Assessment of Indexing Trends with Specific and General Terms for Herbal Medicine

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Abstract

Background: Concepts for medicinal plants are represented by a variety of associated general terms with specific indexing patterns in databases, which may not consistently reflect growth of records.

Objectives: Assess development in databases by identifying general terms which describe herbal medicine with optimal retrieval recall. Identify possible special trends in co-occurrence of specific and general concepts.

Methods: Different search strategies are tested in CAB Abstracts, Medline and Web of Science. Specific terms (Origanum and Salvia) are employed. Relevant general terms (e.g. "Plants, Medicinal", Phytotherapy, Herbal drugs) are identified, along with indexing trends and co-occurrences.

Results: Growth trends, in specific (narrower) terms, are similar among databases. General terms, however, exhibit dissimilar trends, sometimes almost opposing one another. Co-occurrence of specific and general terms is changing over time.

Conclusions: General terms may not denote definite development of trends as the use of terms differs amongst databases, making it difficult to correctly assess possible numbers of relevant records. Perceived increase can, sometimes, be attributed to an increased occurrence of a more general term alongside the specific one. Thesaurus-controlled databases may yield more hits, because of “up-posted” (broader) terms. Use of broader terms is helpful as it enhances retrieval of relevant documents.

Keywords: abstracting and indexing as topic, bibliographic, controlled, databases, herbal medicine, information management, information science, information storage and retrieval, library services, vocabulary

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Key Messages

Implications for Policy

- Information retrieval is strongly influenced by the use of controlled terms.
- General terms promote insights into the trends in the different scientific fields.
- End-users must be better informed as to the particular characteristics of different information systems and controlled vocabularies.
- Harmonisation of indexing schemes, employed by different databases and thesauri, improves information retrieval by end-users.

Implications for Practice

- End users should be aware that more records are available in databases than can be found using general terms alone.

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Note: this is the author's version of the journal article:

Introduction

Important differences exist in topical representation of scientific fields. Some fields may be easier to define, as the natural language, used to describe the fields, may employ fewer synonyms or associated and related terms. The concepts may thus be defined more consistently. In some domains, however, it is more difficult to outline a more general research concept. A domain can display terminological imprecision and "scatter" of relevant terms. Similar, or even identical, research topics can be represented by different expressions. This makes it difficult to track research patterns consistently.

In the field of herbal medicine, or medicinal plants, there are a variety of more general terms, such as herbal therapies, herbal medicines, phytotherapy, medicinal herbs, medicinal plants, which can represent the entire field. We assume that such general concepts may not be used in the same way in different databases, making it difficult to assess the growth of records. Namely, the use of a particular term may evolve over time. A term may be replaced by another term or may, at a certain point, begin to be used differently in structured glossaries, used by many databases. The usage of such terms must be carefully analysed prior to running any searches, otherwise conclusions on the likely increase or decrease of records could be misleading.

In our study we wish to establish the most relevant general terms that will, within selected databases, best reflect the growth of records, giving optimal retrieval recall for medicinal plants (herbal medicine). In contrast to the more general terms, we expect the trends in occurrence of specific terms, such as those denoting individual medicinal plant genera or species, to be relatively similar among databases, and show a consistent growth. But in addition to this seemingly consistent growth, we can sometimes detect some distinctive patterns that cannot be attributed solely to the yearly increase of records in a database. Namely, the co-occurrence of specific and broader terms, within the same record, sometimes shows some changing patterns within the same database. A relevant broader term may not always occur consistently with a more specific narrow term. These patterns seem to be different in different databases, and may change with time. Our tentative assumption is that this co-occurrence has been increasing over time, even though the underlying rules, governing the assignment of indexing terms, may not have changed significantly in some databases. We thus also seek to identify some possible special trends in the co-occurrence of specific terms alongside related, general terms within the records.

Medicinal and aromatic plants have been used previously as the subject of scientometric analysis. A paper by Gupta et al. attempted to identify 'subject based publication indicators', such as different genera of plant species. However, this research was based on one selected national abstracting service. Information on this subject is scattered, so some similar surveys later used both 'agricultural and biomedical databases'. Medline is usually presented as the most authoritative database in the field of medicine but searches of other databases reveal many more publications. In comparison to Medline, CABI database, for example, holds a high proportion of unique records. But a survey on information seeking behaviour in complementary and alternative medicines (CAM; especially herbal medicine) found that 'the majority (of health professionals) had little knowledge of existing CAM resources' outside the Medline database. The interest in this field is expanding globally, not only with regard to the traditional Western complementary and alternative medicines. Traditional Chinese medicine, for example, exhibits constant growth both in Chinese and other languages.

In our study, we placed special importance on the issue of co-occurrence of different terms, especially descriptors, in the same document. Such research usually involves thesaurus-based descriptors, for example MeSH. Words and co-words obtain meaning only in the 'contexts of their use'. Traditional classification systems, however, are frequently resilient to the context. Indexing terms in thesauri are usually based on rather strict, predefined structures and hierarchies so they may not always effectively serve the purpose of specific subject and consequent retrieval. Zhang et al. argue that the terminology used by end-users of health information retrieval systems may differ from formal vocabularies. This should be reflected in the respective thesauri and indexes. Indexers can thus influence the use of terms. Because of problems involving indexing and retrieval, some authors investigated the possibilities for automated classification, since manual classification is a very 'time consuming and expensive task'. Some other authors, however, point to the importance of 'intellectual interpretation of terms'. They propose semi-automatic construction of thesauri.
A more thorough assessment of resources in this field would provide end-users with a more informed view of the full picture. This was pointed out by Lapidus when stating that information professionals 'have a lot to offer pharmacists and physicians in terms of keeping them updated with the most current, evidence-based resources in the field of herbal medicine'. In one such project, three experts developed evaluative criteria for the selection of herbal handbooks. As the research field of herbal medicines is very complex information-science-related research, dedicated to herbal medicine, frequently involves a variety of experts, such as botanists and herbal pharmacologists. This was shown through the example of building an ontological knowledge-base on herbal drugs.

Materials and Methods

We examined growth patterns for both specific and general terms associated with the field of medicinal plants or herbal medicine. This field covers important aspects of biomedical and agronomic research. With this aim in mind, we decided to assess two of the foremost global databases in the domains of biomedicine and agriculture; Medline (US National Library of Medicine), and CAB Abstracts (CAB International). Medline is known as the principal global database for biomedicine. We accessed it through the Ebsco-Host search platform. A large segment of herbal medicine is also related to agronomy, so we chose CAB Abstracts (henceforth CAB) which is the principal global information source for the broad field of agriculture and related applied life sciences. We accessed the CAB database through the CAB Direct search platform. For an additional perspective, we also included Web of Science which is principally a citation database. But it is also a general scientific database which is sometimes used in comparison with other subject-specific databases.

Identification of terms

As well as specific, narrow terms (descriptors), such as the scientific organism descriptors *Origanum* or *Salvia*, most databases also employ many general terms associated with this subject. These more general concepts may take the form of different database-specific terms, depending upon the precise focus of the database concerned. We selected terms that can, to some extent, represent similar concepts in different databases. We considered "related terms" or "see also" annotations in indexing schemes (thesauri). It was necessary to take into account the fact that the meaning of terms, in each database, can differ. In Medline, we selected the terms *Herbal medicine*, "Plants, Medicinal" and *Phytotherapy*. In CAB we selected *Medicinal plants* and *Herbal drugs*. The terms *Phytotherapy* or *Herbal medicine* are not available in the CAB Thesaurus. However, we may presume that *Phytotherapy* (Medline) and *Herbal drugs* (CAB) are related in meaning. Records in the Web of Science are not indexed with controlled subject headings from a thesaurus. This database uses free text terms (Author Keywords and KeyWords Plus). The terms may appear in both singular and plural forms, for example *Medicinal plant(s)*, *Herbal medicine(s)*, *Medicinal herb(s)*, *Herbal remedies*, *Phytotherapy*. In contrast to the Web of Science, the other two databases offer possibilities for a very precise subject-heading-based retrieval, so the retrieval results in the Web of Science can only be compared to other databases with some limitations related to controlled vocabularies.

With the term *Medicinal plants*, and related, many associated terms can be found, so we decided to access an additional concept, *Plant Extracts*, which is frequent in all databases. This concept, however, has a rather broad scope, and can be applied to numerous, agricultural crops, so it was used only as an indication. There are many other such concepts, for example *Plant Preparations* or *Pharmacology* but these are more general or more specialist and cannot be attributed only to medicinal plants. Also, many associated concepts are too database-specific, so we based our further analysis on general concepts which can be attributed to most genera of medicinal plants, and which are generally shared across the various databases. We used advanced search techniques and queries based on each particular database search fields. The searches are described in the ‘Results’ section in the opening paragraphs to each database.
For the three databases in our study, we identified the most frequently occurring, general terms and investigated the growth of records in these databases, with regard to the occurrence of these terms.

Given the constant, and similar growth patterns of specific indexing terms, in the three databases studied, we wanted to finish the study with an assessment of any special characteristics relating to the co-occurrence of both specific and general terms within the same record. We searched for related, general terms (such as Medicinal plants ("Plants, Medicinal"), Phytotherapy, Herbal drugs, etc.), in a Boolean combination, and observed the co-occurrence of any of these general terms with any of the specific terms (Origaniun OR Salvia).

Different methods of measurement, along with the dilemmas of assessing co-occurrence of subject terms in documents, were presented in a review article on the subject of "discovering knowledge in databases". As a method of calculating the level of co-indexing (co-occurrence of two indexing terms in the same record) we used the inclusion index method (Henceforth referred to as co-occurrence index). The index "measures the extent to which a less frequently occurring key-word (Ci) is joined to a more frequently occurring key-word (Cj)". Co-word analysis is used in scientometric research as it has the ability to capture changes in the specific subject area and provides additional information to end-users seeking information.

The Inclusion Index (Iij) = Cij/Ci (with Ci < Cj)

where i represents the less frequently occurring keyword, j represents the more frequently occurring keyword and Ci and Cj = the frequency of occurrence of i and j respectively. Cij is the frequency of records in which both keywords occur (co-occurred).

We tested co-occurrence, within the same document, of both specific terms, describing a plant (Origaniun, Salvia), and general terms (Herbal medicines, Medicinal plants, Phytotherapy, etc.) - Cij. We then divided this co-occurrence, Cij (the concurrent presence of both specific and general terms in the same records), by the occurrence of specific terms (Ci), for every year in the series (Figure 5).

For example, in the year 1990 there were 22 records which were indexed with both specific and general terms (Cij = co-occurrence of i and j) in CAB Abstracts. However, in the same year there were also 76 records in the database indexed with the specific terms (Ci). So the co-occurrence index (Iij) was 0.29 (Cij/Ci = 22/76). In 2006 as many as 244 records were indexed with both specific and general terms (Cij) and 455 were indexed with the specific terms (Ci). The co-occurrence index increased significantly to 0.54 (=244/455).

Results

**Medline (National Library of Medicine)**

We used selected terms obtained from the MeSH Thesaurus. Several fields are available for retrieval with subject headings, such as MJ (Word in Major Subject Heading), MW (Word in Subject Heading), MM (Exact Major Subject Heading), MH (Exact Subject Heading). We used the field label MW (Word in Subject Heading) which retrieves all occurrences of single words or phrases, with the appropriate syntax, such as (MW "plants, medicinal"), (MW "plant extracts"), (MW "Origanum OR Salvia") etc.

In 1999, we saw the first occurrence of the indexing term Herbal medicine (as a subject field or specialty).(Figure 1). According to MeSH Descriptor Data, this concept was previously covered by Phytotherapy (between 1989-2001). Overall indexing with the term Herbal medicine is still quite low, hardly reaching 100 records per year in the most recent period studied. Related to Herbal medicine are two distinct MESH terms: Phytotherapy and "Plants, Medicinal". We can identify, in our results, a constant growth of records indexed with the general concept "Plants, Medicinal" up until the year 2000, with the number of records almost doubling between 1998 and 2000. However, this sharp increase is followed by a decline over the next few years. On the other hand, the number of records indexed with the term Phytotherapy exhibits growth up until 2004, overtaking the use of the term "Plants, Medicinal", but also, for some reason, slowing in the more recent period. We also present data for an associated term, Plant extracts. This particular term exhibits a constant growth throughout the entire period under observation.
In contrast to the term "Plants, Medicinal", the occurrence of records on Origanum or Salvia exhibit constant growth. This can better be observed later in Figure 4, which is dedicated only to the occurrences of both genera in the three databases, whilst being constructed at a similar scale.

**CAB Abstracts (CAB International)**

In this database, we identified general terms which closely approximate to those used in Medline. These were taken from The CAB Thesaurus, CABI’s Indexing Authority File. Several database search fields use these descriptors. These search fields include OD (Organism Descriptors, used for plants and animals) and DE (Descriptors - non-plant/animal terms). We used the specific search field label, SUBJECT (all descriptors) which retrieves all occurrences of single words or phrases, with the appropriate syntax, such as (SUBJECT:"medicinal plants"), (SUBJECT:"plant extracts"), SUBJECT:(Origanum OR Salvia), etc.

General terms Medicinal plants and Herbal drugs, in CAB, are the most closely related equivalents to "Plants, Medicinal", Phytotherapy and Herbal medicine in Medline. Terms such as Phytotherapy or Herbal medicine are not available in the CAB Thesaurus. In contrast to Medline, this database exhibits constant and steady growth of all indexing terms (Figure 2), with Medicinal plants leading the way throughout the entire period of study. However, the term Herbal drugs shows the strongest relative growth. It is almost non-existent, in the first years of this study, but has recently been assigned to almost 2500 records in a single year. The associated term Plant extracts occurs less frequently than Medicinal plants. This is different from the results seen in Medline.
Web of Science (Thomson Reuters)

Web of Science does not use structured, thesaurus-derived subject terms, unlike the CAB Abstracts and Medline. Subject retrieval, in this database, is thus best performed with the use of the search field label TS= (Topic) which includes keywords, as well as the terms in titles and abstracts. The keywords include Author Keywords and KeyWords Plus. KeyWords Plus are index terms created by Thomson Reuters.

As the terms are not controlled, they may appear in both singular and plural forms, such as Herbal medicine or Herbal medicines, so we needed to employ right hand truncation. We again identified some most frequently occurring, general terms recorded in order of a decreasing occurrence: Medicinal plant(s) (7,700 Records), Herbal medicine(s) (4,220), Medicinal herb(s) (1,500), Herbal remedies (1,220), Herbal drug(s) (670), Phytotherapy (530 Records). In Figure 3 we present only selected terms.
The results show a steady growth of all terms, throughout the period of study. The term *Medicinal plant(s)* ranks highest, followed by *Herbal medicine(s)*. As can be seen from Figure 3 the numbers for *Phytotherapy* are very low. There are some 900 occurrences of a more general term *Plant extract(s)* in the Web of Science, in 2010. However, in Medline and CAB Abstracts, this term accounts for as many as 5000 and 8000 occurrences in 2010, respectively (Figures 1 and 2).

**The co-occurrence of specific and general terms in the three databases**

We present the occurrences of the standardised, specific terms for the botanical genera *Origanum* or *Salvia* (Figure 4). We can see that, contrary to the conclusions that one could draw from previous figures, these databases actually exhibit quite similar patterns.

![Graph showing trends based on genera Origanum OR Salvia in the three databases.](image)

The level of co-occurrence of specific and general terms exhibits different trends, in all three databases (Figure 5). In Medline, there is an especially strong growth of co-occurrence between 1995 and 2000, when half of all records, which contain a specific term, also contain a more general term ("Plants, Medicinal" or *Phytotherapy* or *Herbal medicine*). However, after this period, the co-occurrence of general terms begins to drop. The growth in the 1995-2000 period coincides with the general growth, and then weakening, of the term "Plants, Medicinal", in Medline, shown previously in Figure 1. We checked those records, in-depth, and found that the term "Plants, Medicinal" indeed accounted for at least half of *Salvia*- or *Origanum*-linked, general terms, in this period.

In CAB, we can see that the co-occurrence of general and specific terms in the same record, in the early period, is much higher than in Medline (or Web of Science). An average of about 30 % of *Origanum*- or *Salvia*-related records also contain a general term (*Medicinal plants* or *Herbal drugs*), in the initial period of this study. In more recent years, however, there are between 40 % and 55 % of records which contain both a specific and a general term, in the same record.
Co-occurrence of specific and general terms

Figure 5: Co-occurrence of specific and general terms

In Web of Science, the total level of co-occurrence is the lowest. In the initial period of study, about 2% of all Origanum or Salvia-related records contain any of the general terms (Medicinal plant* or Herbal medicine* or Medicinal herb* or Herbal remed* or Herbal drug* or Phytotherapy). However, in the more recent period, the co-occurrence increases to 15% of such records.

Table 1 gives a summary of the most recommended terms to be used for retrieval, in each of the databases we used. In CAB Abstracts and Medline, the number of such terms can be limited, as the terms are derived from a controlled glossary, and thus represent predefined concepts which may correspond to the topic of medicinal plants. In the Web of Science, however, the searches are not based on a 'controlled' glossary, so other general terms may also be applicable. In the Web of Science, it is advisable to employ a wildcard to enhance retrieval.

Table 1: Recommended terms and queries in respective databases

<table>
<thead>
<tr>
<th>Database</th>
<th>Query</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAB Abstract</td>
<td>&quot;Medicinal plants&quot; OR &quot;Herbal drugs&quot;</td>
</tr>
<tr>
<td>Medline</td>
<td>&quot;Plants, Medicinal&quot; OR Phytotherapy OR &quot;Herbal medicine&quot;</td>
</tr>
<tr>
<td>Web of Science</td>
<td>&quot;Medicinal plant***&quot; OR &quot;Herbal medicine**&quot; OR &quot;Medicinal herb***&quot; OR &quot;Herbal remed***&quot; OR &quot;Herbal drug***&quot; OR Phytotherapy</td>
</tr>
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Discussion

The growth of records, based on the model of two genera (Origanum and Salvia), shows an increasing trend in all databases under study (Figure 4). However, the assessment of growth, based on the more general concept of Medicinal plants ("Plants, Medicinal", Phytotherapy etc.) shows some specific patterns. For example, in 2010, there were more than 10,000 occurrences of Medicinal plants in CAB Abstracts, whereas there were only some 1,000 occurrences of "Plants, Medicinal" in Medline. This difference is much greater than the difference in occurrence of Origanum and Salvia (Figure 4) in the two databases. Some other, related, general terms, for example, Phytotherapy in Medline (Figure 1) and Herbal drugs, in CAB (Figure 2), perform differently, showing both (approximately) 2,000 records in 2010, in the respective databases.

In Medline, almost 3,000 records were indexed in the year 2000 with the term "Plants, Medicinal" (Figure 1). These numbers halve over the course of the next three years, and continue to decrease. A study by Fontanarosa, a decade earlier\(^3\) shows a constant growth of records based on a general term. However, the author only used the search term Alternative medicine. Perhaps, a new study using more recent data would present different results. There is no standard international or global coding or
classification scheme for this field (traditional herbal medicines). The history and scope of some indexing terms can change, over time. The fields can evolve making the selection of an 'effective search terminology' more difficult, as was shown in the MeSH example. Indeed, in Medline (MeSH), an additional term Herbal medicine was included in 2002. The scope of this term had been previously represented by the term Phytotherapy. However, in our study there were still only 100 records indexed annually with Herbal medicine in 2010, so this term cannot be associated with the observed decrease of records indexed with "Plants, Medicinal". Also, Phytotherapy-indexed records overtake "Plants, Medicinal" but somehow level out in the most recent period of the study. This could be due to the fact that more specialised terms were being used for indexing in Medline. Some subjective factor might thus be involved. It is difficult to draw any strong conclusions as to the decrease in the use of "Plants, Medicinal" in Medline. Given that the documents related to individual genera are steadily growing, further research is needed to assess this pattern, on a longer time scale. The figures for Web of Science (Figure 3) can only serve for an approximate comparison because there is no controlled thesaurus, and the retrieval in this database can only be conducted in the non-controlled Topics' fields.

Another interesting development, in the use of indexing terms can be observed, if we assess co-occurrence of specific botanical terms (Origanum OR Salvia) and more general terms which represent the medicinal plants as a whole, in all three databases. We see that the patterns of co-occurrence are changing over time (Figure 5). In the CAB Abstracts, between 40% and 55% of the database records contain both broad and associated specific terms in the more recent period. Differences amongst databases are also evident. In Medline, the co-occurrence increases rapidly to more than 50%, in the year 2000, but then begins to drop. In the Web of Science this is increasing throughout the observed period, but it still amounts only to some 15% in the most recent period. In the Web of Science, the lower co-occurrence may be partly explained by the lack of controlled indexing terms, in distinct contrast to the other two databases where the more general thesaurus terms are assigned to the records. This issue of thesaurus dependence in Medline, as opposed to non-controlled-vocabulary databases, such as Web of Science (SCIEXARH), was underlined by Stegman and Grohmann who pointed to the need of using both titles and abstracts, for better retrieval. Also, some authors argue that different terms in the same record will increase retrieval. On this matter, dissimilarity between databases can even be advantageous.

In Medline, the drop in co-occurrence after 2000 appears to coincide with the drop in records indexed with "Plants, Medicinal" in the same year (Figure 1). But the rate of co-occurrence, in the more recent period, is still higher than at the beginning of the observed period. In certain periods, more general terms thus occur more frequently alongside the more specific terms. This may, to some extent, explain the increase in general terms. But, at a certain point in time, the co-occurrence may also begin to drop. The general terms, alone, may thus not conclusively define the patterns and developments in this research field. We suggest that the co-occurrence be also followed in the future, to record development, and possibly identify some novel concepts.

It is often difficult to find one, single general term which can serve as a basis for information retrieval across different databases. In our case, it is possible to provide a list of at least a few of the most useful terms which have a related meaning (Table 1). In the non-thesaurus-controlled Web of Science more terms should be used for better retrieval. The use of such free terms or "text words", to improve retrieval, was even proposed for databases using controlled vocabulary, although this may reduce precision.

For example, Plant extracts. Such terms, however, can only serve as a limited indication of herbal-medicine-related trends, as they can also be associated with large-scale agricultural crops. A better recall will, in general, reduce precision, which was shown in the experiments by Cleverdon.

Portaluppi argues (on an example of chronobiologic references in Medline) that there exists important variability in the consistency of descriptors, and recommends the inclusion of some more commonly used concepts. Several attempts have been made to create more focused indexing and classification systems, for example in newly-emerging scientific fields. In our case, it is difficult to retrieve, for example, the documents on antiviral activity of any medicinal plant. A large proportion of records will still include only the most precise term, as generally suggested by database rules. A more consistent presence of a more general concept, for example Medicinal plants (or "Plants, Medicinal") in the indexing fields would improve recall. But this is only applicable in such databases as Medline or

CAB Abstracts which employ thesauri. It is thus evident that structured databases have the capacity to influence the perception of a growth of records in a research field. This emphasises the importance of the consistent use of appropriate terms, both for indexers, and searchers.

A majority of health professionals have little knowledge of resources on complementary and alternative medicine outside the Medline database, although many other resources are available. Many such resources show a strong coverage of unique records. Future research should thus focus on comparing both coverage of resources and search strategies. Users searching full text are more likely to find relevant articles than searching only abstracts. However, restricted full-text documents are only accessible through a subscription. So we must argue that authoritative databases, such as CAB Abstracts, Medline and Web of Science, which systematically collect millions of records according to specific database-criteria, are a valuable source of information, and should be perceived as complementary, not competitive. Finally, a more competent use of such resources could be promoted by library-and-information professionals who possess good professional knowledge with regard to the functionality of structured information systems.

Conclusion

General terms do not necessarily correctly indicate research trends in a specific scientific field, for example herbal medicine (medicinal plants). The use of such terms can differ amongst databases. This difference depends on the characteristics of each database. Some perceived increase can be attributed to an increased occurrence of a more general term alongside a more specific one, in a given period, thus giving an impression that increase is more pronounced than it really is. Thesaurus-controlled databases yield better results, on account of a more general “up-posted” term (broader term) that will not be used in a database which only uses natural-language terms. A combination of search strategies must thus be considered. The characteristics of search terms, as well as databases, must be carefully investigated before searches are carried out. End users should be aware that many more records are available than could be inferred from general terms alone. We recommend additional examination of the above search strategies, in the field of herbal medicine, perhaps on an example of some other associated general and specific terms, in order to further evaluate the relation between precision and recall, perhaps taking into account the context of some model research in the domain of library and information science.

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