$$

Where F0(x) = theoretical cumulative frequency and *Sn(x)* = observed cumulative frequency

We have following table for observed frequency

Table 9: Showing Lotkas Distribution of Authors and frequency

No.of pairs	Number of Articles	No.of Authors Observed	Frequency
1	1	3513	0.8448773449
2	2	402	0.0966810967
3	3	115	0.0278980279
4	4	42	0.0101010101
5	5	32	0.0076960077
6	6	14	0.0033670034
7	7	16	0.0038480038
8	8	5	0.0012025012
9	9	6	0.0014430014
10	10	2	0.0004810005
11	11	2	0.0004810005
12	12	2	0.0004810005

13	13	1	0.0002405002
14	18	1	0.0002405002
15	21	2	0.0004810005
16	26	1	0.0002405002
17	53	1	0.0002405002

The estimated Beta coefficient is 2.29 with a goodness of fit equal to 0.88. Kolmogorov-Smirnoff two sample tests provide a p-value 0.24 & Lotka constant value is 0.26 that means there is not a significant difference between the observed and the theoretical Lotka distributions.Lotka plot for Articles and frequency of authors for observed and estimated value can be obtained as

Fig 3: Lotka Plot for observed and theoretical frequency of Authors & Articles
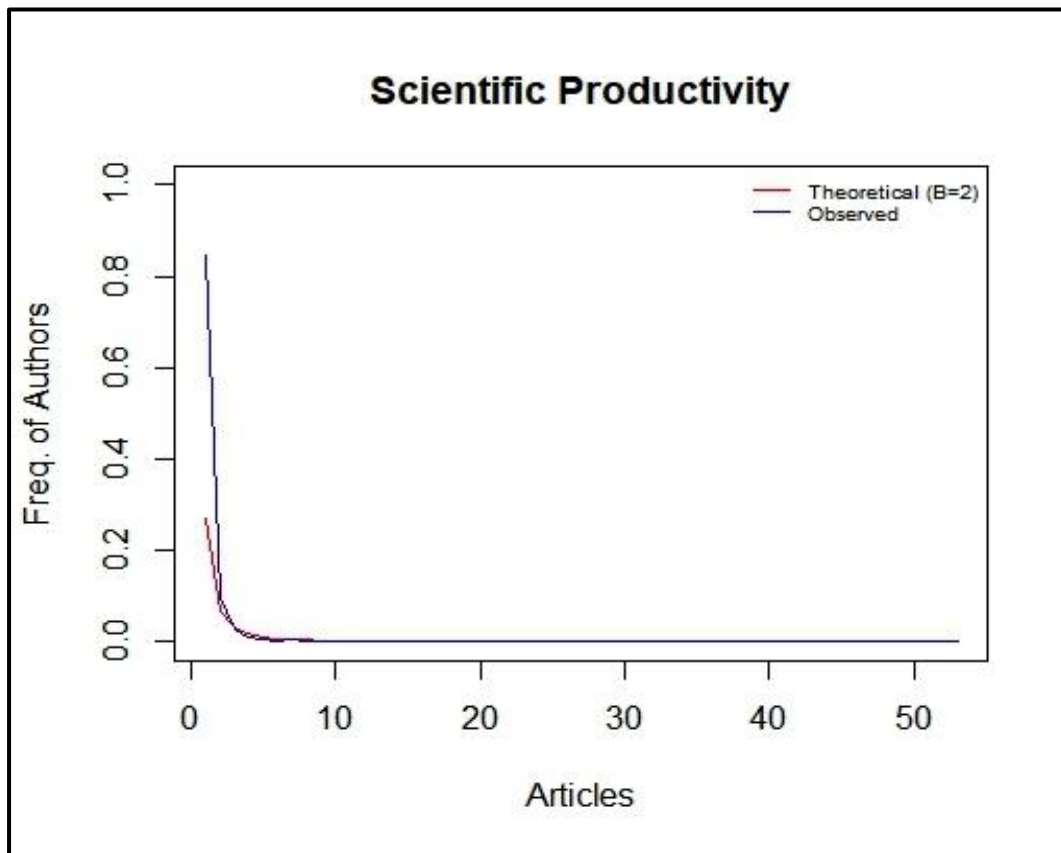
Conclusion-: Most prolific country in information literacy, followed by the UK, Australia, Canada, Spain, Brazil & China. In terms of publications, the USA was again the most prolific country, followed by the UK, Australia, Canada, etc. Overall, the USA and the UK combined accounted for almost half of the total publication output of all countries included in the study. This study is an attempt to understand the general view of information literacy field research based on the papers published in Web of Science. Findings of the study may be helpful for students and other starters in this area. These findings may be interpreted widely by the information literacy professionals.

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