CHAPTER 2

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2.1 INTRODUCTION

Before finalizing the research design, the investigator has to undertake a survey of the literature in the area related to the problem to be studied. Since effective research is based on knowledge, such a survey serves a number of purposes like providing ideas, explanations or hypotheses, valuable in understanding and formulating a suitable research design and locate comparable material useful in interpreting the results of the problem being investigated. Best and Khan (1986) observe, “citing studies that show substantial agreement enables a clear understanding of existing knowledge in the problem areas, provides a background for the research project and makes the reader aware of the status of the issue”.

With the above guidelines in the mind, the investigator scanned a number of journals, abstracts and theses and located a host of literature in the field of Educational Technology, Bibliometric studies, citation analysis and studies of journals.

The investigator has found that there has been a proliferation of Studies focusing on various aspects of introduction of Educational Technology in the field of Education. Some of the aspects studied include the attitudes of teachers and students towards technology integration in Education, E-learning, E-resources, online teaching and learning, virtual
classrooms, computer assisted teaching and learning, video conferencing, technology in curriculum, simulation studies, and so on.

However, the present study is a quantitative statistical study applying bibliometric techniques, with the purpose of understanding a body of literature, not directly related to the contents of individual publications. The quality aspect of the individual publications has already been taken care of by the process of peer review.

Since the problem under investigation is inter-disciplinary involving the field of Education and application of Bibliometric techniques, which has its origin in Library and Information Science, the investigator has planned his review in the following categories:


2.2 BIBLIOMETRIC STUDIES ON A SPECIFIC ASPECT OF EDUCATION

Breitenstein (2003) studied the field of Visual Literacy by analyzing bibliometrically the Conference papers of International Visual Literacy Association-1991-2000. It was an inter-disciplinary research involving convergence of interests from the more traditional disciplines of
Art, Education, Psychology, and others. Bibliometric techniques were applied to find out the most cited authors in IVLA Conference papers 1991-2000; the most cited works of these authors; and the citation patterns of these authors.

The study collected data by searching inside conferences via DIALOG, the online database. 322 papers on the subject of Visual Literacy were returned and it was narrowed down to 249 by adding IVLA as the conference. The 40 most cited authors and 18 most cited works were identified through bibliometric techniques of citation analysis using SPSS package. The results of study revealed predominance in both the cited influences and conference paper titles, of the disciplines of Education, Psychology, and Communications combined with the use of Visual Arts and current technologies to create and interpret visual messages. It was concluded that Visual Literacy is a modern meta-discipline that has emerged from the interaction in both theory and practice, of these factors. Breitenstein concluded that bibliometric techniques offered well-tested methods for characterizing the physical and intellectual structure of the literature of a discipline.

O’Connor (1999) analyzed Bibliometrically the pedagogy literature in the serials that encompassed Adapted Physical Activity content from 1988 – 1998 to find out whether it adhered to the principles of a Bradford distribution and whether Price’s law substantiated the findings of the Bradford Distribution by identifying a nucleus of the most
productive authors in Adapted Physical Activity pedagogy. 770 articles in 259 serials were selected for the study from Article first, ERIC, MEDLINE, and SportDiscus databases. Results of this study supported the use of Bradford Distribution to describe and quantify the literature of Adapted Physical Activity Pedagogy for the period of 1988-1998. Based on the analysis of the data, the applicability of Price's law to pedagogy literature of Adapted Physical Activity was not supported.

Smith (1984) studied the Periodical literature on Learning Styles which appeared as periodical articles during September, 1978, to June, 1983. The study involved identifying those periodicals which were most productive with regard to publishing articles on learning style by applying Bradford's Law and also analyzing the references and citations contained in those articles. Out of 70 periodicals containing 146 articles authored by 107 authors during the study period only two were identified as core periodicals. The results of the analysis of the references and citations showed that most of the articles in the core periodicals were written by the same person and that there was a high rate of self-citation. Approximately one third of the references were to other journal articles; one third was to books; and about one fifth were to doctoral Dissertations. The conclusion reached was that learning style concept was not sufficiently defined in periodical literature.

Smith (1998) investigated whether Bibliometric analysis of a sample of Journal literature on academic librarianship demonstrated the
existence of a mature and unique knowledge base that is one component of a profession. The answer to the question was derived by applying four Bibliometric measurements.

1. The price’s index for the sample demonstrated an adherence to the research front providing support for the general research question.
2. The mean number of references per source article in the sample fell within the range specified as the “norms of scholarship”
3. The percentage of references to other journal articles in the sample did not meet the threshold level and did not support the research question
4. The disciplinary self citation rate for journal article citations in the sample was above the threshold level and lent support to the question.

The conclusion was since the sample met only 3 of the 4 criteria the study did not fully demonstrate the existence of a mature, unique and scholarly knowledge base to view academic librarianship as a profession.

Hultgrenn and Limberg (2003) examined the research bearing on the relationship between information seeking and use and learning in a school context. Studies examined included research on how school assignments, reading ability, access to tools and children's understanding of information seeking and use influence their information behaviour and learning outcomes. Library catalogues and databases covering several disciplines were searched and the results were
correlated with the findings of a bibliometric study in order to locate relevant research. The results indicated that little research has focused specifically on the relationship between information seeking and use and learning outcomes, although all research taken up in the study elucidated aspects that touched upon the relationship. Taken together, research showed that a strong relationship existed between school children's understanding of information seeking and use, the nature of school assignments, the quality of access tools and children's experience and knowledge of them. It seems likely that this relationship in turn influences learning outcomes.

Defining Computer mediated Communication (CMC) as it exists in the scholarly communication concerning business, education, psychology, sociology, and social sciences, Wallace (1999) attempted an exploratory analysis employing bibliometric techniques to establish Computer Mediated Communication's artifacts, producers, and concepts i.e. journals, authors of the articles of those journals, and conceptual keywords. A more fine-grained analysis was applied to concepts. They were examined in terms of their prevalence, academic orientation and also their relationship to each other.

An area of scholarly communication, heavily popularized in education related journals was identified. Psychology and other social science affiliated disciplines contributed in a less prolific fashion. Multi-disciplinary with some interdisciplinary linkages would be a good
description of CMC. Where there was interdisciplinary overlap, the communication discipline appears to be the boundary spanner in the majority of cases. This role did not extend to the business index analyzed.

The distribution of first authors was overwhelming with one-time authorship. This significantly differed from theoretically defined literatures associated with a field of study. Moreover, CMC's articles tended to be localized in a relatively few journals. Clusters of conceptual topics tended to be database affiliated. Those with the most wide-ranging support among all databases tended to come from topics traditionally associated with the communication discipline. Also "telecommunications", "information network" and "Internet" affiliated topics were widely indicated from a number of the databases.

This study was significant for three reasons. First, it documented CMC's historical emergence. Second, it identified descriptive boundaries concerning CMC's authors, journals, and areas of inquiry that were prevalent. Third, it examined the communication discipline's role in the literature as defined. Additionally, it provides guidance concerning CMC's future research.

Kwak (2002) used citation analysis to assess trends in articles published in the five major school psychology journals. Citation analysis is characterized by its objective ability to highlight the ways that
information moves within and between a scientific discipline and has been used frequently to assess such trends. Specifically, the degree of self-citations and cross citations were found to be relatively low compared to findings in other areas of psychology and only one journal had most of its references come from a journal that was behavior analytic in nature. Finally, it was found that *Best Practices in School Psychology* (Thomas & Grimes, 1995) was the most often cited book, T. R. Kratochwill was the most frequently cited author, and "School based consultations: Theory, techniques, and research" (Gutkin & Curtis, 1990) was the most often referenced article/book chapter.

Overall, these data support the notion that school psychology field was growing and remained diverse in author contribution, and research and extension to journals other than those focused simply in the field of school psychology. It was concluded that, school psychology as a field was maturing into its own and sustained a focused group.

*Nilsen (1997)* undertook a bibliometric research to objectively document policy effects on social science researchers' use of statistics sources by examining a sample of 360 articles published from 1982 to 1993 in 21 Canadian social science research journals in Economics, Education, Geography, Political Science and Sociology. Examination of citations, tables, and text in the sampled articles reveals extent of use of statistics from Statistics Canada and other governmental and
nongovernmental sources, both Canadian and foreign, over a period before and after policy implementation. A survey of authors of sampled articles supplemented the bibliometric findings. Results of the case study showed that Statistics Canada sought to recover costs and achieve greater revenues through higher prices and increasing electronic data dissemination. Bibliometric analysis shows there was no significant change over time in use of statistics from Statistics Canada or any other governmental or nongovernmental source. The use of Statistics Canada paper products declined significantly. The survey reveals that social science researchers were unhappy with the price increases, but did not change the statistics sources they used. The movement of statistical information into electronic formats was well received, though more respondents (in 1995) still used paper products than electronic ones. Possible explanations for these findings were proposed. Alternative effects of increased prices and format changes were suggested for future research. Additionally, the implications of the research findings in relation to these social scientists and the agencies involved in information and management were discussed as potential topics for further research.

Mittal, Sharma and Singh (2006) in their paper on Library and Information Science Education literature in India have presented an analysis of 536 papers published on library and information science education during the period 1995 to 2004. The productivity of authors and core periodicals were determined using Lotka's and Bradford's law.
Literature growth, country-wise distribution of papers and language pattern were also studied. Literature growth in this area of LIS was found to be negative. Most of the papers were contributed by single authors (72.8%) and two authors (20.69%) and 72% of literature was published in 72 journals.

Budd (1990) applied the bibliometric laws formulated by Bradford and Lotka to 569 papers on Higher Education. Bradford's law focused on scatter while Lotka's law concentrated on productivity of authors. The conformity of higher education literature was not perfect with both the laws but the study suggested that they were applicable to examination of the literature of a discipline and that this kind of examination had implications with regard to the means by which scholarship is communicated.

Derrick (1973) undertook a study of Educational Research, the official Journal of the National Foundation for Educational Research, UK. He reviewed the 1968, 1969 and 1970 issues of the Journal and analyzed the distribution of the articles, the age-groups of the persons studied, methodologies of the design and the number of contributions from the various British Universities.

To consolidate the conclusions from his study in 1973, Derrick (1974) reviewed their other journals for the same period 1969-1970.

Anglin and Towers conducted a bibliometric research study to identify authors who were most frequently cited in Educational
Technology Research and Development, Educational Communication and Technology Journal, and in the Journal of Instructional Development. Thirty-seven authors with 20 or more citations over a five-year period were identified and rank-ordered by total number of citations.

Furnham (1990) stated that one measure that has been extensively used in North America for over 20 years to measure individuals’ and departments’ research productivity and impact is the "Citation Count", which is the number of times an article is cited in the literature. He refers to Garfield’s mammoth work of counting citations for all disciplines for the 15 years period from 1961 to 1975 from which he listed 250 most cited authors. Each of the top 250 was cited more than 4000 times during the 15 years period. Another interesting finding was that 17% of the above had received Nobel Prizes, 44% were elected to the U.S. National Academy of Sciences, 22% were Fellows of the Royal Society, 3% were members of the French Academy of Sciences and nearly 2% belonged to Swedish Academy of Sciences.

Furnham has studied the works of American and Canadian researchers which has established high correlation between the citation index and such things as distinguished scientific awards, academic opinion polls, learned society presidencies, etc. He says that the method has concurrent validity as it correlates with other different less objective
measures of the same things and then the method is also reliable as the results are stable over a period of time.

He also lists the possible errors and biases in the citation analysis but asserts that "it is a robust, reliable, valid and comparable method of evaluating quality and a very impressive performance indicator".

Field, Lovell and Weller (1991) carried out an empirical case study of citation counting applying it to Studies in the Education of Adults and the International Journal of Life-long education. They scanned all references during the five years 1986-1990. They added together all the references and awarded one full publication equivalent (FPE) for each reference cited and a half FPE for an author involved in a joint-author publication. They found out the ten most frequently cited Authors:

They obtained similar results for finding out the 10 most frequently cited publications. They found some interesting results such as only one woman among the 10 most frequently cited authors, most are Americans; only 2 British and so on They further concluded that within the field, the strongest area was education of Adults. Fijeire's 'The Pedagogy of the Oppressed' was clearly the most frequently cited reference in both journals. The findings of this study suggested that:

- the study of continuing education was still in a formative and under-developed stage;
- there was little dialogue and debate between continuing education scholars;
there were no widely shared conceptual frames of analysis; and
the field is heavily weighted towards the study of adult education, with relatively little research into vocational education or FE.

These findings point to important defects and gaps in the body of continuing education and that there is a dearth of scholars in Continuing Education in Britain.

2.3 BIBLIOMETRIC STUDIES BASED ON DATABASES

Databases containing bibliographic references on published scientific literature are significant for quantitative studies. The prominent databases being used for this purpose are Science Citation Index or its online version, SCI search. Chemical Abstracts, Biological Abstracts, Physics Abstracts, COMPENDEX, LISA etc.

In the following paragraphs a few recent Bibliometric studies conducted by using various databases are reviewed.

Johnson (1988) investigated the process of paradigm change within the nursing field using a Bibliometric analysis of nursing journal literature with focus on four elements of the diffusion process namely, the innovation, communication channels, time and the social systems.

A MEDLINE search of the nursing journal list covering the years 1966-87 was conducted using the words identified by a national sample of practicing nurses. Results of the search indicated a convergence on a
group of keywords that described holistic health. MEDLINE search analysis using these words showed a dramatic rise in the number of articles in which they appeared from 1976-1987. The majority of the articles on holistic health were written as one time project by their authors.

Todorov (1989) proposed a new bibliographic method for representing links between sub-fields as defined by a classification scheme which has been applied to describe the internal links within the field of condensed Matter Physics, using the Physics Abstracts Database 1984.

Begum and Rajendra (1990) analysed the Indian Zoological science literature covering the period 1975 – 1984 by extracting the data form Indian Science Abstracts. The study identified the authorship pattern, collaborative research trend in the field of zoological sciences, and compared the results with authorship pattern in other scientific fields. Similarly, authorship pattern and collaborative research in psychology has been analyzed by Karisiddappa, Maheswarappa and Shirol (1990) based on the data collected from Psychological Abstracts for the year 1988 which reveals that the trend towards multiple authorship varies from one subject to another subject.
Martin (1991) has made a bibliometric assessment of UK scientific performance based on the CHI/ NSF Science Literature Indicators Database and suggested more consistent and realistic set of indicators in assessing the scientific performance.

Sengupta and Lalitakumari (1991) analysed AIDS literature published during 1976-1986 and identified its international channel of communication, medium of communication, contributing countries’ authorship trends etc. While analyzing the bibliographic data from 430 journal articles on liquid Crystals covered in Physics Abstracts, Singh and Arunachalam (1991) found that Liquid Crystal literature is developing and that the share of Soviet Union is rising fast and that of USA is on the declining trend.

In order to measure a country’s relative specialization in different scientific fields, Barre (1991) constructed Revealed Scientific Advantages index, based on the INIST/ CNRS PASCAL database classification of science, consisting of 107 sub – fields.

Bliss (1993) analysed the data in Library Science literature published during 1958-1990, to examine the disciplines that contributed to international librarianship and the individual authors and countries who have contributed to the field.

The increasing specialization of researchers necessitates collaboration, more access to electronic means of communication, and more competition for research funds are the findings of the study,

The analysis of science Citation Index annual files for the years 1987-1989 and 1992 – 1995 by Stefaniak (1998) reveals that a considerable increase in the number of publications were accompanied by the geographic development of co-authorship after the 1980's political changes in Poland.

Rao (1999) using COMPENDEX database for 1990 and 1994, found that engineers in India published their articles in a few selected journals. Chemical engineering, ceramics, plastics and polymers were the main fields of their concentration.

The publication output of 25 major counties in 10 sub fields of physics drawn from INSPEC database for the period 1989-1994 were analysed by Nagpaul and Bhattacharya (2000) to study the national patterns of research output and priorities with the help of statistical techniques such as Research Priority Index, Typological analysis, Multidimensional analysis, and correspondence Analysis, to monitor the changes in the structure of research in Physics.

A methodology for exploring the characteristics of a core international conference, a concept of Conference Impact Factor (CIF), has been explored by Clausen and Wormell (2001) on the pattern of Journal Impact Factor (JIF), this study was based on online citation database in DIALOG and the CD versions of the USA.
The time trends of publications types relating to Clinical Medicine based on the MEDLINE database have been analysed through correspondence factor Analysis (CFA), which reveals that internal clock of the database was broadly consistent. However, there were periods of erratic activity.

A bibliometric analysis of LISA covering 1994-1998 has been conducted by Parameswarn and Smitha (2001) which shows the vital role performed by LISA in the dissemination of information in LISA literature. is meagre but also the representation of contributions from the third world countries. library and information science. It was found that not only the proportion of Indian contributions compared to the total output of countries.

Subbiah Aruchalam and Jayshree Balaji (2001) examined fish and aquaculture research in the People’s Republic of China over the six years 1994-1999 using data from six databases – three abstracting services and three citation indexes; the results are compared with fish science research in India. By using bibliometric studies, they have found that about 78% of China’s journal paper output has appeared in 143 domestic journals compared to 70% from India in 113 Indian Journals.

The application of informants in veterinary Medicine has been studied by Smith and Williams (2002) which identified a slow growth rate of Veterinary information during 1966-1985 and the growth of
Veterinary related articles that include an informetrics components that have increased almost two- and one half fold in 1986-1995.

Maclas-Chapula (2002) studied the literature on health system reform in Latin American and Caribbean countries through the web as well as the databases on CD RIM. The results in his webometrics and bibliometric investigations stated that there were no comprehensive databases in terms of time, document type and content coverage. The result indicated the need to organize and administer the existing literature on healthcare reform so as to transfer it into the knowledge as demanded by the user community.

Lopez_Munoz,F et al (2003) performed a bibliometric study of the scientific publications referring to selective serotonin reuptake inhibitors (SSRIs) using the Database EMBASE: Psychiatry and applied the principal bibliometric indicators: Price's and Bradford's laws on the increase or dispersion of scientific literature, Lotka's law on the productivity of authors, the participation index (Pal) of countries, the productivity index (PI) of authors, and the collaboration index. They analyzed 3,622 original documents published between 1980 and 2000. The results did not adhere to Price's law because production on SSRIs does not grow exponentially. The journal most employed was the Journal of Clinical Psychiatry (Bradford's first zone). The United States is the most productive country. Documents were distributed in four groups:
experimental pharmacology (8.38%), tolerance and safety (34.94%), clinical efficacy (49.11%), and not specified (7.56%). The drug most studied was fluoxetine. The results of the present study showed that the SSRIs are not solely antidepressant drugs, but also have a wide range of uses both within the psychiatric sphere (especially in the field of anxiety) and outside it.

Telemedicine/Telehealth literature has developed in recent years, fueled by research and the development of telemedicine as a field of study. The bibliometric study by Welsh (2005) examines the publishing and citing patterns of telemedicine literature indexed by the Telemedicine Information Exchange (TIE), an online database maintained by the Telemedicine Research Center (TRC) with major support from the National Library of Medicine. Citation counts in the TIE bibliographic database trace the growth and development of telemedicine literature and identify the most prolific authors. Citation counts in SciSearch cited reference science database indicate the most cited telemedicine journals and authors and are used to compute journal impact factors. Seventy percent of the telemedicine literature was published since 1995; 86 percent was published since 1990. Core telemedicine journals, Journal of Telemedicine and Telecare and Telemedicine Journal, are peer-reviewed, research-oriented, highly cited in SCI, and have a high Journal Impact Factor. The most prolific authors are not necessarily the most
cited (only 30 percent of top ten most prolific telemedicine authors are also among the top ten most cited in Science Citation Index.

Krampen and Schui (2006) bibliometrically analyzed the historical development and current state of family psychology literature for the period from 1980 to 2001. Psychological literature databases PSYNDEx and PsycINFO were used to determine the relative frequency of family psychology publications within the total publications from psychology. Bibliometric analyses refer to index terms with significance for family psychology. Results show that family psychology publications have a relatively stable and high proportion within the total of all publications from psychology since the 1980's, referring to 5-7 percent in the psychological literature from the German-speaking as well as the Anglo-American research community. Historical trends could not be observed. However, the results point at a high empirical orientation in the family psychology literature, which is increasing since the late 1980's. Moreover, results show that family psychology has connections to many other disciplines of psychology. Pleas for a stronger institutionalization of family psychology in research as well as psychology education are supported by the bibliometric results presented. The purpose of this study was to describe, analyze, and compare the status of professional nutrition literature in the fields of medicine, nursing, nutrition/dietetics, and health education.
Psychological research on aggression between 1977 and 2003 was analyzed and reviewed by Hans Huber (2006) with reference to publications documented in the databases PsyclINFO (with its focus on the Anglo-American literature) and PSYNDEX (focus on publications from the German-speaking countries). Bibliometrical results refer to general historiographical trends in aggression research as well as to developments in social psychology (i.e., aggressive, antisocial behavior), personality research (i.e., aggressiveness), and in research on violence and aggression in micro/macro-systems, criminal behavior, victimization, and clinical settings. Additionally, main foci of research on aggression are described based on the distinction of basic and applied psychological research. All bibliometric analyses follow a comparative and historiographical approach pinpointing essential similarities as well as differences in the development of aggression research in the Anglo-American and the German-speaking research communities.

The study by Pulina and Francescoin (2007) calculated several bibliometric indexes to analyze the scientific output of 363 members of the Scientific Association of Animal Production in Italy, based on their publications listed by ISI-Thompson, Web of Science database for the period 1989-2006. The study considered five main research areas-animal genetics and breeding, animal Nutrition and feeding, animal husbandry, and poultry, rabbits, and fish production and categories of researchers' positions. Results showed that Professors of Animal Genetics and
Breeding came out with highest values of bibliometric indexes. It was also found that the scientific system of Animal Science in Italy has a good degree of internationalization.

2.4 BIBLIOMETRIC STUDIES 1957 – 1970

Starting from Cole and Eales mammoth study in 1917 to evaluate statistically the Bibliographical citations on Comparative Anatomy covering the period 1550-1860, for ascertaining the growth of literature on the subject and Hulme's effort in 1923 to quantify, through Statistical Bibliography, the growth of scientific knowledge and thereby assess the overall development and growth of modern civilization, Bibliometric studies have been growing at enormous rate. Some select studies are discussed below:

Louttit (1957) analysed the language performance of writing research papers by psychologists, Chemists and Physicists. It was observed that reference made by writers in English language journals were 92.5 percent in English, in German journals 91 percent German and French journals 64.6 percent French. Further it was said that numerous studies in Social Sciences show reference in American sources having around 90 percent in English.

Simonton (1960) identified that in two language source journals in the field of Fine arts, more than half of the references were the materials in foreign language reference.
De Solla Price (1963) made a study on Collaborative Authorship which had increased steadily over time and has been rapidly growing since the beginning of twentieth century.

The rate of increase in multiple authorship varies from one subject area to another. In physics the proportion of the single author papers have fallen from 75 percent in the 1920s to 39 percent in the 1950s. The Corresponding figures for psychology are from 84 percent to 55 percent, reports by Merton (1963).

It is evident that the single authored articles termed as solo research or research in peril has been on the declining trend in the modern era, reports by Ranganathan (1963). What he predicted for the modern era holds good for the post modern era also.

Clarke (1964) in his study on Bibliometric papers criticized the view of Price and concluded with a generalization as regards the increasing trend towards multiple authorship is not valid for science as a whole.

Manten (1968) made a study on earth science and found that: The multiple authorship in the field of Earth Science increase in the frequency of multiple author papers.

Zuckerman (1968) examined the research output contribution of 41 Nobel Laureates. The result indicated that there was high degree of collaboration and productivity among them.

Narain (1970) inspired by a model proposed by Fermi in 1949 in cosmic ray astrophysics proposed a simple model to account for Bradford’s law. The most significant first step in a model was to recognize the Badford’s law is equivalent to a simple power law distribution or articles in journals. Specifically J(p) the number of journals carrying exactly p articles is of the form of J (p) = Kp (K being constant and = 270) to explain the power law relation.

2.5 BIBLIOMETRIC STUDIES 1971 – 1990

Turkeli (1973) studied the post doctoral productivity of Turkish physicists along with related social environmental factor. The study reveals that about 60 percent of contributions are based on collaborative research.

Meadows (1974) has studied that there has been consistent trend towards increased collaboration in all major branches of sciences over the years.

Rangarajan and Poonam Bhatnagar (1981) analysed the bibliometric data compiled from physics Abstracts on research papers published in the field of Mossbauer Effect studies over a period of two
decades from its discovery in respect of media choice. The findings indicated that there was a world-wide trend to publish in journals outside the country of origin of the research work.

White (1985) observed that the super-imposition of the Bradford distribution over the linear zipf distribution, which demonstrates the emergence of more used and popular items may yield a technique to describe the pattern of books used by library patrons. She feels that this law, when applied to circulation data, these formulations can support such policies as shortened loan periods for heavily used and the identification of a core collection.

Todorov (1985) studied the distribution of physics literature in 36 countries over 10 sub-fields using physics abstracts to compare national pattern of publication and to determine groups of countries with similar publishing activity. He found that physics publications came predominantly from nine countries. USA, USSR, UK, Japan, Germany, France, Canada, India and Italy.

Schubert et al., (1985) compared the medical research output of 11 mid-size countries (Austria, Belgium, Czechoslovakia, Denmark, Finland, Hungary, Netherlands, Norway, Sweden, Israel and New Zealand) in the field of clinical medicine using papers indexed by SCI during (1978 – 1979) and their citations in literature till 1980. The study indicates that professors proved to be more productive than “average scientists” of the same country with no particular eminence, and also a
correlation existed between the quality of clinical medicine papers and the infant mortality of the countries in question.

Paul Mohan Roy (1985) conducted a Bibliometric study under the title “A Bibliometric Analysis and Evaluation of Research Writings by Indian Authors in the field of Physics”. The overall objective of the study was to analyze and evaluate the Indian Scientific Literature using Bibliometric techniques.

The objective of the study was to study the pattern in which the literature of Science produced by Indian scientists is structured and to what significant extent it differed from that of the literature of Science produced by Scientists of other countries. The Bibliometric variables relating to the source papers like Author, Title and Subject and those of the cited references were subjected to Bibliometric study with the objective of studying the Multiple Authorship Trend, rate of expressiveness of Titles, and the citation pattern of the scientists.

Klaic (1990) examined the research activity of Chemists from Rugjer Boskovic, Yugoslavia during 1976 – 1985 covering 2018 research papers of scientific work. The papers were classified according to subfields used in the Journal Citation Reports. In this study he found that over 67 percent of papers corresponded to journal articles.
2.6 BIBLIOMETRIC STUDIES 1991 – 2000

Jain and Garg (1992) made a scientometric assessment of the laser research in India during 1967 – 1984 using journal of Current laser Abstracts. Authors found that laser research performed in India forms a part of the mainstream science, however, emphasis on application oriented research by India was less as compared to the world research.

Sancho et al., (1992) studied scientific and technological trends in research and development of new refractory materials employed in iron and steel making processes. From the study they identified that the countries and institutions which are the world leader in this particular field using six different database during 1976 – 1995.

Nederhof et al., (1993) made a Bibliometric study to assess the performance of departments in the field of Natural and life Sciences, the social and behavioural sciences and humanities. The result explains that nearly one third of the departments publications were not covered in the Science Citation index.

Harsanyi (1993) examined the authorship pattern of publications in Library and information Science and considered the methodological impact of various ways of allotting “credit” for multiauthored works and relationships between multiple authorship and other publication variables such as qualify and impact. Given the complex relationship between collaboration and productivity, the concomitant use of non – bibliometric
of studying collaborations, as well as the application of meta-analysis is suggested.

**Braun (1994)** has studied the scientific publications on the basis of the data obtained from the institute for scientific information, (ISI) Philadelphia. All countries which published at least 50 first authored papers in the field in question during the study period were included. The sources journals during the period 1980 – 1984 and 1985 – 1989 were considered as source items and citations to them were counted for the periods from 1980 to 1989 respectively.

**Nagpaul and Sharma (1994)** compared the profile of research output and trans-national co-operation as revealed through multi-country publications of 36 countries in 10 sub-fields of physics during 1891 – 1985 using SCI database. They state that multiple authorship pattern is highly notified in 10 sub-field of physics.

In another study, **Nagpaul and Sharma (1995)** compared the research priorities of 33 countries in Physics, Chemistry, Biology, Mathematics, and Engineering using data files of Braun et al., for the period 1980 – 1984 and 1985 – 1989. Authors found that research priorities in different countries are influenced more by scientific traditions and national needs than by geographical or socio-cultural proximities with other countries.

**Dhruv Raina (1995)** and others have studied the evolution of collaboration in four sub-disciplines of Physics for the period 1800 –
1950. The overall evolution of physics publications in India reveals a remarkable break with a past in the decade 1920s onwards. In fact the growth rate enters a new face after this time. Further, these growth rates exhibit quasi—doubling. The collaboration coefficients taken decade wise and strongly correlated with the total number of publications taken decade wise. This conforms with increasing collaboration as the number of publications increases.

Humayun Kabir (1995) made a Biobliometric study of bibliometric literature and reported that solo research predominates and degree of collaboration ranged from 0.20 — 0.35. Bibliometric literature is doubling in every 10 years.

Nagarajan (1995) examined the research productivity of Indian Scientists in Marine Biology. He identified the Marine Science Literature at the International level reveals that the relative growth rates of marine science research output have shown a declining trend, contrastingly doubling he time for publications that have increases remarkably. The same trend is witnessed in terms of Indian level output.

Chudyk (1995) analyzed the professional nutrition literature in the fields of medicine, nursing, nutrition/dietetics, and health education to describe, analyze, and compare the status of their role as a source of knowledge for primary care provider’s. Diffusion Theory was used as a framework to conduct a descriptive, retrospective, bibliometric analysis. A sample of nutrition articles was selected from general, high-circulation,
professional journals representative of one of the four fields published from January, 1990 through December, 1994. A coding form developed for this study was used to analyze thirteen article characteristics, four sources of recommendations, guidelines, and objectives, and the journals cited by the articles.

 Statistical analyses showed much diversity in article characteristics. The majority of recommendations, guidelines, and objectives were diffused across the literature of the four fields. Overall, the four sources did not impact the literature, did not impact the authors, and were not a focus of the articles. The results did not show strong evidence of interdisciplinary endeavors in the area of nutrition. These results substantiated the complex and multifaceted nature of nutrition and the journals.

Ravi (1996) studied the nuclear science research productivity of Indian Scientists and found that the nuclear science research papers were published mainly in Journals. Among the International sources of publications United States and United Kingdom predominated in Publishing Indian Nuclear Science Research papers. Two authored and three authored papers were more than the single authored and other multi authored papers.

Kundra (1996) investigated the collaborative research trends in Indian Medical Sciences 1900 – 1945 and drew general and broad
conclusion. The growth pattern suggests that a large proportion of co-authored papers in a discipline or a journal depend to some extent on the type of research and the discipline involved. As a result, it is not impossible to have a relatively lower proportion of collaborative papers in a particular sample, even when collaborative research overall has become the normal practice.

Rajeswari (1996) analysed the patents fields in India during 1970–1992 she found in her study that the Indian patending activity was pathetically low when compared to any other resource factors of the country such as the stock of scientific and technical manpower, their deployment in R&D activities, resources input to R&D activities, vast R&D infrastructure, and the large population.

Anwar and Abu Baker (1997) studied the contribution of Muslim countries to world science literature using SCI for the time span of 1990–1994 and found that their share to world science is meager. Forty–six Muslim countries contributed 1.17 percent to world science literature as compared to 1.66 percent by India alone and 1.48 percent by Spain. Twenty Arab countries constitute 0.55 percent as compared to 0.89 percent Israel alone.

Ugolini et al., (1997) assessed the publication quality of the National Institute for Cancer research (Genoa), Italy, and found that the
scientists of the institute published in high quality journals as reflected by the impact factor of the journals.

Suresh Kumar, Parveen Sharma and Garg (1998) have contributed a study which aims at determining the applicability of Lotka’s law, negative binomial distribution and lognormal distribution for institutional productivity, in the same way as it is to authors and their productivity in the field of engineering science and the patterns field by industrial firms in laser Science and Technology. The study indicates that none of the three distributions for institutional productivity in engineering sciences. However, Lotka’s law holds good for full as well as truncated set of data for the patents filed by industrial firms.

Okubo et al., (1998) have analysed the publication profile of 48 nations during 1981 – 1992 using Science Citation Index (SCI) to examine cutting edge versus ancient research in these nations and identified countries whose publication patterns underwent the most marked changes. The study points out that there appears to be an overall shift towards the American pattern or research interests worldwide. The south Asian nations still have not acquired the balanced publication pattern that characterizes the most advanced countries, although these countries have ventured into new areas like computer and material science and are also concerned about environmental and health science research.
Chun (1999) undertook a descriptive Bibliometric study of the field of Korean Studies to quantitatively describe the literature of Area Studies. The study analyzed 193 source articles and 7166 citations in the articles in four representative Korean Studies journals published in North America from 1977 to 1996 – Korean Studies, the journal of Korean Studies, the journal of Asian Studies and the Harvard Journal of Asiatic Studies. Subject and author characteristics of source articles along with form, date, language, country of origin, key author, and key titles of the literature cited in the source articles were collected.

Results of the study showed that research in Korean Studies fell within 14 broad disciplines, but concentrated only in a few disciplines. Americans were the most active authors followed by authors of Korean ethnicity. The mean and median age of publications cited was 20.87 and 12 respectively. Sources written in English were most cited (47.1%) and references to Korean language sources accounted for only 34.9%. No significant core authors and no significant core literature were identified. The conclusion was Korean Studies was still evolving and ways to promote well-balanced growth in the field to be explored.

Cano (1999) reviewed 17 years of research in Library and information Science in Spain for a period 1977 – 1994. He identified that the Spanish research in Library and information science had concentrated more on information retrieval, description of service and
Studies of scientific communication. Authorship pattern suggested prevalence for individual authorship (68 percent).

Bibliometric study of the publication pattern and impact of South African Scientists during 1981 – 1996 was conducted by Jacobs and Lagwersen (2000) in the field of physics, chemistry, plant and animal sciences. This study found that there was a direct relation between academic position, research experience, and productivity among South African Scientists in the scientific disciplines.

Ramesh et al., (2000) analysed the papers published in Oryza the quarterly International Rice Journal from 1986 – 1995. The analysis showed that multiple author contributions constituted the maximum proposition (87.82 percent) and the degree of collaboration over his period varied from 0.90 – 0.95. The lengths of the articles with 1-5 pages were found to be at the maximum with 78.3 percent.

Saravanan (2000) has studied research productivity of G7 countries in Astronomy literature. He identified that USA occupied the first place with 66.24 percent, UK has 16.47 percent, 8.37 percent gone to Germany and remaining 8.92 percent respectively covered by France, Japan, Italy, India and Canada.

Kamalesh Goel (2000) examined the Gender differences in psychological research in India based on Ph.D theses covering the period between 1976 and 1986. The analysis showed that among the
total 1271 theses 62.94 percent has been produced by male researcher and 37.06 percent by female researchers in India.

Dhawan (2000) examined physics research in India and China using Physics Abstracts for the years 1990 and 1995. He found that China was ahead of India in terms of publication output; however average impact per paper for India was higher than that of China.

A descriptive analysis of the characteristics of the authors and the citation of the articles in the journal “Theological studies” from 1940-1995 was carried out by Phelps (2000) Data was gathered on the institutional affiliation, geographic location, occupation, gender and personal characteristics of the author. The citation characteristics were examined for the cited authors, date and age of citations, format, language, place of publication and journal titles. These characteristics were compared to the time period before and after the second Vatican Council in order to detect any changes that might have occurred in the characteristics after certain recommendations were made to the theologians. The results of the study showed that articles by women and lay persons increased since the recommendations of the Council. The data had a good fit to Lotka’s Law for the pre- Vatican II and not for post- Vatican II. The data was a good fit to Brad ford’s law for the predicted no of Journals in the nucleus and zone 2.

Subject dispersion of research from disciplines other than Theology was low but citation to works from the fields of education,
psychology, social sciences and sciences was on the increase since Vatican II.

2.7 BIBLIOMETRIC STUDIES SINCE 2001

Jacobs (2001) made a study covering the period 1992 – 1996, and demonstrated that there was a direct relationship between status and publication productivity. Further, there were significant differences in productivity between areas of sciences, but there was no direct relationship between institutional funding and productivity.

Kamlesh Goel (2001) studied the authorship pattern, areas of research, journals, institutions and regions covered in the Social Science Citation Index (SSCI) pertaining to the year 1998.

- The number of highly productive research and Academic institutions were almost the same and the highly productive institutions produced about 33 percent of the total Indian output in Social sciences.
- Research in Sociology received maximum attention followed by Psychology, Economics, Planning and development.

Most of the findings were published in journals from the west. However, most commonly used journals were from India.
Parameswaran and Smitha (2001) made a bibliometric analysis of Library and information Science abstracts 1994 – 1998. Their findings were:

- Maximum number of publications falls in the broad fields of information and communication technology with 13.41 percent coverage.
- More people write individually i.e., single authorship amounted to 77.5 percent and double authorship to 15.83 percent indicating that solo research predominates in the field of LIS.

The portion of Indian contribution of LIS research is very meager (1.14%)

Kannapannavar and Vijayakumar (2001) made a study on the authorship trend in international Monetary Fund Literature for a period from 1991 to 1998 and concluded that collaborative research was in an increasing trend varying from 0.45 – 0.62. The average degree of collaboration was found to be 0.56 – 0.81 by studying five select journals in geology covering the period 1987 – 1996.

Bandyopadhyay (2001) analysed the references appended to 92 doctoral theses submitted to department of mathematics, physics, mathematical engineering, philosophy and political science, University of Burdwan. The findings showed that authorship collaboration was high in physic; moderate in mathematics and mechanical engineering very low in
political science and philosophy excluding psychology. It is highest in nuclear physics followed by optics.

Although multiple authorship trends have increased steadily through decades (1950-1990) in all the branches of physics and mathematics and also in psychology: In mechanical engineering, philosophy and in all the branches of political science the multiple authorship trend has declined for certain periods.

The study of the subject Information Science as a science has been explored by analyzing articles published in Journal of the American Society for Information Science from its initial publication, American Documentation, in 1950 through 1999, by Koehler (2001). The analysis of the study reveals that there has been a slow but perhaps inevitable to a much wider research and publishing participation among authors, regions, corporate authors, and countries.

The development of Bibliometric and Scientometric research has been analysed by Schoepfin and Glanzel (2001) based on the articles, and their references published in Scientometrics. The study indicated that mean citation rate was 0.52 which is increasing over the years.

Garg and Padhi (2001) analysed 3174 papers published in journals in the field of Laser Science technology. It indicated that only 401 papers were single authored and the rest 2773 were co authored papers. Of the 2773 papers, only 687 showed domestic, national collaboration and others international collaboration.
The output of female researchers in Iceland in the field of Life Sciences relative to that of male covering the period from 1980 – 2000 has been analysed by Lewison (2001) which reveals that there is no significant difference in the quality of female and male research output as measured by journal impact categories or by citations.

Robert Dalpe (2002) conducted a study to assess quality for bibliometric studies in relation to collaboration of authors using biotechnology research and revealed the interaction between science and Technology.

Subbiah Arunachalam and Subbiah Gunasekaran (2002) made a bibliometric study on Tuberculosis Research in India and China and identified that there was a tremendous mismatch between the share of the burden of the disease and the share of the research efforts.

Karisidappa, Gupta and Suresh Kumar (2002) studied the distribution of productivity of authors and their collaboration in theoretical population genetics. The study revealed that the productivity of authors and their collaboration in theoretical population genetics were closer to Lotka’s type of distribution for the later group of authors and collaboration.

Maclas- Chapla (2002) analysed AIDS documents as produced on Sub – Saharan Africa and found out that the main countries participating in AIDS research were Democratic Republic of Congo and Cameron. The results indicated a high pattern of collaboration through multiple
authorship. The subject content of the documents was found to be focused mainly on epidemiology, complications and prevention and control issues of AIDS.

**Suresh (2002)** also examined the collaboration trends in AIDS literature. His study revealed that out of the total 43,468 bibliographic records, 50.06 per cent was contributed by United states individually while 49.04 per cent from other 74 countries, England was the second major individual and contributed 20.94 per cent, United states and England taken together contributed an exact 70 per cent to the world AIDS literature.

**Vijayakumar, Kalyane, and Kademan (2002)** analysed the publications of Ahmed Hassan Zewail, Nobel laureate in Chemistry, who had collaborated with one or two colleagues and published 246 papers during 1976 – 1994. The study revealed that the collaboration was high in all the years of the study period.

**Ponzi (2002)** conducted a study of productivity of authors and their collaboration. The study indicated that the collaboration studies explored intellectual structure and interdisciplinary breadth of knowledge management in its early stages of development.

**Ramesh and Nagaraju (2003)** discussed the various features of distributions of papers, the authorship pattern and year – wise distribution of degree of collaboration in their study. They revealed that the author
affiliations emptations the dominance of Indian authors and the multiple authorship belonging to academic institutions.

Inonu and Kurnaz (2003) carried out a comparative study between scientific production of Turkish Physicists during the periods 1961 – 1971 and 1994 – 2000. The results showed that in 30 years, appreciable increases have occurred in the number of collaborative authors making significant contributions.

Kim (2003) examined the productivity of Korean researchers in physics and Mechanical Engineering. The study identified the type of authorship and their collaboration pattern that influenced the choice of sources cited by Korean scientists.

Sadik Batcha (2003) examined the cancer research output in SAARC countries covering the period 1966 – 2001. The study identified that the growth of cancer disease research output have shown a declining trend; hence doubling time for publications have increased much. The same trend was witnessed in terms of Indian level of research output.

Gupta and Dhawan (2003) carried out a study on the research collaboration between India and China. It revealed a rise in the number of co-authored papers, from 21 in 1994 to 74 in 1999; it was also found that the S&T collaboration between India and China was mainly through multilateral channels and the output through bilateral channels was very small (11.7 percent).

Berghmans (2003) with the aim of determining whether there was a relationship between citation factors and a trial's methodological quality using published randomized trials in lung cancer clinical research studied 181 articles and found that American authors published trials more often in journals with high citation factors than European and non-American authors, despite no better methodological quality. They concluded that journals with higher citation factors do not publish clinical trials with higher levels of methodological quality, in the field of lung cancer research.

Abbas Horri (2004) made a bibliometric overview of library and information science research productivity in Iran over the years 1996 – 1988. His findings indicated that most of the contributions to the scientific production of the field were research papers, theses and research reports respectively.

Glamzel Wolfgang (2004) studied the role of author self-citations in scientific communications. The results characterized author-self citations process obeying rules that could be measured and described with the help of mathematical models. The rules used in evaluating micro and macro analyses identified significant deviations from the reference standards.
Trueba and Hector (2004) developed a robust formula to credit authors for their publications. The formula satisfied several criteria of theoretical and practical significance and tested bibliographical references from INSPEC data base, mainly from physical sciences. Their results satisfy several objective and quantitative criteria in the process of evaluating relative scientific productivity in a given discipline.

Eggle and Rousseau (2004) carried out a study, to measure own group preference as a novel approach to a sociometric problem. From their study it is understood that the concept of own group preference is an interesting notion with applications in different fields such as sociology, political science, economics management science and of course the information science.

De Bakker et al (2005) analyzed bibliometrically 30 years of research and theory on corporate social responsibility and corporate social performance. Social responsibilities of businesses and their managers have been discussed since the 1950s. Yet no consensus about progress has been achieved in the corporate social responsibility/corporate social performance literature. In this article, the authors seek to analyze three views on this literature. One view is that development occurred from conceptual vagueness, through clarification of central constructs and their relationships, to the testing of theory - a process supported by increased sophistication in research methods. In contrast, other authors claim that hardly any progress is to be expected because of the
inherently normative character of the literature. A final view is that progress in the literature on the social responsibilities of business is obscured or even hampered by the continuing introduction of new constructs. This article explores which of these three views better describes the evolution of the literature during a period of 30 years and suggests implications for further research.

Patra and Chand (2006) made a bibliometric study of library and information science research literature emanating from India based on the data abstracted in Library and Information Science Abstracts (LISA). Standard bibliometric techniques were employed to analyze the collected data and accordingly get indicators. Bradford's law of scattering was used to identify core journals of library and information science wherein Indian authors published their research output. To understand the productivity pattern of authors, Lotka's Law has been applied. The identified core journals were mostly published from India. Indian authors' contribution in international journals was very low. A list of authors who have published 10 and more papers during 1967-2004 was drawn. Such authors were 37 (1.35%) in number and authors with single publication had a major share (74.63%). The author's productivity pattern is in conformity to Lotka's law.

International collaboration is becoming an increasingly significant issue in science. During the last few years, a large number of bibliometric studies of co-authorships have been reported. Mostly, these studies have
concentrated on country-to-country collaboration, revealing general patterns of interaction.

Anuradha and Shalinii (2007) in their study analyzed international collaborative patterns as indicated in the Indian publications by tracking out multi author publications as given in Science Citation Index (SCI) database. Correspondence analysis was used for analysis and interpretation of the results. According to correspondence analysis of the data set, Physics, Chemistry, Clinical medicine were the first, second and third largest subjects having international collaboration. USA, Italy, Germany, France, England were the top five countries with which India was collaborating. The data set showed an association between Physics and Italy, Switzerland, Algeria, Finland, South Korea, Russia, Netherlands contrasting an association between Biology & Biochemistry, Immunology, Ecology & Environment, Geosciences, Multidisciplinary subjects and England, Japan, Canada. It also showed an association between Agriculture and Philippines, Canada, Denmark in contrast to an association between Chemistry and Malaysia, Germany, France. An association between Clinical medicine, Astrophysics and England, Sweden, USA, New Zealand in contrast to an association between Agriculture and Canada, Philippines, Denmark was shown. An association between Engineering, Mathematics, Computer Science, Neuroscience and Singapore, Canada, USA in contrast to an association between Chemistry, Astrophysics and Malaysia, Spain is shown. This
association of collaborating countries and disciplines almost tallied with the publication productivity of these countries in different disciplines.

**Patra and Chand (2007)** investigated the growth over time of Indian AIDS research output based on bibliographic data from PubMed and Web of Science. Authorship distribution was examined using Lotka’s law. Bradford’s law of scattering was used to identify core journals. The study identified active institutions and statewide distributions of Indian AIDS research output. The yearly analysis of data showed that there was a rapid growth of literature from 1992 onwards. Still, in the international context, relative productivity of India is low and required more focused research and development.

**Singh, Mittal and Ahmad (2007)** studied the growth and characteristics of digital library literature. Over 1,000 articles for the period 1998-2004 were collected from LISA Plus and were analyzed to study authorship patterns, authors’ productivity and prominent contributors, language-wise and year-wise distribution of articles, country-wise distribution of journals, core journals in the subject area, and indexing term frequency. Some of the important findings were that most articles (61 percent) were single-authored; author productivity was not in agreement with Lotka’s Law, except in one case where number of articles was three; the maximum number of articles were published in 2003 with English being the most productive language; maximum articles were published in the journal D-lib Magazine; distribution of articles
nearly followed Bradford's Law; and USA ranked first for maximum number of journals. The paper provides a comprehensive overview of authorship in the library and information science community.

Campos and Campos (2007) in their study have presented the results of Spanish immunological research from the perspective of the publication of patents during 2004 and 2005, together with its position in the international framework. The immunological patents filed by Spaniards accounted for 1.99% of patents granted worldwide in 2004, and 1.75% in 2005. Spaniards were the first listed inventor or applicant in 10% of their patents. In Madrid most patents were filed by the Public Research Institutions, due to the fact that the CSIC, (scientific research council) is based there, whereas in Catalonia most patentees were private enterprises. The authors assert that patents not only protect inventions but also make available to researchers a whole wealth of information not found in scientific publications and that Bibliometric indicators are essential to evaluate scientific activity in the field of Immunology.

Loomen, Hage, and Kon (2007) analyzed bibliometrically publications of plastic surgery over the last three decades. Data on the topic of surgical interest and the anatomical region of research, the country of origin, origin and number of collaborating clinics were noted for each original article published in Plastic and Reconstructive surgery, the

The results revealed that the number of articles in the three journals has more than doubled in the last three decades. Reconstruction of acquired defects remained the most important topic in all three journals. An interest in rejuvenation of Aesthetic surgery replaced that of basic research. The head and neck area was the anatomical region of most interest. Most articles originated from the USA but the publications from Europe and Asia showed an increasing trend. The publication output of multi-national scientific collaboration was increasing. Even though authors from larger countries, in general, contributed more publications in absolute number, authors from smaller countries had a more efficient output relative to the number of inhabitants and the GDP of the country.

Valmatjiana and Sabate (2008) carried out a Bibliometric study on the citations within the chemistry Ph.D. dissertations to ascertain what types of documents were the most frequently used in the research process, the most frequently consulted journals and obsolescence rate of the journals. The analysis covered 46 doctoral theses presented at the Institut Quimic de Sarriá (IQS) from 1995 to 2003. The results obtained from the 4,203 citations revealed that the most frequently used documents were scientific papers, which accounted for 79 percent of the
total; 33 journals met 50 percent of the informational needs; and the age of 50 percent of the citations was no older than 9 years.

2.8 RECENT LITERATURE ON BIBLIOMETRIC INDICATORS

Until now, a few citation based indicators have been used to measure research performance of researchers, institutions, and journals. But many reservations were expressed by academics about the use of such indicators to measure performance as some papers were cited for reasons unrelated to the quality or utility of a study. There were many such papers that proved to be ‘one time wonders’ (Kelly & Jennions, 2006; Miller, 2007).

Hirsch (2005) proposed a new indicator, which has come to be called Hirsch index or simply h-index for the assessment of the research performance of an individual scientist. According to Hirsch, “A scientist has index h if his or her N papers have at least h citations each, and the other N-h papers have lower than h citations each.” Hirsch’s work generated great interest among scientists and many studies were undertaken projecting the pros and cons of h-index. Ball (2005); Braun, Glanzel and Schubert (2005); Glanzel and Persson (2006); Van Raan, 2006 have made significant studies on h index.

Rousseau (2007) studied the evolution of the h-index of the Journal of the American Society of Information Science over the period 1991-2000 variable citation window. Since the results using h-index
(absolute value) he suggested the use of relative h-index obtained by dividing the h-index by the number of articles published. Using relative h-index he observed a linear decrease in time (or increase when going backward in time) as expected. The Pearson correlation coefficient was also found to be statistically significant and positive.

**Van Raan (2005)** made a comparative study of Hirsch index with standard bibliometric indicators and with peer judgement for 147 Chemistry research groups and presented the characteristics of the statistical correlation between h-index and other indicators. It was an evaluation study covering the period 1991-2000 of the work of 700 senior researchers in Netherlands. The results showed a strong positive correlation between h-index and total number of citations for all chemistry groups. The correlation was positive but less strong in the case of h-index and number of publications. In this study Van Raan used a fixed citation window of three years for citation.

**Egghe (2006)** studied the h-index in detail and suggested his own **g-index** an improvement over h-index by giving more weight to highly cited articles. According to Egghe, for a given set articles, ranked in decreasing number of the citations that they received, the g-index is the (unique) largest number such that the top g articles received (together) at least g^2 citations.

**Sidiropoulos, Katsaros, & Manopoulou (2006)** contributed to the literature on bibliometric indicators by their work leading to **Generalized**
h-index which adds an age-related weighting to each cited article, giving less weight to older articles. For example, for an article published during the current year, its citations account four times. For an article published 4 years ago, its citations account only one time and for an article published 6 years ago, its citations account 4/6 times and so on.

New concepts, such as, Individual h-index by Batista, Campiteli, Kinouchi, and Martinez (2006) and Age-weighted citation rate (AWCR) by Jin (2007) have been proposed. The conclusion is that Hirsch’s work has provided a clear background for further research on h-index.

Barendse (2007) Stressing the need for a uniform method that can be applied across all fields, Barendse calculated h-value for journals, over a twenty year time span and compared to the size of the journal in four fields, Agriculture, Condensed Matter Physics, Genetics and Heredity and Mathematical Physics. He found that there was a linear log-log relationship between the h-index and the size of the journal: the larger the journal, the more likely it is to have a high h-index. The four fields cannot be separated from each other suggesting that this relationship applies to all fields. A strike rate index (SRI) based on the log relationship of the h-index and the size of the journal shows a similar distribution in the four fields, with similar thresholds for quality, allowing journals across diverse fields to be compared to each other. The SRI explains more than four times the variation in citation counts compared to the impact factor.
2.9 INFERENCES FROM THE REVIEW OF RELATED LITERATURE

A review of the related literature has revealed that most of the Bibliometric studies are based on applications of elementary mathematical and statistical methods. There are conceptual studies, empirical studies, theoretical modeling and application oriented studies. In most of the studies the Bibliometric techniques are profitably used.

The impact and use of bibliometric techniques on scientific disciplines have led to its application in other disciplines also. Bibliometry has been increasingly applied in the case of social sciences, Arts and humanities, and Technology.

Bibliometric studies using databases are on the increase. Databases provide easy and reliable sources for collecting and analyzing data pertinent to the study.

Many specific aspects of various disciplines have been subjects of bibliometric analysis, such as, pedagogy literature in adapted physical activity, Learning style literature.

Generally, the source articles are analyzed category wise, language wise, country wise etc. Further, many of the studies have tested the applicability of bibliometric laws like, Bradford's law of scatter, Lotka's law for author productivity, Zipf's law etc. and thereby identify the core periodicals and rank them accordingly; and also rank the authors according to their productivity.
The growth rate and the doubling time of the literature are calculated.

The trend of authorship, whether single or multiple authorship prevails and quantify the trend by finding out the degree of collaboration.

The references appended at the end of each article are also analysed bibliometrically to find out the category of references and priority in their use; the age of cited references, and their obsolescence and half-life etc.

Studies of citations have helped in evaluating journals, by applying bibliometric indicators- Impact factor, or h-value or any other metrics.