

# Knowledge Representation and Subject Access in ETDs: Analysis of Creators' and Users' Assumptions and Expectations

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**Abstract:** Successful retrieval of materials that are useful to a user relies on the quality of the information representation. This study analyzes the relationship between subject terms -- both authorized terms from controlled vocabularies and free-text keywords -- used to succinctly describe the content of the electronic theses and dissertations (ETDs) and the search terms entered by users to discover and access the ETDs. Identification of search terms and comparison of search results with subject terms used in describing ETDs provides a basis for assessing the relative usefulness of controlled-vocabulary subject terms supplied by professional indexers and free-text keywords supplied by authors of ETDs in facilitating access to ETDs. Arguably, there has been a shift in the way users search, access, and use information resources. The findings of this study will help to revisit the two traditional approaches that demonstrate the process of representation: the document-oriented approach, which claims that indexing summarizes or represents the content of a document, and the user-oriented approach, which requires that indexing reflect the requests for which a document might be relevant. The authors also discuss the subjectivity and objectivity of the process and the need to distinguish functional representation from mere descriptions of a topic. After all, aboutness is often in the eye of the beholder. Considering the diverse global ETDs users' communities and the possible risk of false assumptions, the authors further argue that effective retrieval depends not only on the subject terms assigned to describe an item, but on the search query terms entered by users as well.

**Keywords:** ETD, Scholarly Communication, Digital curation, Information organization, Information retrieval, aboutness, subject authority

## 1. Introduction

Academic libraries around the world are seeking to take advantage of the powerful forces that transform higher education, including new and rapidly changing technologies, an abundance of digital (mostly open access) resources in myriad formats, and changing practices in how scholars communicate and disseminate their research and creative work. As forms of digital scholarship evolve, so do users' and creators' roles and expectations. Advancing knowledge requires not only enhancing our capacity to generate more knowledge, but also cultivating our ability to comprehend and communicate the vast quantities of knowledge we continue to generate. Although the digital environment has now introduced new resource types and new user expectations into the current information landscape, the goal of most academic libraries is still to acquire, preserve, provide access to, and disseminate recorded knowledge in all its forms.

Digital content needs to be given the same consideration as other library materials when conducting collection development, organization and cataloging of works. In an ideal world, detailed subject access is applied to all catalogued items so that users can find resources in their areas of interests, disciplines or subject domains. However, in practice it is difficult to comprehensively represent every item with subject and index terms. The process of subject representation is even more challenging for multidisciplinary documents such as theses and dissertations.

## 2. **Electronic Theses and Dissertations (ETDs)**

### 2.1. *Background*

Theses and dissertations represent a wealth of scholarly and artistic content created by graduate students in masters and doctoral programs in the degree-seeking process. The first electronic theses and dissertations (ETD) project was launched in 1987 by a business company and a long-term vendor of theses and dissertations for academic libraries, University Microfilms International (UMI), by converting its large collection of dissertations on microfiches and microfilms going back to 1930 into electronic form. The first non-profit ETD hosted by a university was launched seven years later, in 1994, at Virginia Tech which made electronic submission of theses and dissertations through its ETD system a requirements for university's graduating students. Virginia Tech University was also one of the founders, along with representatives from UMI and the American Council of Graduate Schools, of the Coalition for Networked Information's joint project with the goal to collaboratively develop collections of ETDs which resulted in creation in 1995 of the Networked Digital Library of Theses and Dissertations (Fox et al., 1997).

Since late 1990s, more and more academic institutions have mandated the electronic submission of theses and dissertations. A move to an all-digital means of providing electronic theses and dissertations is accelerating their discovery and facilitating their use, value and impact in research.

There have been various global initiatives to bring ETDs and similar indigenous research works across the world to the wider public domain. For example, the KT press in partnership with the Middlesex University in UK have created a searchable list of thousands of MA and PhD theses and dissertations on feminist art and contemporary women artists in various (35) countries (from 1974-present). The list contains links to information pages with abstracts in Open Access Repositories and full text PDFs: [www.ktpress.co.uk/feminist-art-theses.asp](http://www.ktpress.co.uk/feminist-art-theses.asp). Such initiatives amplify the role of ETDs in the current evolving scholarly communication landscape.

#### 2.1.1. *University of North Texas ETD*

The University of North Texas (UNT) has a long history of providing access to electronic theses and dissertations. One of the first three North American universities to require ETDs for graduation, UNT began accepting theses and dissertations in electronic format in 1999. Partnering with the UNT Graduate School, the UNT Libraries provide long-term storage and preservation, and facilitate access to these documents to interested users around the globe.

UNT tracks the use of its ETD, as well as the use of other digital collections hosted by UNT Libraries. As can be seen from Figure 1 which illustrates overall usage of UNT ETD, the UNT ETD collection consists of more than 15,000 items and close to 2 million pages or files and is heavily used, with daily use level ranging between over 2,000 and over 5,000 uses. Currently, the UNT Library is in the final phase of its retrospective digitization project, with the goal of digitizing all UNT's pre-1999 theses and dissertations previously available only in analog formats and make them available online according to open access principles. As a result of this retrospective digitization project, the number of ETDs at the UNT has grown at a rapid pace. Currently, approximately 52% of the UNT ETDs are Doctoral dissertations, while the remaining (48%) are Master's theses.

At UNT, graduate students are encouraged to submit nontraditional items, including datasets, audio, video and other supplemental files related to the production of their ETDs. As ETD creators continue to be more innovative, libraries and other ETD stakeholders need to identify innovative ways to better serve the scholarly communication needs of the academic community.

## Statistics for UNT Theses and Dissertations



**Figure 1.** The Usage Statistics for UNT ETDs, May 12- June 11, 2015:  
<http://digital.library.unt.edu/explore/collections/UNTETD/stats/>.

### 2.2. *Studies on ETDs*

According to Alemneh and Hartsock (2014), because ETDs usually constitute original research, each is unique to the bibliographic world; as a result, catalogers need to provide original cataloging (i.e., creation of metadata record from scratch) as opposed to copy cataloging (i.e., use of pre-existing metadata records with or without augmentations) to describe each ETD. Considering the multi-disciplinarity and interdisciplinarity characteristics, often several subjects and terms need to be supplied to adequately represent ETDs for efficient access.

In the early years of existence of ETDs, few studies looked into the usage patterns of ETDs developed and hosted by universities and other research institutions. One example of such study is an analysis of Korean Institute of Science and Technology Information ETD system transaction logs which demonstrated that the ETD was used mostly by users affiliated with educational institutions and observed significant increase in overall usage and the number of returning users after one year of ETD existence, the growing proportion of international use, the high level of use of search function, including the search in tables and figures, etc. (Zhang, Lee, & You, 2001).

Despite the wide adoption of ETDs over a substantial period of time, it has been noted (e.g., Bailey, 2011; McKay, 2007; Schmitz, 2008) that there exists the lack of end-user research into the use of ETD repositories. In particular, there was a lack of studies that looked into where the users come from (i.e., within or outside the hosting institution, via the institutional homepage or via search engine referrals); what kinds of information ETD users look for; and how users utilize the functionality offered by the ETD. Collecting and analyzing transaction logs of ETD use with the help of applications such as Google Analytics which was launched in late 2005 provides the tools to more easily answer some of these questions. For example, a recent study of Auburn University (Alabama, USA) ETD (Coates, 2014) which used Google Analytics as a data collection and analysis tool, found -- similarly to earlier Korean study (Zhang, Lee, & You, 2001) -- that most of the AUETDs collection visitors came from outside the hosting institution and via web search engines, and discovered that over a third of all pages viewed were internal navigation pages, with local visitors viewing these more often than external visitors.

The review of the literature on ETDs reveals that very few published studies to date have focused on metadata in ETDs. Park and Richard (2011) analyzed metadata element sets used by research institutions across Canada to describe their ETDs and conformance of the local metadata applications to the ETD-MS metadata scheme developed by the Networked Digital Library of Theses and

Dissertations. The study discovered variations in metadata usage across Canadian ETD repositories and lack of standardization.

### 3. Subject Representation and ETDs

The successful management of information resources requires effort across the entire life-cycle to ensure that contents are identified, organized, managed, preserved, and made accessible in a manner that today's users expect. Although the starting point for new researches are increasingly digital, the challenge yet to be overcome in the provision of subject access to digital contents or achieving a level of description sufficient to ensure success in information retrieval.

Like any resources, users' discovery of ETDs is facilitated by prior activity (be it manual, automated, or sometimes a combination) in which metadata creation or descriptions of resources and related phenomena such as the subjects (i.e., topics) of resources, are produced and organized in the form of database records. Furner (2012) took a philosophical—more specifically, an ontological—approach to the study of subject analysis, with a view to answering basic question of “What kind of thing is a subject (i.e., a topic) of a work?”

Traditionally, the relationship between a document and its subject terms (or entries) is one of some kind of semantic condensation. Although no consensus has been reached on conceptual and operational definitions of term quality, Ochoa and Duval (2007) argued that metadata term quality is not an absolute value, but dependent on the community of use. The traditional view finds universal acceptance, namely that for the purposes of document indexing and information retrieval the 'aboutness' of a document is to be equated with some kind of 'summary' of its contents. As described by Hjørland (2001), the determination of the subject of a document is closely related to questions of relevance. If a document is assigned to too many descriptors, users will be overloaded and the quality of the indexing is less than optimal. If too few descriptors are assigned, the document becomes less retrievable.

The aboutness principle suggests that the message produced will be considered to be about the message topic rather than about the audience for whom it was tuned. However, good representation requires taking the users' characteristics into account. Several of the existing models of subject access and subject analysis, which is a basis for assigning subject metadata (e.g., Beghtol, 1986; Hjørland, 1998; Langridge, 1989; Šaupert, 2002; Wilson, 1968), guide metadata creators to consider not only the content of the document, but also author's intentions, viewpoints and possible bias. They further recommend taking into account the intended audience and intellectual level, as well as possible uses of information in the process of assigning subject descriptors. According to Hjørland (1997), subject terms express intellectual potentials of a document which can differ at different periods of time and society development, as well as across different domains. This fluidity, in Hjørland's opinion necessitates periodical revising of subject terms in metadata records.

In a study that looked at the impact on retrievals of the absence of subject headings, Gross & Taylor (2005) note that such absence of subject headings in a library catalog record, could result in more than one third of the retrievals been missed when a user performs a keyword search. In a study that looked at the benefits of adding subject metadata to online records of the Northwestern University Library's Eighteenth Century Collections Online (ECCO), Garrett (2007) echoes the arguments put forth by Gross & Taylor (2005) on the benefits of having subject headings on access provision even when there is full text availability of a work. In a study replicating the 2005 one, Gross, Taylor and Joudrey (2015) found that in spite of bringing a reduction in lost hits through the addition of table of contents and summaries or abstracts in the catalog records, still an average of 27% of the relevant items are not retrieved in a search due to the absence of subject headings. A study conducted at Montana State University (Peterson, 2009) which looked at the usage of folksonomy tags and subject headings, observed that the level of assigning tags to items and the level of usage of patron-assigned tags increased, but concluded that no evidence was found to support the removal of subject headings from bibliographic records.

In some disciplines, the subject can also be an aspect of study. In music, for example, the author achieves originality by analyzing a specific composer or composition(s), or applying a unique approach to a compositions study. That means, in addition to denoting aboutness (or what it is about), music

subjects will have “Isness,” (that tells what the resource is) as well. For example, Sonata or Symphony can represent a form while Opera represent a genre in subject headings.

### 3.1. *Creators’ vs. Users’ Assumptions and Expectations*

Arguably, there has been a shift in the way users search, access, and use information resources. But, in principle, subject terms and indexes today serve the same function that they always have: link creators or authors with users or readers. But the way this is done has changed drastically over the years.

The changes and expansion of types of representations have been necessary because of the changes in forms of information and delivery mechanisms. Five hundred years ago books and book-like manuscripts made up the major part of a library. Two hundred years later the scholarly journal emerged and with it the invention of the abstracting journal. By the middle of the 19th century journals had proliferated to the point where indexes across journals were needed. As we moved into the digital age, new forms of representation were needed to get access to the electronic information.

Well, traditionally there are two approaches that demonstrate the process of representation. The document-oriented approach claims that indexing summarizes or represents the content of a document. The user-oriented approach requires that indexing reflect the requests for which a document might be relevant.

Successful retrieval of documents that are useful to a user relies on the quality of the document's information representation. But at the same time, effective retrieval depends not just on the terms assigned to an item, but on the query terms entered by users as well. In the increasingly self-structured Web 2.0 (3.0?) environment, it is clear that traditional (usually linear) user experience and research methods will be of limited use. All this means that in light of changing requirements/needs and semantic-web environment, we need new types of approaches and methods.

## 4. **Methodology**

This study analyzed the subject access in UNT’s ETD Collection from two sides -- the document side (supplied by creators and librarians) and the user side.

For the Users’ side, the transaction logs of UNT Digital Libraries, specifically ETDs Collection use, collected by Google Analytics application, were analyzed to obtain the data about user subject searching. The terms occurring in subject fields of metadata records describing electronic theses and dissertations were analyzed to obtain the data about the subject representation. The two datasets were compared and synthesized with the literature to answer the following three research questions:

1. What role (if any) does ETDs play in the current evolving scholarly communication landscape?
2. How does subject representation of ETDs meet users’ subject access needs as expressed in search queries?
3. How effective is ETD authors-supplied key words in matching user search terms as compared to cataloger-supplied terms?

Google Analytics report tool was used to obtain the data on the overall level of use of UNT ETDs - number of user searches per day, week, and, month, as well as over the entire period of 4 years, 2011-2015 -- the distribution of use instances by geographical region from which the user accessed the ETD and by the type of device used to access it.

R Package for Statistical Analysis was used for further analysis of user search queries exported from Google Analytics. User queries were treated as corpus of documents and text mining techniques were applied. R packages such as nlp (natural language processing), tm (text mining), and snowballC, were applied in the analysis. The following transformations of the dataset were made:

- removing numbers, punctuation and English-language stopwords
- stripping white spaces.

Term document matrix was created and explored to:

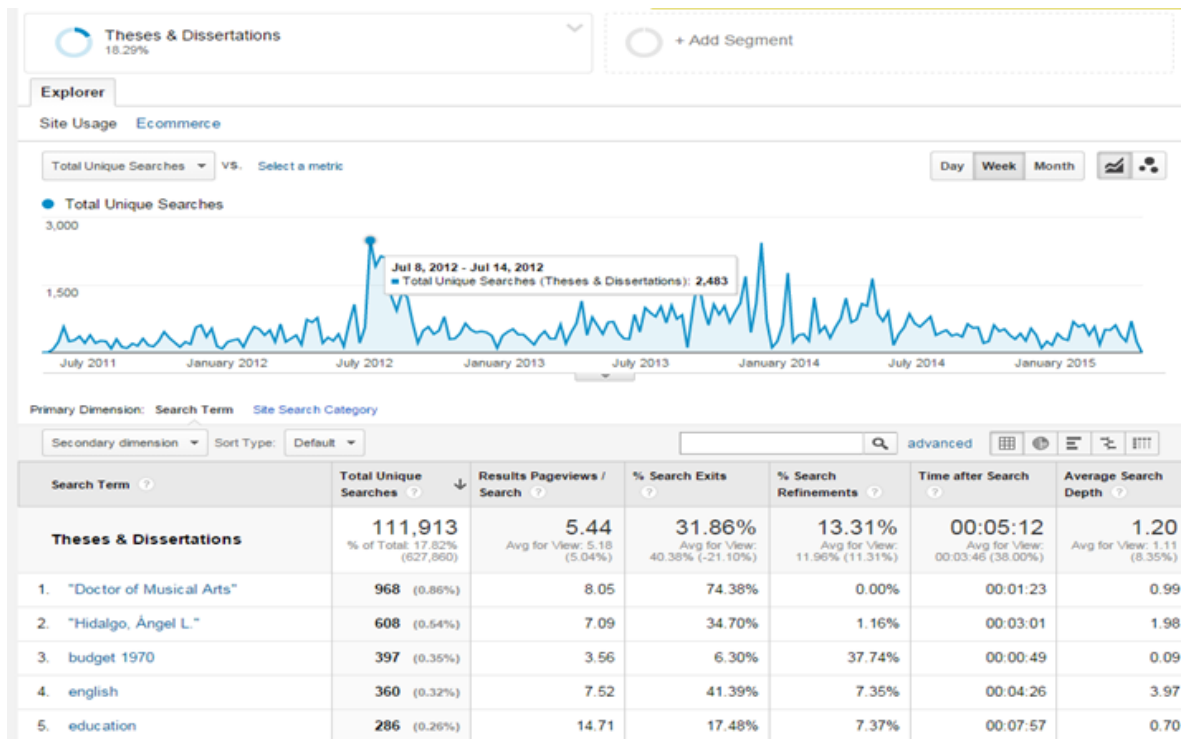
- find term frequencies

- order term frequencies
- find most frequently occurring search terms
- find associations of the most frequent term with other words (with a specified correlation limit)
- build word cloud using the wordcloud R package

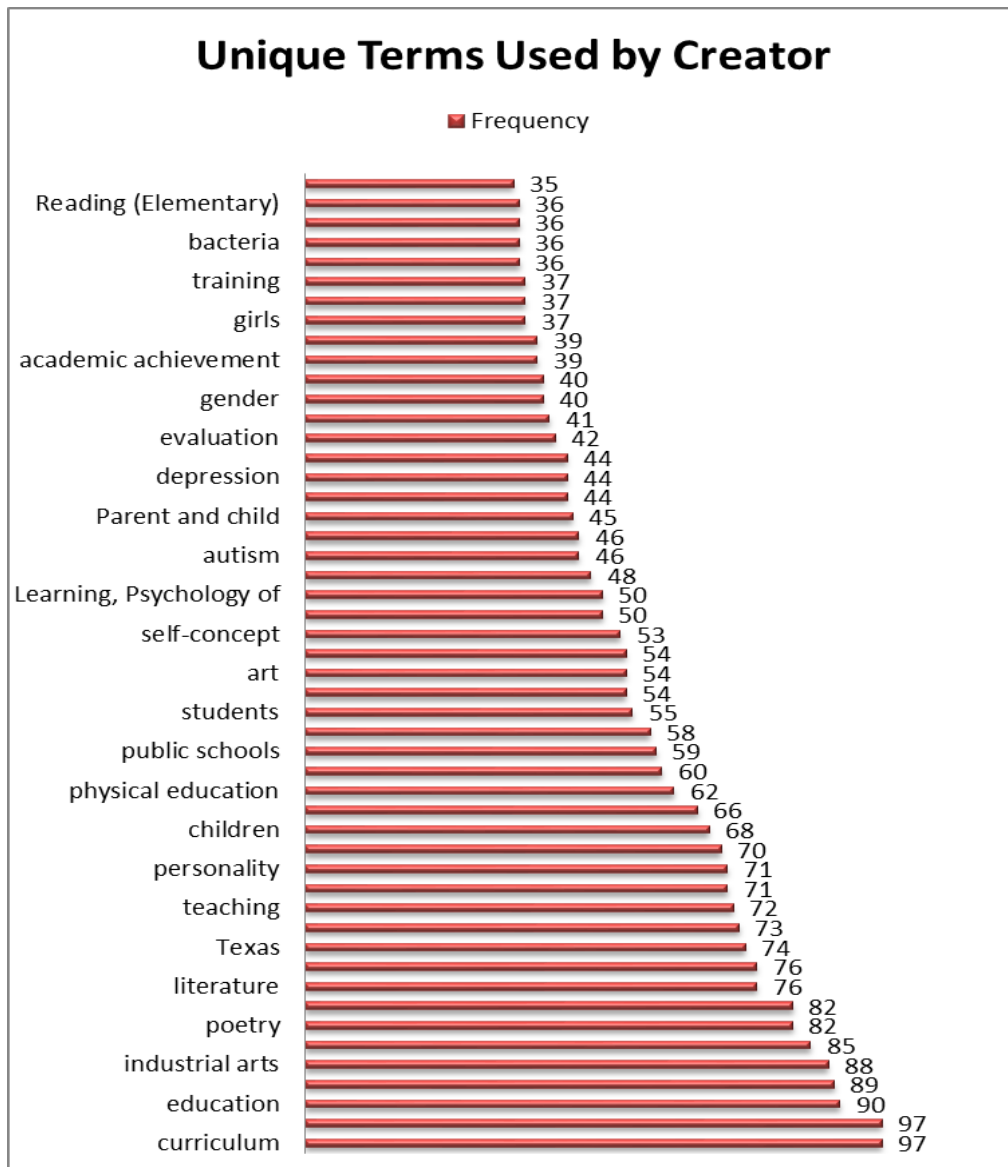
## 5. Findings

In the UNT metadata guidelines for ETD, the “Subject” field has been defined as the subject or topic of the ETD that succinctly describes the content of the ETD. Typically, a subject will be expressed as keywords, key phrases, or defined subject headings (in the UNT case -- from the Library of Congress Subject Headings (LCSH)). Authors usually provide some terms (three to five free-text keywords) that will be added as keywords. Figure 2 lists the top 50 subject terms that had been used in describing the items in the UNT ETDs collection. Out of these 50 subject terms only 6 are from the controlled vocabulary (LCSH) supplied by the professional catalogers; the rest (88%) are the author-supplied free-text terms.

As can be seen from the Figures 2 and 3, in the last four years (2011 to 2015), users from 188 countries entered more than half a million (600,000+) terms to look for items in the UNT Digital Libraries’ ETDs collection. The highest number of unique searches per day (1,192) was observed on January 14, 2014. The highest total numbers of unique searches per week and per month -- close to 2,500 and 8,000 respectively -- were both registered in July 2012.



**Figure 2.** The Weekly Usage Statistics for UNT ETDs (from May 2011 to May 2015)



**Figure 3.** The frequencies of top 50 unique subject terms used by ETDs authors and metadata creators to describe ETDs (from July 2011 to June 2015).

Country ?	Sessions ? ↓	% New Sessions ?
<b>Theses &amp; Dissertations</b>	<b>691,791</b> % of Total: 22.58% (3,064,391)	<b>88.06%</b> Avg for View: 83.84% (5.03%)
1.  United States	<b>390,314</b> (56.42%)	86.60%
2.  United Kingdom	<b>33,357</b> (4.82%)	90.66%
3.  India	<b>31,098</b> (4.50%)	92.89%
4.  Philippines	<b>24,878</b> (3.60%)	93.16%
5.  Canada	<b>18,398</b> (2.66%)	91.50%
6.  Australia	<b>10,440</b> (1.51%)	90.13%
7.  Germany	<b>8,988</b> (1.30%)	89.92%
8.  Malaysia	<b>8,951</b> (1.29%)	88.63%
9. (not set)	<b>8,603</b> (1.24%)	91.63%
10.  China	<b>6,095</b> (0.88%)	89.01%

**Figure 4.** Top 10 countries users from which used the UNT ETDs collection (May 2011-May 2015)



Figure 4 shows the Top 10 countries users from which visited UNT's ETDs collection. Between May 2011 and May 2015, the UNT ETDs have been used by 692, 791 users from 188 different countries. Even though some ETDs are restricted to UNT's users, consulting the metadata description may convey sufficient information and can be adequate for most users' needs. Making the metadata accessible to providers of search and discovery services via Open Archive Initiative Protocol for Metadata Harvesting (OAI-PMH) facilitate usability. While it adds value by suggesting to end-users potentially interesting ETDs or related objects the users did not actively search for, it also facilitate ETD management by allowing log file analysis to see what users are searching for.

It is also interesting to note that few users used different languages (mainly Chinese and Korean languages) to search for items in the UNT ETD collection. Although our ETD collections include contents in other languages (in Spanish and French) the primary ETD content needs to be in English. But those users probably used online language translation services (such as Google, Yahoo! Babel Fish,) that instantly translates text and web pages.

Our content analysis of almost 112,000 of unique search queries in UNT ETD (Figure 5) shows that the most frequently used words in user search queries included topical and genre terms, with a strong representation of music-related terms (e.g., jazz, sonata, piano, concerto, solo etc.); document type and format terms (PDF, image, poster etc.); and a number of general research-related terms such as test, analysis, method, theory, measurement, etc. Figures 5 and 6 show the top 50 terms repeatedly used by searchers in the last 4 years. In Figure 6, the number of results pageviews for each query is also represented,



**Figure 5.** The most frequently used terms in UNT's ETDs users search queries (2011- 2015)

As can be seen in Figure 6, most of the commonly occurring user search queries in UNT ETD are phrases, with some of them containing dates. We also found personal names(e.g., “Hidalgo, Angel L.”, pradip gali”, “miles davis”, etc.) to be widely used among commonly occurring user search terms. UNT's metadata guideline encourages to include named-person in the Subject and Keyword field. Named persons' refers to people who are significant in some way to the content of the item, however all possible names may not be consistently included in the subject field.

One of the top 50 search terms -- “Human anatomy -- Outlines, syllabi, etc.” -- is an authorized string of terms from the LCSH controlled vocabulary. The degree name -- “Doctor of Musica Arts” -- was the most widely used search term in UNT ETD, with almost a thousand user searches. The College of Music at the University of North Texas is one of the country's two largest and comprehensive music schools. So the high number of search by music degree name is not surprising.



The only term that appeared in both the top 50 user search queries (with a total of 286 queries) and in the top 50 subject terms describing ETDs was “education”. Except for the word “Texas”, appearing as part of the “University of North Texas” user search query with the frequency of 137, and the word “Psychology” appearing on its own in 161 user search queries and as part of subject term phrase “Learning, Psychology of” in top 50 subject terms in ETDs metadata records, no partial match between the top 50 most used user search terms and the top 50 creator- or indexer- supplied subject terms was observed.

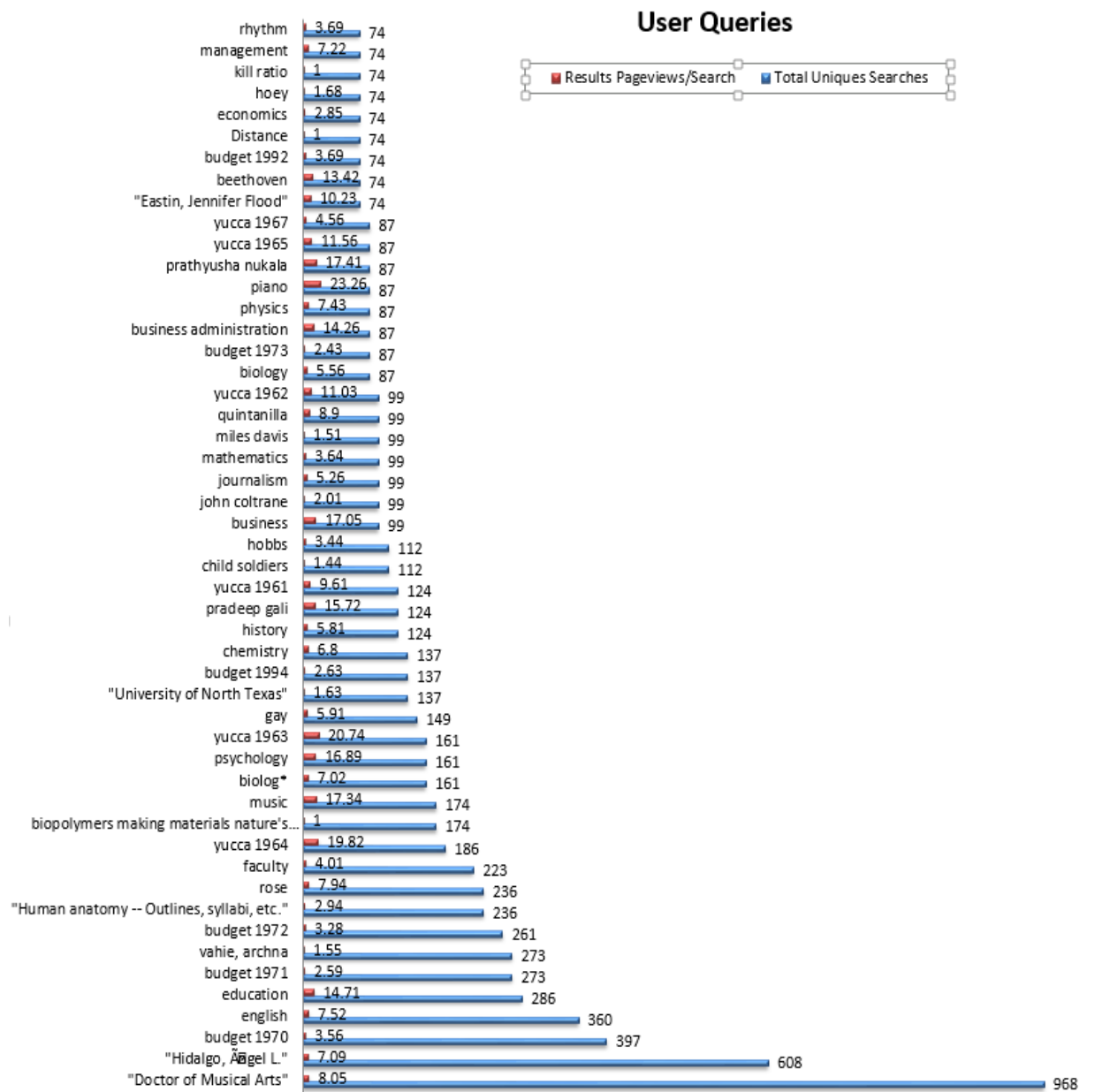


Figure 6. Top 50 terms repeatedly used by UNT ETD searchers (May 2011 to May 2015).

## 6. Summary and Conclusion

ETD has experienced a continuous change in format and structure that require different lifecycle management to facilitate access, use and reuse. Various institutions (including UNT) and international organizations (including the Networked Digital Library of Theses and Dissertations (NDLTD) give annual innovative ETD awards and recognize ETDs authors effort to enhance public access of ETDs through the creative and innovative uses of technologies. Our findings demonstrate the high level of use and the global reach of UNT ETD, with almost half of the users accessing UNT ETD from outside

the United States, from 188 different countries, using different languages and translation tools. The analysis of user search queries further reveal high proportion of search by personal name, which is not necessarily matched by subject metadata describing UNT ETDs. Since the "subject and keywords" element describes both what the object is about and what it is, some subject-related information may be repeated in other elements. For example, although geographic terms are normally handled by the Coverage (Place Name) element, subject fields could include geographic terms. Similarly, the consistent use of named persons (people who are significant to the content of the item), should be encouraged and enforced.

Overall, little overlap was observed between the top 50 user search queries and top 50 subject terms used in UNT ETD metadata records. Considering the diverse global ETDs users' communities, the authors speculate that effective retrieval depends not only on the subject terms assigned to describe an item, but on the search query terms entered by the users as well. Recognizing the complex issues of knowledge organization and retrieval, which are actually beyond semantic representation and access, such findings may have wider implications in the evolving scholarly communication landscape.

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