RESEARCH DESIGN

This chapter deals with contents and meaning of undertaking the study in terms of objectives, methodology, data collection, statistical tools and techniques used, operational definition of key concepts and limitations of the study.

3.1 OBJECTIVES

The main objective of this study was to use 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 Collaborative Distribution of Publications;
- To identify the word wise distribution of publications.
- To test the law of metrics.

3.2 STATEMENT OF THE PROBLEM

The present study aims at analyzing the research performance of Digital Learning. Therefore, it is through publication, the scientists
receive professional recognition and esteem as well as promotion, advancement, and funding for future research. 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 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”.

3.3 HYPOTHESES

Keeping the contented and reporting of the objectives framed, the following hypotheses are formulated and tested with appropriate statistical tools:

- The journal source of publication of Digital Learning research output occupies a predominant place in comparison with other source of publications.
- There is significant level of increase in the growth of Digital Learning research output, indicating the progressive performance of research in the field.
- The distribution of Digital Learning research output in journals and articles conform the implications of Brad ford’s law.
• The scientific productivity of authors in the discipline of Digital Learning research conforms to Lotka’s \( (n – value) \) inverse square law of scientific productivity.

• The relative growth rate of total scientific publications show a declining trend and the doubling time for publications reflects an increasing trend.

• There is a significant variation in the growth and deliberation of research output on Digital Learning research among the selected continents and countries.

• There has been an increasing trend in collaborative research in Digital Learning during the research period.

3.4 METHODOLOGY

Sceintometric / Bioibliometrics study is the examination of the frequency, patterns, chart, and graphs of citations in articles and books. Scientometric Study” is a study encompassing records output on digital learning from Web of Science (WOS) online database. 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 and so on. 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 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.

3.5 DATA COLLECTION

For collecting the publication metadata, the renowned Web of Science (WoS) was used which covers a selected group of journals, conferences and other sources. The data was collected for the period 1989-2015. The 27 years period is a good period for detailed analytical purpose.

3.5.1 TOOLS AND TECHNIQUES

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

3.5.2 APPLICATION OF STATISTICAL TOOLS

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.
3.5.2.1 RELATIVE GROWTH RATE

In order to identify the relative growth rate, the researcher has adopted a model developed by Mahapatra. The relative growth rate is the increase in the number of publications per unit of time. The mean relative growth rate \( R(1-2) \) over a specified period of interval can be calculated from the following equation.

\[
R(1-2) = \frac{W_2 - W_1}{T_2 - T_1}
\]

Where,

- \( R(1-2) \) = Mean relative growth rate over the specified period interval;
- \( W_1 \) = \( \log w_1 \) (Natural log of initial number of publications)
- \( W_2 \) = \( \log w_2 \) (Natural log of initial number of publications)
- \( T_2 - T_1 \) = the unit difference between the initial time and final time.
The relative growth rate for publications can be calculated separately. Therefore,

\[ R(a) = \text{Relative growth rate per unit publication per unit of time (year)} \]

**3.5.2.2 DOUBLING TIME**

It is also calculated that there is a direct equivalence existing between the relative growth rates and doubling time. If the number of publications of a subject doubles during a given period, then the difference between the logarithms of the numbers at the beginning and at the end of the period must be the logarithms of the number 2. If one uses natural logarithms, this difference has a value of 0.693. Thus, the corresponding doubling time for publications can be calculated by the following formula:

\[ \text{Doubling time (Dt)} = \frac{0.693}{R(a)} \]

Therefore,

\[ \text{Doubling time for publications Dt(a)} = \frac{0.693}{R(a)} \]

**3.5.2.3 COLLABORATIVE COEFFICIENT (CC)**

The pattern of co-authorship among different countries have been examined by making use of Collaborative Coefficient (CC) suggested by Ajiferuke et al. (1988). The formula used for calculating CC is as follows. Where

\[ CC = 1 - \left[ \sum_{j=1}^{k} \left( \frac{1}{j} \right) F_j / N \right] \]
Fj=the number of authored papers
N=total number of research published; and
k=the greatest number of authors per paper

According to Ajiferuke, CC tends to zero as single-authored papers dominate, and to 1-1/j as j-authored papers dominate. This implies that higher the value of CC, higher the probability of multi-authored papers.

### 3.5.2.4 Activity Index (AI)

Activity Index characterises the relative research effort of a country to a given field. It is defined as

\[
AI = \left( \frac{I_i}{I_o} / \frac{W_i}{W_o} \right) \times 100
\]

AI =100 indicates that the country’s research effort in the given field corresponds precisely to the world’s average. AI>100 reflects higher activity than the world’s average, and AI<100 indicates lower than average effort dedicated to the field under study.

In this study, Activity Index for India has been calculated for different years to see how India’s research activity changed during different years using the above formula.

Activity Index characterizes the relative research effort of a country to a given field.

Mathematically

\[
AI = \left( \frac{I_i}{I_o} / \frac{W_i}{W_o} \right) \times 100
\]
Where

\[ \text{AI} = \left( \frac{N_{ij}}{N_{io}} \right) / \left( \frac{N_{oj}}{N_{oo}} \right) \times 100 \]

- \( N_{ij} \): Number of Papers in theme i and block j;
- \( N_{io} \): Number of Papers in theme i for all blocks;
- \( N_{oj} \): Number of Papers for all themes for blocks j;
- \( N_{oo} \): Total number of Papers for all theme and all blocks;

### 3.5.2.5 CO-AUTHORSHIP INDEX (CAI)

To study how the patterns of co-authorship have changed during a period use of Co-authorship index has been applied in this study. For calculating CAI the entire data set was divided into four blocks.

\[ \text{CAI} = \left( \frac{N_{ij}}{N_{io}} \right) / \left( \frac{N_{oj}}{N_{oo}} \right) \times 100 \]

- \( N_{ij} \): Number of papers having j authors in block I
- \( N_{io} \): Total Output of Block I
- \( N_{oj} \): Number of papers having j authors for all blocks;
- \( N_{oo} \): Total number of papers for all authors and all blocks

\( J = 1, 2, 3, > 4 \)
CAI = 100 implies that co-authorship in a particular block for a particular type of authorship corresponds to the world average, CAI>100 reflects higher than average co-authorship effort and CAI<100 lower than average co-authorship effort in a particular block for a particular type of authorship.

3.5.2.6 DEGREE OF COLLABORATION

In order to identify the degree of collaboration, the research has adopted K. Subramanyam’s formula. The formula is

\[ C = \frac{N_m}{N_m + N_s} \]

Where,

- \( C \) = Degree of collaboration in a discipline
- \( N_m \) = Number of multiple authored papers
- \( N_s \) = Number of the single authored papers

Further, the researcher has applied various statistical tools to analyze the various empirical data such as “t” test percentage and averages.

\[ C = \frac{N_m}{N_m + N_s} \]

3.5.2.7 RESEARCH PRIORITY INDEX (RPI)

Research priority Index is a statistical tool for applying cross-national comparisons. Priority index (PI) is computed by the following formula

\[ PI = \frac{n_{ij}/n_{io}}{n_{oj}/n_{oo}} \times 100 \]
Where as
\[ n_{ij} = \text{the number of publications of country } i \text{ in sub-field } j. \]
\[ n_{io} = \text{the number of publications of country } i \text{ in all sub-field} \]
\[ n_{oj} = \text{the number of publications of all countries in sub-field } j, \text{ and} \]
\[ n_{oo} = \text{the number of publications of all countries in all sub-fields.} \]

Here ‘all’ refers to the comparison set (i.e. the set of major countries). The value of PI=100 indicates that research priority of a country for a given sub-field corresponds precisely to the average of all countries, i.e. average priority. PI>100 indicates higher than average priority and PI<100, lower than average priority. It should, however, be kept in mind that (by virtue of definition of PI), no country can have high or low priority in all sub-fields. From the values of PI, one can compare:

- The priorities of a given country to different sub-fields in a given time-span;
- The priorities of different countries to a given sub-field in a given time-span;
- The priorities of a country to a given sub-field in different time spans.
3.6 APPLICATIONS OF BIBLIOMETRICS LAW

3.6.1 LOTKA’S LAW OF AUTHOR’S PRODUCTIVITY

Lotka’s law of author productivity explains number of authors contributed ‘n’ number of paper. Potter2 identified the Lotka’s fraction 1/an – 4.65 on the basis of Euler – Maclaurin formula of summation. This model is applied in the present study.

The sum was used as deviser for 1/n 4.65 to determine the proportion of the total number of authors expected to produce ‘n’ paper (in the case of present study n=1,2,3,4,… 10), the following formula was used to find the proportions.

\[ S = \sum \frac{1}{n^{4.65}} \]

For present study S is the sum of Lotka’s modified rations for the value a= 4.65.

The formula

\[ A_n = \frac{1}{n^{4.65}} \frac{T}{S} \quad (n = 1,2,3, \ldots \ldots 10) \]

Where T is total number of authors in the sampling and ‘An’ is the total number of expected authors producing ‘n’ papers.

The Lotka’s law also tested with the application of scientific productivity chi-square model in relation to a number of authors who contributed ‘n’ number of publication.

It can be expressed by the equation \( a_n = a1/n2, \quad n = 1,2,3 \)

Where ‘an’ is the numbers of authors contributing ‘n’ papers each; and al is the number of authors contributing each one paper.

The chi-square can be computed as \((F-p) \frac{2}{p}\).
F = observed number of authors with ‘n’ publications

P = expected number of authors.

3.6.2 PRICE’S SQUARE ROOT LAW

Price’s Square Root law, which states that half (50%) of the literature on a subject will be contributed by the square root of total number of authors publishing in that area.

3.6.3 PARETO PRINCIPLE (80/20 RULE) AND COLLABORATIVE INDEX

Pareto Principle (80/20 Rule) states that, for many events, roughly 80% of the effects come from 20% of the causes. The original observation was in connection with income and wealth. Pareto noticed that 80% of Italy’s wealth was owned by 20% of the population. He then carried out surveys on a variety of other countries and found to his surprise that a similar distribution applied.

3.6.4 BRADFORD’S LAW OF SCATTERING JOURNALS

Bradford’s law is to explain that a group of journals could be arranged in an order of decreasing productivity and showed that journals which field most productive articles are coming first and the most unproductively in the last. According to this journals are to be grouped into a number of zones each producing a similar number of articles. However the number of journals in each zone will be increasing rapidly. Then the relationship between the zones is 1:n:n^2. According to Bradford’s distribution, the relationship between the
zone is 1:n:n2 contrastingly the relationship in each of the present study.

3.7 VOS VIEWER

VOSviewer is a software tool for constructing and visualizing bibliometric networks. These networks may for instance include journals, researchers, or individual publications, and they can be constructed based on co-citation, bibliographic coupling, or co-authorship relations. VOSviewer also offers text mining functionality that can be used to construct and visualize co-occurrence networks of important terms extracted from a body of scientific literature.

3.8 HISTOGRAM AND CITATION MAP

Used by the Histcite software the researcher makes graphs (called historiography) for the selected option of top forty records for related studies.

3.9 SCOPE AND LIMITATIONS OF THE STUDY

Following few Scope and limitations of the study are observed by

- Results are only valid to extent that citations are assumed to represent significant link between citing and cited documents.
- Technical issues related to data obtained from citation indexes and bibliographics.
- The study period covers only 27 years from 1989-2015 Journals alone are given more weight age, in analyzing the growth, trend and performance in publishing research articles. The publication data is exclusively from web of science database.
REFERENCES


