CHAPTER 3

RESEARCH DESIGN
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The purpose of the chapter is to explain the method used to generate, analyze, and interpret the data pertinent to the research questions given below.

1) What is the pattern of communication between the researchers in the field of Educational Technology?

2) What is the trend of growth of Educational Technology literature?

3) What is the relative growth rate of Educational Technology literature over a given period?

4) How do the researchers in this field work, whether they involve more in solo research or in collaborative research?

5) What is the degree of collaboration between them?

6) Is there any research front of authors contributing immensely to the growth of the literature?

7) What is the citing pattern of the researchers in the field?

8) Do they cite more articles from other journals or books or from Research reports, Dissertations etc?

9) Do they refer to recent literature or of archival nature?
Further, the study will also find out the number of citations received by the articles on educational technology literature published in the core journals during 1998-2007 and thereby evaluate the impact of the set of articles published in the above journals by using h-index. In order to deal with these questions, specific types of data were needed. A method for gathering the data needed is presented. Further, the method for presenting the data for analysis and interpretation is also explained.

3.1 STATEMENT OF THE PROBLEM

Advances in Science and Technology have made a tremendous impact on every dimension of our society. The field of Education is not an exception. The whole process of teaching-learning has undergone radical transformation. Though Educational Technology is only of recent origin, it has found wide applications in the field of Education. The concept of online teaching and learning, video-conferencing, the use of Internet and other latest electronic and communication technologies have invaded the academic campus in every country. The teacher from being an orator on the platform of the class is now compelled to take the role of a facilitator and a guide to the student. In view of the significance of the field of Educational Technology, the investigator has chosen to study the impact on the Educational Technology Literature. The researcher has chosen as the subject of the study, a thorough bibliometric analysis of the
educational technology literature during 1998-2007 under the title “Educational Technology Literature: A Bibliometric Study”.

For research to be useful, the results must be communicated to those persons who are interested. Zinan (1969) asserted that “… the results of research only become completely scientific when they are public”. The information or research concerning educational technology must be communicated or disseminated to others for the concept to be of much use. This communication can be most expeditiously done through periodical literature.

The researcher has framed the following objectives:

1. To apply Bibliometric techniques and analyze the Educational Technology literature as to the category, language, and country of affiliation of the authors of the publications;
2. To identify a core list or nucleus of Periodicals publishing articles on Educational Technology;
3. To apply Bradford’s Law of Scattering and find out whether the journals publishing articles on Educational Technology adhere to the principles of Bradford’s Law;
4. To study the authorship pattern among the authors publishing articles on educational technology literature;
5. To calculate the degree of collaboration among the authors;
6. To calculate the relative growth of articles on educational technology and from that the doubling time of the educational technology articles;

7. to calculate the relative growth of the number of pages of articles on educational technology and the doubling time of the pages;

8. To find out the author productivity of the authors and to test Lotka's Law of Productivity.

9. To carry out an analysis of the cited references and find out;
   (a). the categories of references
   (b). age of references
   (c). obsolescence of references and half- life of documents; and

10. To analyze the source articles in the nucleus and find out the number of citations received by each article and to calculate the h-index for the set of documents published in each of the journals in the nucleus.

11. To find out whether there is correlation between the h-index and the number of citations received; between the h-index and the number of publications over the given period; between the citations per publication; between the h-index and the relative h-index.

3.2 SIGNIFICANCE OF THE PROBLEM

The study of research output in educational technology literature in the form of journal articles in peer reviewed journals will be of interest and use to various researchers, policy makers and educational
planners. The impact of advances in science and technology has revolutionized the total educational system and the process of teaching-learning. Hence an understanding of the communication pattern of researchers in the field of Educational Technology will be of immense value and significance to every one in the field of education—teachers, students, educational administrators, policy makers, fund providers and technologists.

3.3 SCOPE OF THE STUDY

The study covers only the research articles which have been published in the journals covered by the online database SCOPUS during the period 1998-2007. The analysis involves the application of Bibliometric techniques an overview of which has already been provided.

DATA COLLECTION

One facet of this investigation was the identification of a core list of journals which contained articles on educational technology which may prove most useful to educationists and educational administrators. This could be done in several ways—Interviews, Questionnaire, Observations of Journal use, or the examination of library holdings. However, in each of these methods, there is a danger of the results being affected by the prejudice or predisposition of the investigator or the respondent. To lessen the danger of outside effect on data gathering, Webb, Campbell, Schwartz, and Sechrest (1966) suggested the use of unobtrusive or nonreactive measures. Unobtrusive research methodology consists of
observing and analyzing the natural artifacts or traces of the phenomenon being studied. The use of unobtrusive methods minimizes the difficulty of the responses being distorted.

Journal articles and the references listed at the end of each article appear to be a source of non reactive data which can be used for studies. Parker, Paisley and Garrett (1967) studied the use of bibliographic citation as unobtrusive methods and found them to be an excellent method for studying the communication pattern between researchers. Smith (1981) verified that the reference lists of documents provided the data necessary for citation analysis. According to Smith, they are readily available and non reactive. Smith emphasized that, "Citations are signposts left behind after information has been utilized and as such provided data with which one may build pictures of user behaviour without ever confronting the user".

Specific data were needed to carry out this study. The population for this study is an exhaustive list of journal articles on Educational Technology, published in the periodical literature from 1998-2007. This time period was chosen because articles published during this period represented the recent literature in Educational Technology. To develop such an exhaustive list of articles which would be used as data for the investigation, SCOPUS the largest and the most comprehensive abstract and citation database was selected. The articles on Educational Technology were identified for the time period 1998-2007 by searching
for “Educational Technology” in the Title, abstract, and key-terms. By going through the title, abstract, and the key-terms the researcher could ascertain whether the records returned were relevant to the study. The search produced a list of articles on Educational Technology with facility to get all relevant bibliographic information. All the data were gathered and entered into a database from which needed fields were generated as and when required.

ABOUT SCOPUS

SCOPUS is the largest and the most comprehensive abstract and citation database. It covers over 15000 peer-reviewed journals from more than 4000 international publishers, including coverage of over 1000 open access journals, 500 conference proceedings, 600 trade publications and 125 Book-series. The database contains 30 million records, of which, 16 million records include references, going back to 1996 and 17 million pre-1996 records going back, as far 1869. The subject areas covered include:

- Social Sciences 2850 titles;
- Physical Sciences 5500 titles;
- Life Sciences 3400 titles; and
- Health Sciences 5300 titles.

The database has smart tools to track, analyze and visualize research. Full bibliographic details about an article-author, title, Year of publication, Volume and issue number of the journal, source title, references with full details, citations, language of article, country of affiliation, organizational affiliation etc are available. SCOPUS includes
publications from many languages on condition that English translation of the abstract and the title should be made available. Smart tools like citation tracker, author identifier etc are of immense benefit to researchers.

3.4 DELIMITATIONS OF THE STUDY

The following are the de-limitations of the study:

1. The study period covers only 10 years, from 1998 -2007.
2. The population for the study, the journals and the journal articles published in those journals, on the subject of Educational Technology are compiled from the database SCOPUS only.
3. The study is confined only to the journal articles and does not cover other categories of publications since journal articles provide up-to-date development in the field and most of the journals follow peer-review before selecting articles for publication.
4. The study applies only Bibliometric techniques to quantify statistically the results for the objectives framed and does not reflect on the quality of the content of the articles. The quality has been already judged by the process of peer review prior to publication.

3.5 METHODOLOGY

The present study is carried out in two dimensions. The first dimension relates to source documents and research output. The published educational literature source documents and their research output are analyzed in terms of their distribution during the period of this
study i.e. 1998-2007. This study further examines the growth rate of research output (number of published articles) in terms of absolute growth and relative growth over a period of time. The author productivity is examined by identifying the pattern of research contribution among the authors publishing articles on educational technology. The study would identify the research concentration in journals of priority in publishing educational technology articles. The authorship pattern would be studied to find out the degree of collaboration in this field.

The second dimension is with regard to the cited references appended at the end of each article. It aims to analyze the nature and category of cited documents, the age of cited documents and the obsolescence of the references. The difference between references and citations has already been explained by Smith (1981). While a reference is the acknowledgement that one document gives to another, a citation is the acknowledgement that one document receives from another. The importance of citations has been stressed by many experts in studying the relationship between the cited article and the citing article. The number of citations that an article has received from other articles has been found out by using the citation tracker tool provided by SCOPUS.

An h-graph which is a measure of the output of an article or a group of articles in a journal is provided to gauge the popularity of the article/journal. The publications of educational technology literature published in journals covered by the database SCOPUS are taken as
the source of the present study. For a better understanding of the use pattern of the authors all relevant details are gathered, tabulated, graphically presented, analyzed and interpreted.

METHODOLOGY OF APPLYING BRADFORD'S LAW

An overview of Bibliometrics was given in the previous chapter. Several Bibliometric techniques or procedures have been formulated which are helpful in analyzing the literature of a particular subject. Donhue (1973) identified four Bibliometric techniques which can be used in the analysis of a subject literature – The Bradford distribution, citation analysis, epidemic theory and bibliographic coupling. Of these the Bradford Distribution and citation analysis will be mainly used in this study.

One of the fundamental Bibliometric techniques is the Bradford law of scatter or the Bradford Distribution. Bradford (1934) stated the law of scatter as follows:

If scientific journals are arranged in order of decreasing productivity of articles on a given subject, they may be divided in to a nucleus of periodicals more particularly devoted to the subject and several groups are zones containing the same number of articles as a nucleus, where a number of periodicals in the nucleus and the succeeding zones will be as $1:n:n^2$
Bradford postulated that every scientific subject is in some way, related to every other subject. He felt that periodicals contain the articles on a given subject could be arranged according to the number of articles each contained on the subject. This could be arranged in order of decreasing productivity and one could identify zones of periodicals where the number of periodicals in each zone was inverse to number of articles in each zone. This was the basis for his law of scatter. Bradford (1934) surveyed the articles concerning Applied Geophysics and Lubrication which were published from 1928 through 1933. The results of this survey are shown in Table 1.
Table 1
Applied Geophysics, 1928 – 1931

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Column A - number of Journals Producing a corresponding number of articles in Column B

Column C - Running sum of the number in Column A.

Column D - Running sum of Column x column A.

Column E – Common logarithms of Column C Numbers

(Source: Bradford, 1934, p. 85)

Bradford partitioned the figures into three groups of approximately equal number of articles. In Applied Geophysics there were 9 journals in the first group which produced a total of 429 articles. The second group consisted of 59 journals with an aggregate of 499 articles. The third
group had 258 journals with 404 articles. The Lubrication literature also approximated the results of applied geophysics. In the first group of Lubrication, there were 8 journals with 110 articles, the 2\textsuperscript{nd} group contained 29 journals with 133 articles and the 3\textsuperscript{rd} group contained 127 journals with 152 articles.

Bradford found that when the results were plotted using the logarithms from column E (Table 1) as abscissa and the number from column B as ordinate, the resulting curves were similar (Figure 1).

![Graph showing Bradford's Bibliograph Curve]

(A - Geophysics (Ordinates increased twofold)
B - Lubrication (Ordinates increased fivefold)

(Bradford, 1934, p. 36)

Fig. 1 Bradford's Bibliograph Curve
Bradford suggested that the arrangement of periodicals in this way “acts as a family of successive generations of diminishing kinship, each generation being greater in number the preceding, and each constituent of a generation producing inversely according to its degree of remoteness”.

Goffman felt that Bradford had established a method for identifying the most productive journals in a subject literature, but there was need to find out at what point journals cease to be of low productivity and become highly productive. Goffman formulated a procedure and a formula to find the transition point which is stated below:

\[
T = \frac{-1 + \sqrt{1 + 8I_1}}{2}
\]

where \(T\) is Transition point and \(I_1\) is the number of journals producing only one article on a given subject in a given time.

**METHODODOLOGY OF APPLYING CITATION ANALYSIS**

Martyn (1975) defined a citation as an event which is “only immediately quantifiable in terms of its frequency of occurrence.” He defined citation analysis as “the analysis of the citations or references which forms part of the scholarly apparatus of primary communication” (pp. 290).

Smith differentiated between references and citations. “A reference is the acknowledgement that one document gives another. A citation is the acknowledgement that one document receives from another.” (pp.
Citation analysis is thus a study of the relationship which is implied between two documents.

Price (1965) reported that normally papers average about 15 references per paper. About 10% of the papers published contained no references. 12 of these are to other periodicals. Normal research papers usually contain 25 or fewer references each. Price also noted that the body of world literature was growing at the rate of about 7% per year. Thus seven new papers appear for every 100 papers published in any one year. Based on the average of 15 references per paper these seven new papers would produce 105 references to the previous 100 papers. Or, each paper should be cited an average 1.05 times per year.

However, Price compared the references to the citations and found that 35% of the papers were never cited; 49% cited only once; and the remaining 16% were cited at an average of 3.2 times each.

3.6 STATISTICAL TOOLS AND TECHNIQUES USED

Relative Growth Rate

The researcher has applied the relative growth rate and doubling time model developed by Mahapatra (1985) to examine the growth rate of the educational technology literature during 1998-2007.

The relative growth rate is the increase in the number of publications/pages per unit of time. The mean relative growth rate \((1-2)\) over a specified period of interval can be calculated from the following equations.
\[ \bar{R}(1 - 2) = \frac{w_2 - w_1}{T_2 - T_1} \]

Where \( \bar{R}(1 - 2) \) = Mean relative growth rate over the specified period of interval.

\[ w_1 = \log w_i \] (Natural Log of initial number of publications/pages)

\[ w_2 = \log w_j \] (Natural Log of initial number of publications/pages)

\( T_2 - T_1 \) = the unit difference between the initial time and final time.

The relative growth rate for both publications and pages can be calculated separately.

Therefore,

\[ \bar{R} (a) = \text{Relative growth rate per unit of publications, per unit of time (year);} \]

\[ \bar{R} (p) = \text{Relative growth rate per unit of pages, per unit of time (year);} \]

**Doubling Time**

The doubling time is the period of time required for a quantity to double in size or value. It is applied to population growth, inflation, literature growth in a discipline and many other things which tend to grow over time. When the relative growth rate (not the absolute growth rate) is constant, the quantity undergoes exponential growth (also known as
geometric growth) and has a constant doubling time or period which can be calculated directly from the growth rate. This time can be derived by dividing the natural logarithm of 2 by the exponent of growth. If one use natural logarithms, this difference has a value of 0.693. Thus the corresponding doubling time for publications and pages can be calculated by the following formula.

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

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

Doubling time for pages \(Dt(p) = \frac{0.693}{R(p)}\)

**Author Productivity**

It examines the prevailing trend in carrying out the research process on educational technology in terms of the extent to which the research performance is concentrated by a single author.

The Lotka's Law of author productivity is tested with the applications of scientific productivity, Chi-square model, and it is applied in relation to number of authors contributing to the number of publications. Potter (1981) identified the Lotka's fraction \(1/n^a - 4.65\) on the basis of Euler–Maclaurin formula of summation. This model is applied in the present study.

The sum was used as a deviser for \(1/n - 4.65\) to determine the proportion of the total number of authors expected to produce ‘n’ papers.
(in case of present study n=1,2,3,4…..65), the following formula was used to find the proportions.

\[ S = \sum_{n=1}^{65} \frac{1}{n^{4.65}} \]

For the present study, "S" is the sum of Lotka's modified rations for the value \( \alpha = 4.65 \). The formula is

\[ A_n = \frac{1}{n^{4.65}} \frac{T}{S} (n = 1, 2, 3….65) \]

where \( T \) is total number of authors in the sample and "\( A_n \)" is the total number of expected authors producing “n” papers.

The Lotka’ s Law was also tested with the application of scientific productivity Chi-Square model in relation to a number of authors who contributed “n” number of publications.

It can be expressed by the equation,

\[ a_n = \frac{a_1}{n^2}, n=1,2,3...... \]

In other words, for every 100 authors, making one contribution each, there would be 25 authors contributing two articles each \((100/2^2=25)\) about 11 authors contributing 3 articles each \((100/3^2 = 11.1)\), and so on.

Here "\( a_n \)" is the number of authors contributing “n” papers each and “\( a_1 \)"is the number of authors contributing one paper each.
The chi-square can be computed as

\[(f-p)^2/p\]

where \( f \) = observed number of authors with "n" publications

\( p \) = expected number of authors

**Degree of Collaboration**

It explains the prevalence of proportion of single authored papers and multi-authored papers on educational technology. Subramanyam’s (1983) formula is adopted to examine the extent of research collaboration in educational literature output.

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

where \( C \) = degree of collaboration in a subject

\( N_m \) = number of multiple authored papers

\( N_s \) = Number of single authored papers

Further the researcher has applied various statistical tools to analyze the various data such as mean, standard deviation, coefficient of variations etc. Graphic and diagrammatic representations are presented wherever necessary.

**Concepts**

The following concepts are operationally defined for the purpose of this present study.

**Relative Growth Rate**

It explains the increase in the number of publications/ pages of educational technology literature per unit of time.
Doubling Time

It means two fold multiplications of number of publications/pages of educational technology literature.

Authorship Pattern

It denotes the percentage concentration of single authored papers in relation to multi-authored papers on educational technology literature during the period of analysis.

Definition of Terms

The following definitions and/or explanations of terms are used throughout this study:

Annual: "A type of serial in which the parts, usually in volume form, are intended to be issued at intervals of a year. An annual usually contains material particularly relevant to the year in which it is issued" (Nicholas & Ritchie, 1978, p.166).

Bibliometrics: It is a quantitative study applying statistical techniques to the characteristics of publications, such as, language of publication, place of publication, date of publication, date and time of use, frequency of use, journal productivity, publisher productivity, author productivity, characteristics of the users of literature, and the citation and referencing patterns exhibited by the literature.

Bradford Distribution: A distribution of serials arranged in order of decreasing productivity of articles on a given subject, such that they may
be divided into a nucleus (serials that are more particularly devoted to the subject) and several groups or zones containing nearly the same number of articles as the nucleus. The number of serials in the nucleus and succeeding zones will be as $1: n: n^2$ (Bradford, 1977).

**Bradford's law:** A law used in library and information science that states that in a given subject field over a given period of time: (a) a few journals publish most of the articles in the field; (b) many journals publish only a few articles each (Diodato, 1990).

**Citation age:** The age of a citation is a measure of the “synchronous obsolescence” of an article. Citation refers to a mention made by one document of another document; the mention is considered to be a citation (Diodato, 1994). The mention may occur in the footnotes, endnotes, bibliography, or reference list.

**Core journals:** Journals that produce more number of articles on a particular topic. One or more core journals appear during a comprehensive search of a given topic. Bradford's law predicts that there will be relatively few core journals for a given topic. The core journals are found in the Bradford nucleus (Diodato, 1990).

**Educational Technology:** Educational technology is a system in education in which machines, materials, media, men and methods are interrelated and work together for the fulfilment of specific educational objectives.
Educational Technology Literature refers to the articles published in the journals, covered by the online database SCOPUS during the period 1998-2007.

Periodical (journal, magazine): A type of serial in which the parts (called issue are published more frequently than annually. The periodical is generally characterized by two or more of the following features: (a) regularity of publication; (b) consecutive and systematic numbering and dating (c) variety of contents and contributors, both within the issue and from one issue to another. With the general exception of newspapers and some types of popular periodicals, issues are usually designed and numbered as constituents of a national volume, completed at determined intervals by the issue of a volume title page and or by an index (Nicholas & Ritchie, 1978.).

Proceedings: A publication, often serial, containing the texts of papers communicated to a conference, society, or institution and sometimes also reporting or transcribing discussions arising from the papers and business in connection with them. (Nicholas & Ritchie, 1978.pp. 167-168).

Scatter: Scatter refers to the spread of items among many different sources. Scatter often refers to Bradford’s Law, which suggests that, in a comprehensive collection of articles on a given topic covering some time period, there will be many journals (sources) that each publish only a few articles (items) on the topic (Diodato, 1994).
Serial: A publication consisting of a number of separate and successive parts in a uniform format, having a constant title and being designed for consecutive issues at intervals over an infinite period of time and an indefinite number of parts (Nicholas & Ritchie, 1978).

Serial productivity: This refers to the number of articles published by a serial in a given period of time. This number may be interpreted as one measure of the research productivity of the serial in question (Diosdato, 1994). The length of the article or the relative size of the page does not contribute to this measure.