

# Bradford's Law of Scattering: Ambiguities in the Concept of "Subject"\*

Birger Hjørland and Jeppe Nicolaisen

Royal School of Library and Information Science,  
Birketinget 6, DK-2300 Copenhagen S., Denmark  
{bh, jni}@db.dk

**Abstract.** Bradford's law of scattering is said to be about *subject scattering* in information sources. However, in spite of a corpus of writings about the meaning of the word "subject" and equivalent terms such as "aboutness" or "topicality", the meaning of "subject" has never been explicitly addressed in relation to Bradford's law. This paper introduces a distinction between Lexical scattering, Semantic scattering, and Subject scattering. Neither Bradford himself nor any follower has explicitly considered the differences between these three and the implications for the practical applications of Bradford's law. Traditionally, Bradford's law has been seen as a neutral and objective tool for the selection of the most central information sources in a field. However, it is hard to find actual reports that describe how Bradford's law has been applied in practical library and information services. Theoretical as well as historical evidence suggest that the selection of journals based on Bradford-distributions tend to favorite dominant theories and views while suppressing views other than the mainstream at a given time.

## 1 Introduction: Bradford's Law

Bradford's law of scattering (of subjects in information sources), first published in 1934, is often mentioned together with Zipf's law (about word frequencies in natural language texts) and Lotka's law (about distribution of authors' productivity) as one among the three most important bibliometric laws, and is often considered the best model or example of scientific research that is available within Library and Information Science (LIS). Bradford's law states that documents on a given "subject" is distributed (scattered) according to a certain mathematical function so that a growth in papers on a subject requires a growth in the number of journals/information sources. The numbers of the groups of journals to produce nearly equal numbers of articles is roughly in proportion to 1:  $n^2 \dots$ , where  $n$  is called *the Bradford multiplier*<sup>1</sup>. Ex-

---

\* The authors are currently investigating various issues relating to Bradford's law of scattering. The project is partly sponsored by The Danish Ministry of Culture [A2004 06-026].

<sup>1</sup> Bradford believed  $n$  to be constant in the different zones ( $n_1=n_2=n$ ); Results reported by Rao [1] indicates, however, that Bradford's assumption was wrong: Bradford multipliers vary from zone to zone.

plained in words, Bradford's law states that a small core of, for example, journals have as many papers on a given subject as a much larger number of journals,  $n$ , which again has as many papers on the subject as  $n^2$  journals.

Bradford himself provided both a graphical and a verbal formulation of his law that have later been found not to be mathematical equivalent. The exact mathematical function has been subject to much subsequent research, and the very question what a Bradford distribution is has been debated. As the distribution is very sensitive to different subjects and conventions, Heine [2] found that it is unclear under which circumstances a distribution should be regarded as a Bradford distribution.

Bradford's law has been used as an argument about how to build collections, how to select journals to be indexed in bibliographies, how to measure the coverage of bibliographies, how to solve practical problems related to information seeking and retrieval, and by Bradford himself as an argument for a new way to organize bibliographical work and scientific documentation.

Bradford's law is explicitly about the scattering of documents on specific subjects. The meaning of the term "subject" (and related terms such as aboutness, topicality, and theme) as applied in subject indexing, classification and knowledge organization, has been investigated in LIS for about a hundred years. Among the important contributions are Cutter [3], Wilson [4], Hutchins [5, 6, 7], Maron [8], Miksa [9], Soergel [10], and Hjørland [11, 12]. Since Bradford published his works, there has also been an impressive literature about Bradford's law. The peculiar thing is, however, that with a few exceptions nobody have thus far tried to outline the consequences of different conceptions of "subject" for Bradford's law of (subject) scattering. The two lines of research have never really met.

## 2 Applications of Bradford's Law

B.C. Brookes was among the first to address the possible applications of Bradford's law. In a short note in *Nature* he wrote that the law "seems to offer the only means discernible at present to reducing the present quantitative untidiness of scientific documentation, information systems and library services to a more orderly state of affairs capable of being rationally and economically planned and organized" [13, p. 953].

Several commentators have suggested using Bradford's law to solve practical journal collection management problems. The basic idea is to conduct Bradford analyses of journals - i.e., to sort the journals in Bradford zones - and thus identify which belong to the core and which does not. Any Bradford analysis involves three steps [14, pp. 16-17]:

1. Identify many or all items (usually articles) published in this field;
2. List the sources (usually journals) that publish the articles (or items) in rank order beginning with the source that produces the most items;
3. While retaining the order of the sources, divide this list into groups (or zones) so that the number of items produced by each group of sources is about the same.

Nisonger [15, pp. 139-140] argues in his textbook *Management of Serials in Libraries* that the following points are some of the "most obvious potentials" of Bradford analyses:

- Selection/deselection
- Defining the core
- Collection evaluation
- The law of diminishing returns
- Calculation of cost at various coverage
- Setting priorities among journals

Other commentators have suggested using Bradford's law to solve practical problems related to information seeking and retrieval. Howard D. White [16] proposed an automatic option for sorting the output from online searches of journal literature, which he argued would help online users. What he had in mind was a "computerized sorting of hits by the journals in which they appear, and then of journals, high to low, by the number of hits appearing in each" [16, p. 47]. He termed the procedure "Bradfordizing", and argued that "the ability to retrieve items selectively by journal after learning contributing titles and their yields, would seem to be the greatest single advantage of the proposed option" [16, p. 50]. The reason for his optimism is spelled out in the article. According to White it is easy to imagine situations in which the searcher would want to retrieve hits only in the core journals of a literature. He mentions that it is often troublesome to track down the articles in the tail of a Bradford distribution, and concludes that "one may have the prejudice that items published in the core journals of a subject are generally superior to those scattered over journals in the tail, which is tantamount to believing that journals publishing the most items on a topic also publish the items most worth reading, as a rule" [16, p. 50]<sup>2</sup>. Perhaps as responses to White's suggestion, the proposed option is today a standard option in the products of most database vendors.

However, it is hard to find actual reports that describe how Bradford's law has been applied in practical library & information services<sup>3</sup>. The near absence of such reports is hard to comprehend in light of the many suggestions for applications. It is furthermore a bit strange as G. Edward Evans in his primer on collection management writes that:

"Special libraries and information officers make good use of data generated by bibliometric techniques in selecting and maintaining collections of the most needed serials. Bradford's law, Lotka's law, Zipf's law, and citation analysis have contributed to the effective operation of special libraries" [18, p. 104; emphasis added].

Unfortunately, Evans does not provide any details or references on this.

There is no reason to believe that the assumptions about universalism and neutrality underlying the application of Bradford's law can be combined with the demands on pluralism, which may be expected from libraries and information systems. In other words: The application of Bradford's law to the selection of information sources may

<sup>2</sup> This prejudice is probably quite common. Sandstrom [17, p. 584], for instance, argues: "Knowing how the core is constructed and integrated with other research concerns makes it easier for scholars to track down necessary information".

<sup>3</sup> One exception is the ISI databases. The ISI journal selection process is partly based on Bradford analyses  
[<http://scientific.thomson.com/knowtrend/essays/selectionofmaterial/journalselection/>].

not be just a neutral tool, but may possibly turn out to function discriminatorily against minority views. Cognitivism has dominated American psychology (and thus also international psychology) since the early 1970's. Before that time behaviorism was the dominant approach in psychology (see [19]). However, historians of psychology have found that cognitive approaches may be tracked long back in the history of psychology. Greenwood [20] identifies sources of cognitive psychology in the hey-days of behaviorism, often in more remote psychological journals. It is reasonable to expect that if Bradford's law had been applied to select (or deselect) journals to libraries and databases around 1930, then the result would have been that journals with an exclusive behavioral orientation would have been too strongly represented and that journals more open towards, for example, the cognitive approach, would have been too weakly represented. The cognitive view later developed to a majority view. If journals open to the cognitive view had been deselected due to the application of Bradford's law, this may well have made it more difficult for the view to develop, why the application of Bradford's law would have counteracted scientific progress. This is the opposite of what library and information services are supposed to do.

### 3 The Underlying Mechanisms

Bradford [21, p. 110, 22, p. 148] wrote under the heading *The scattering of articles on a given subject*:

"It is, therefore, necessary to examine the extent to which articles on a given subject actually occur in periodicals devoted to quite other subjects: as, for instance, a paper on the mechanism of the heart, contributed to the *Proceedings of Physical Society*, or one on genetics, occurring in an agricultural magazine. Investigation shows that this distribution follows a certain law, which can be deduced both theoretically from the principle of the unity of science and practically from examination of the references.

According to this principle every scientific subject is related, more or less remotely, to every other scientific subject.

It follows that from time to time, a periodical devoted to a special subject may contain an article of interest from the point of view of another subject. In other words, the articles of interest to a specialist must occur not only in the periodicals specializing on his subject, but also, from time to time, in other periodicals, which grow in number as the relation of their fields to that of his subject lessens and the number of articles on his subject in each periodical diminishes".

Bradford's empirical data are well known and well considered in the literature. The principle of which he felt he could deduce his famous law, is, however, extremely superficially treated in [21] (equal to [22]; and not mentioned at all in Bradford's 1934 paper [23]). To our knowledge this theoretical principle has also been unnoticed by subsequent research. Disregarding the short quotation given above, no discussion

of this principle of the unity of the sciences<sup>4</sup> and the consequences for the organization of the scientific literature has to our knowledge been produced. Although it seems very probable and fruitful to us, we do have difficulties in deducing any specific statistical distribution of papers or subjects from it. In fact in the original paper [23], two different distributions were hypothetically mentioned in the beginning. This indicates that at this time, at least, Bradford himself did not deduce or anticipate or had intuitions that the distribution, which was later widely recognized as *Bradford's law*, followed from the principle of the unity of the sciences.

A more productive understanding related to the unity of science would probably be to connect the phenomenon of scattering with the concept of *interdisciplinarity*. It seems rather obvious that the more interdisciplinary a field of research (or a tradition or a "culture" of research) is, the more scattered the subject will be over different disciplines and clusters of journals. The kind of distribution in terms of mathematical functions should be expected to depend on the nature of the borders between fields. If such borders are strictly and formally defined and if the contribution to such fields demand conditions that can only be met by a small group of scientists, then the degree of scattering should be low (high concentration) and the distribution rather discontinuous. Experimental science depending on very special equipment should have a high concentration, while contributions to philosophical problems should have a high scattering because such problems have a high degree of generality and at the same time many different professions have the qualifications and conditions to make a contribution. The social sciences are generally considered very interdisciplinary (see e.g., [26]), with legal science as an exception. The degree of interdisciplinarity probably influences phenomena of scattering. In some journals (e.g. in some psychoanalytic journals) only authors with a specific training are allowed to publish. Such regulations may also influence phenomena of scattering. Unfortunately, Bradford did not consider such more sociologically oriented thoughts. His thoughts were dominated by the metaphysical view to find in reality an a priori pattern or law to which his empirical data would fit.

Bradford himself had very little interest in the underlying mechanisms that produced the observed distributions. His motivation to do the investigations was to show that the existing documentary system was incomplete and "chaotic". His conception of subject matter was in our opinion rather primitive, and what interested him was primarily a better coverage of abstracting and indexing services, which he demonstrated was very low: "Less than half the useful scientific papers published are abstracted in the abstracting periodicals and more than half the useful discoveries and inventions are recorded, only to lie useless and unnoticed on the library shelves" [22, p. 146].

#### 4 Bradford's Conception of "Subject"

As Bradford never explicitly discussed the meaning of "subject", we have to infer his meaning of this concept indirectly by considering how he uses this word. We have

---

<sup>4</sup> That Bradford mentions the concept "unity of science" in 1948 is no surprise. This concept was a hot issue at that time due to the influence of the logical positivists who published the *International Encyclopedia of Unified Science*. The first issue came in 1938. The last in 1962 (cf. [24] and [25]).

already seen that "a paper on the mechanism of the heart, contributed to the *Proceedings of Physical Society*, or one on genetics, occurring in an agricultural magazine" are considered "quite other [different] subjects". But do these examples really exemplify "quite different subjects"? The heart can be regarded from a physical point of view and a paper on this subject can be regarded as part of the interdisciplinary field of biophysics. The paper can thus be considered a subject on (or rather for) both human biology and physics. The same argument may be applied to the paper on genetics appearing in an agricultural magazine. Bradford's conception of "subject" reflects a view close to *naïve realism* [11].

Bradford's empirical distribution was based on the sources indexed in four years of the current bibliography *Applied Geophysics* and two and a-half years of the current bibliography *Lubrication*, both prepared by the *Science Library* in London, of which Bradford was the keeper. There is no discussion, however, of how papers were assigned subject descriptors (e.g. classification codes) and how this assignment may have influenced the actual distributions. Indirectly however, we may get a little insight of his thinking about this issue and its consequences for his law.

Bradford realized the needs for deep indexing addressed towards specific subject areas (such as lubrication). His library, however, could not provide bibliographies with sufficient coverage of the relevant documents. Because the sources were too scattered, no special library could cover all the needed documents, and no compulsory team of a realistic size could manage to scan all the needed sources. Because of this insight Bradford suggested a two-step procedure. All journals and other information sources should be indexed by source, not by subject. That is: one team should make a crude indexing of journals one by one. Then other teams of information specialists could make specialized indexing to special purposes. "On the average, a general abstract requires two classification numbers to specify the main subjects of the paper [...]. A special abstract, which included every substance mentioned and every piece of apparatus described, might well need as many as twelve classification numbers" [22, p. 145].

Bradford imagined that 12 classification numbers per document would hardly be worthwhile, as many of these numbers might never be consulted. This is in contrast to present-day information retrieval in which every word in documents may be used as subject access point (in full text retrieval), where all references may be used as access points (in citation indexes), and where many kinds of subject access points and retrieval techniques may be applied. Bradford's view reveals a mix of theoretical considerations and practical constraints that probably are typical and harmful in the development of general knowledge in information science.

Concerning indexing and the concept of "subject" the quotation given reveals something about how Bradford looked at things. A comprehensive indexing should list "every substance mentioned and every piece of apparatus described". This is a kind of thinking related to a listing of all "substantive" words. When he suggests that these words should be indexed with the UDC classification, it is not the words, but the concepts (words including synonyms and excluding homonyms) that are indexed. This may therefore be interpreted as indexing of concepts rather than by subjects proper. But what difference does this make?

A proposal for the differentiation between concept indexing and subject indexing is given by Bernier [27]. In his opinion subject indexes are different from, and can be

contrasted with, indexes to concepts, topics and words. Subjects are what authors are working and reporting on. A document can have the subject of *Chromatography* if this is what the author wishes to inform about. Papers using Chromatography as a research method or discussing it in a subsection do not have Chromatography as subjects. Indexers can easily drift into indexing concepts and words rather than subjects, but this is not good indexing<sup>5</sup>.

## 5 Kinds of Scattering

The idea about different kinds of scattering came up when the first author served as referee on a paper by Hood & Wilson [28]. This paper examines - in the tradition from Bradford [23] - the distribution of bibliographic records in online bibliographic databases using 14 different search topics, which are searched in DIALOG (see table 1.).

The first author's suggestion to the authors was that these 14 questions represent three different kinds of questions. This is acknowledged in the paper, in which Hood & Wilson [28, pp.1253-1254] write:

“Hjørland [[29]] suggests that at a deeper and more theoretical level, scattering among databases is related to different kinds of scattering within the journal articles. He proposes three types of scatter: lexical scatter or the scatter of one word as in search #4 (shakespeare); semantic scatter or the scatter of one concept with different synonyms as in search #10 (dark matter); and subject scatter or the scatter of concepts useful to a problem [[11]] as in search #9 (hair loss). The gradation of scatter is from simple to complex, with lexical scatter being the most objective and subject scatter the most problematic, requiring a comprehensive search formulation. Further, the degree of semantic and subject scatter may be important indicators of interdisciplinarity. A logical progression of this research is to investigate further the underlying mechanisms for the types of literature scatter so as to answer suggested questions, such as: “To what degree is the overlap caused by overlap in the indexing of the same journals in different databases?” and “To what degree does overlapping terminology and concepts in different fields cause the overlap?”

---

<sup>5</sup> Bernier does not, however, differentiate author's subjects from those of the information seeker. A user may want a document about a subject, which is different from the one intended by its author. *From the point of view of information systems, the subject of a document is related to the questions that the document can answer for the users.* Such a distinction between a content oriented and a request-oriented approach is emphasized by Soergel [10]. The implication of a request-oriented approach is that subject analysis should predict the questions that the document is going to help answering (See e.g., [8]). Based on such analyses, Hjørland [11, 12] proposes that subjects are the epistemological or informative potentials of documents, and sees the job of the indexer as that of making a prognosis of the most important future applications of the document. This view corresponds to the functional theory about sources in history, which states that what count as an information source is always relative to the question that it is supposed to answer.

Thus, there are at least three different kinds of scattering:

- Lexical scattering is the scattering of words in texts and in collections of texts.
- Semantic scattering is the scattering of concepts in texts and in collections of texts.
- Subject scattering is the scattering of items useful to a given task or problem.

These three kinds of scattering are not independent of each other. There are, of course, internal relations between them.

Concerning lexical scattering: A word may, for example, be defined operationally as a sequence of letters surrounded by blanks. The most known formula for this kind of scattering is Zipf's law that states that the number of occurrences of a given word in a long stretch of text is the reciprocal of the order of frequency of occurrence.

Concerning semantic scattering: A concept may, for example, be defined operationally as nouns and their synonyms. Classes in classification systems and descriptors in thesauri are the most operationally available lists of concepts in domains and in databases. They do not, however, exhaust the number of concepts in a given domain and they may be subject to different interpretations.

**Table 1.** Queries used in DIALOG by Hood & Wilson [28]

1	fuzzy(w)set? ?
2	(informetric? ? or bibliometric? ? or scientometric? ?)
3	bradford?(5n)((law? or distribut? or dispers? or scatter? or zipf? or lotka or multiplier? or bibliograph? or rank? or bibliometr? or analys? or technique? or yield or method? or constant? or curve? or zone?))
4	Shakespeare
5	disease?(5n)eye?
6	(domestic or family)(5n)(violen? or abus?)
7	supervene or supervenes or supervened or supervening or supervenient or supervenience or supervention
8	librar?(5n)(privati? or outsourc?)
9	(finasteride or minoxidil or proscar or propecia) and (bald???? or alopecia or (hair(4n)(thin???? or loss)))
10	(Dark(w)matter or (weakly(w)interacting(w)massive(w)particles) or (massive(w)compact(w)halo(w)objects))
11	(el(w)nino or la(w)nina) and (climat?(5n)change?)
12	neandert?
13	((euro(w)dollar?) or (euro (5n) currency))
14	Cladism? or cladist? or cladogram? or cladogen?

Concerning subject scattering: This is what Bradford's law is supposed to be about. What is useful to a given task is, however, determined by given theories in the subject field, and different theories imply different views of what is relevant in case (cf. [30]). Subject scatter is difficult to operationalize. Probably the best expression of what different theories or "paradigms" identifies as useful to given tasks can be operationalized by studying patterns in citations because citations are supposed to reflect subject relations as relations of relevance or usefulness (see [19] and [31]).

## 6 Implications

What are the implications of the three kinds of scattering for the practical use of Bradford's law?

If core journals (or other information sources) are selected from the frequencies of words or concepts, rather than subjects proper, then such cores may contain journals that are not relevant to users. The core may be "polluted" with journals not belonging to "the subject". Such journals may take the place from other journals "on the subject" that use different words or concepts. In other words: an adequate indexing of documents is as relevant for providing Bradford distributions as for providing relevant documents to users.

Besides, while the distribution of documents according to word frequencies is a rather mechanical, neutral, and "objective" process, the distribution of information sources according to subject matter is a much more interpretative and political process. It is much more difficult to make operational implications of "subjects". What is a subject for one person need not be the same subject for another. The best way to generalize views about subjects is probably to consider different theoretical views or epistemologies regarding subjects. A pure mechanical view of selection must consequently be replaced by a reflective view in which the selector must justify the selection on axiological arguments.

## 7 Conclusion

Urquhart [32, p. 25] notes that the way Bradford's law has been handled by information scientists is "a good illustration of the unfortunate effects of the academic approach to information science". We have done our utmost to break with that tradition. In this paper we have put forward serious arguments against the received view on Bradford's law. The fact that it is difficult to find any examples of its actual use in practice may be an indication that such problems have intuitively been foreseen. Future research comparing and explaining different kinds of scattering in information sources should decide the potentials of Bradford's law.

## References

1. Rao, I.K.R. (1998). An analysis of Bradford multipliers and a model to explain law of scattering. *Scientometrics*, 41(1/2): 93-100.
2. Heine, M.H. (1998). Bradford ranking conventions and their application to a growing literature. *Journal of Documentation*, 54(3): 303-331.

3. Cutter, C.A. (1904). *Rules for a Dictionary Catalog*. Washington, DC: Government Printing Office.
4. Wilson, P. (1968). *Two Kinds of Power: An Essay on Bibliographical Control*. Berkeley, CA: University of California Press.
5. Hutchins, W. J. (1975). *Languages of Indexing and Classification: A Linguistic Study of Structures and Functions*. London, UK: Peter Peregrinus.
6. Hutchins, W.J. (1977). On the problem of "aboutness" in document analysis. *Journal of Informatics, 1*: 17-35.
7. Hutchins, W.J. (1978). The concept of "aboutness" in subject indexing. *Aslib Proceedings, 30*: 172-181.
8. Maron, M. E. (1977). On indexing, retrieval and the meaning of about. *Journal of the American Society for Information Science, 28*: 38-43.
9. Miksa, F. (1983). *The Subject in the Dictionary Catalog from Cutter to the Present*. Chicago, IL: American Library Association.
10. Soergel, D. (1985). *Organizing Information: Principles of Data Base and Retrieval Systems*. Orlando, FL: Academic Press.
11. Hjørland, B. (1992). The concept of "subject" in Information Science. *Journal of Documentation, 48*(2): 172-200.
12. Hjørland, B. (1997). *Information Seeking and Subject Representation. An Activity-theoretical approach to Information Science*. Westport, CT & London, UK: Greenwood Press.
13. Brookes B.C. (1969). Bradford's law and the bibliography of science. *Nature, 224*: 953-956.
14. Diodato, V. (1994). *Dictionary of Bibliometrics*. Binghamton, NY: Haworth Press.
15. Nisonger, T.E. (1998). *Management of Serials in Libraries*. Englewood, CO: Libraries Unlimited.
16. White, H.D. (1981). "Bradfordizing" search output: How it would help online users. *Online Review, 5*: 47-54.
17. Sandstrom, P.E. (2001). Scholarly communication as a socioecological system. *Scientometrics, 51*(3): 573-605.
18. Evans, G.E. (2000). *Developing Library and Information Center Collections*. 4<sup>th</sup> ed. Englewood, CO: Libraries Unlimited.
19. Hjørland, B. (2002). Epistemology and the socio-cognitive perspective in Information Science. *Journal of the American Society for Information Science and Technology, 53*(4): 257-270.
20. Greenwood, J.K. (1991). *Relations and Representations: An Introduction to the Philosophy of Social Psychological Science*. New York, NY: Routledge, Chapman & Hall.
21. Bradford, S.C. (1948). *Documentation*. London, UK: Crosby Lockwood.
22. Bradford, S.C. (1953). *Documentation*. 2<sup>nd</sup> ed. London, UK: Crosby Lockwood.
23. Bradford, S.C. (1934). Sources of information on specific subjects. *Engineering, 26*: 85-86.
24. Carnap, R. (1938). Logical Foundations of the Unity of Science. In: Neurath, O., Carnap, R. & Morris, C. (eds.), *International Encyclopedia of Unified Science*. Chicago, IL: University of Chicago Press.
25. Kuhn, T. (1962). *The Structure of Scientific Revolutions*. Chicago, IL: University of Chicago Press. [Also issued as Vol. II, No. 2, of the International Encyclopedia of Unified Science].
26. Andersen, H. (2000). Influence and reputation in the social sciences - how much do researchers agree? *Journal of Documentation, 56*(6): 674-692.

27. Bernier, C.L. (1980). Subject Indexes. In: Kent, A.; Lancour, H. & Daily, J.E. (eds.), *Encyclopedia of Library and Information Science: Volume 29*. New York, NY: Marcel Dekker, Inc.: 191-205.
28. Hood, W. & Wilson, C.S. (2001). The scatter of documents over databases in different subject domains: How many databases are needed? *Journal of the American Society for Information Science and Technology*, 52(14): 1242-1254.
29. Hjørland, B. (2001). Towards a theory of aboutness, subject, topicality, theme, domain, field, content . . . and relevance. *Journal of the American Society for Information Science and Technology*, 52(9): 774-778.
30. Hjørland, B. & Sejer Christensen, F. (2002). Work tasks and socio-cognitive relevance: A specific example. *Journal of the American Society for Information Science and Technology*, 53(11): 960-965.
31. Nicolaisen, J. (2004). *Social Behavior and Scientific Practice – Missing Pieces of the Citation Puzzle*. Copenhagen, DK: Royal School of Library and Information Science. PhD Thesis.
32. Urquhart, D. (1986). Librarianship is an experimental science. In: Allen, G.G. & Exon, F.C.A. (eds.), *Research and the Practice of Librarianship: An International Symposium. Western library studies, 7*. Perth: The Library, Western Australian Institute of Technology: 21-28.