

ETD Visibility: A Study on the Exposure of Indian ETDs to the Google Scholar Crawler

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Abstract—*Electronic theses and dissertations are often stored and made accessible by universities, as a means of disseminating research results to a wide audience. Google Scholar provides an index separate from the Google index, and strives to provide results filtered for scholarly users. This research will determine to what degree a sample of online theses from Indian universities are indexed by Google Scholar.*

A sample of theses currently stored in the repositories of some Indian universities has been taken from Shodhganga. Search queries were then constructed for each thesis. These queries were executed on Google Scholar, and results recorded.

None of the full-text PDF content pages from Shodhganga were indexed by Google Scholar, although some metadata was indexed. In one case, the thesis full-text was indexed, but it was hosted on a university website.

Recommendations include that the Shodhganga database be restructured according to the guidelines, to enable Google Scholar to index its contents. Also, the practice of storing one thesis as a number of separate files works against the achievement of high visibility.

Since open access to research publications is becoming the norm rather than the exception, scholars are expected to ensure that their publications enjoy a high degree of global visibility. This study has measured the visibility of a small sample of research publications, proved that it is virtually non-existent, and provided guidelines to improve the situation. This is a unique approach, and according to the literature survey, has not been done before.

INTRODUCTION AND CONTEXT

The recording and online hosting of electronic university theses and dissertations (ETDs) is a topic which has seen an explosion of interest in published research lately. Especially, scholars from Africa, Asia, Europe and the USA have published many results of research on this topic. This is understandable, since the body of completed theses held by a university is a valuable asset, and it should be made accessible as widely as possible. This access is not gained automatically, and is further complicated by the masses of irrelevant search results sometimes provided by search engines.

Search engines have proven to be a major entry point for many users in the search for relevant, useful information on the Internet. However, academic data (specifically journal articles, theses and conference papers) is often difficult to find when spaced out inside thousands or even millions of search engine results. As a result, Google Scholar (GS) was born, with the intent of providing results where advertisements and other non-academic content have been suppressed (Google Scholar, n.d.). GS uses a separate crawler, index and algorithm from the standard Google search engine, and produces as results mostly academic documents and websites. At the same time, GS calculates and

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displays various metrics based on the number of times works from authors have been cited by others. These include the well-known 'h-index' (based on Hirsch's work) and the i10-index (Hirsch, 2005). A recent study has proven that GS has indexed 100% of a subset of 738 publications listed in top medical databases (Gehanno, Rollin and Darmoni, 2013).

An attempt by Microsoft to create a similar academic search engine, however, has apparently failed. Microsoft Academic Search (MAS) slowed down its updates as from 2011 (Orduña-Malea, Martín-Martín, Ayllon, and López-Cózar, 2014), and it is claimed that only 8000 documents have been added in 2013 (Van Noorden, 2014). This proves that to create and maintain a successful repository is not a trivial task.

The purpose of this research was to measure to what extent certain completed theses and dissertations, stored electronically, were indexed by GS.

PRIOR RESEARCH

Information retrieval studies date back many decades—even long before the birth of the Internet. In the days before the Internet, these studies focussed on retrieving information from databases, and in many cases an intermediary (in the form of a librarian) was needed before a user could get access to specific information. However, the ease of access to the Internet has gradually put the user more and more in charge of his/ her own information needs. Since the first search engine became freely available, many information seekers have trained themselves on using the interfaces. Information seeking using search engines has become just another everyday event, and billions of users revert to search engines almost daily to satisfy their information needs.

However, many universities have started storing academic information in electronic format, giving access to these documents to their own staff and students. Recently, many have opened up the institutional repositories to the outside world, making the research results available globally. Sometimes the term 'ETD' is used interchangeably with 'institutional repository', and even with 'digital library'. In this research, ETD will be used for brevity's sake. In the present survey of recent literature, various aspects of ETDs will be investigated, as a foundation for the empirical research following.

DEMOGRAPHICS—INSTITUTIONAL REPOSITORY USERS

It is important to know who the users of any product are, and how they behave when they use the product (Krug, 2014). This information could be especially useful to the designer of the product. In the case of the ETD, it could include how users interact with the interface of the ETD, and how they found their way to this system. In one study, it was found that most users close to the physical location of the university where the study was done used the university website as starting point (Coates, 2014). In these cases, they mostly started their search on the 'Collections' webpage, from where they then navigated to their target. Not surprisingly, most of the authors contributing to this ETD were from the university itself.

In contrast, those visitors who were not local mostly used search engines. In these cases, they landed on sub-pages of the ETD, where the metadata of the document they were searching for was stored. It was suggested that analytics data (as provided in this case by Google Analytics) be used more to ensure that users have a positive experience when attempting to satisfy their information needs.

A different study set out to compare the behaviour of younger and older ETD users (Zimmerman, 2012). It was proven that younger users prefer to use standard search engines. The three biggest shareholders in the Western world were noted—Google, Bing and Yahoo!. The older users preferred the use of academic databases. These results provide further motivation for this study. Whether or not the use of search engines in place of academic databases is commendable, the younger generation is leaning towards using them. This study will provide useful guidance in improving the success rate of these information seekers.

These studies underline the importance of considering entry points into any online system separate from the landing page, as equally important. Search engines simply list webpages which are relevant to the search on the search engine result page (SERP), without any regard for where in the structure of the website they appear. Consequently, the increased use of GS to find research documents is further motivation for this research.

ACCESS TO ETD CONTENTS

One of the fundamental requirements for an institutional repository to be successful is that it should be accessible to its users. Part of this accessibility depends on usability of the interfaces, and part on the technical design of the system on which the ETD is based. One study has identified no fewer than 202 accessibility errors in a test on 21 separate webpages in a digitally accessible library (Borchard, Biondo, Kutay, Morck and Weiss, 2015). According to the tools used in this study, this puts the system in the bracket: ‘... does not pass the minimal level of acceptability...’. However, it was also noted that some of the errors reported would be relatively easy to repair.

In another study, the stages a typical library system went through towards providing access to ETD to users, based on the Dublin Core metadata system, were investigated (Howard and Goldberg, 2011). It was found, not surprisingly, that electronic access to these documents increase the user interaction with them. Furthermore, research was done to focus on the difference between searching for full-text and abstracts of academic documents (Lin, 2009). Testing was done on large medical science databases. Results show that searching for full-text content does not always produce better results than when searching for abstracts only. On the contrary, when using text segments (typically paragraph-sized) from full-text, it yielded better results than when searching for abstracts only. It was suggested that these two concepts be combined to improve searching results.

A contradiction was found in the literature in terms of the metadata structure to be used when designing an ETD. Some authors claim that Dublin Core metadata is one of the reasons why GS does not index ETDs well (Arlitsch and O'Brien, 2012).

The experiments done by these authors included replacing the Dublin Core metadata with the specifications of GS, resulting in these being expressed in HTML meta-tags. These and other changes increased the indexing ratio of the test repository to 90%.

These results again confirm the need for the current study—realizing the importance of GS as indexing mechanism, and ensuring that academic authors rank well on GS.

TECHNICAL ETD ISSUES

Many studies have been done on a variety of technical aspects of ETDs. One of them focussed on the use of a certain software package to set up and maintain an ETD, and found that this programme made the process much easier (Dhamdhare, De Smet and Lihitkar, 2014).

Another study attempted to adjust parameters of an existing ETD platform, to increase retrieval efficiency (Solomou and Koutsomitropoulos, 2015). The authors extracted semantic descriptions from the existing metadata, and applied it in a different way to enhance performance. It is claimed that this approach holds promise for both novice and experienced users. However, the technical elements of the design of ETDs are outside the scope of this research, and will not be investigated further.

USABILITY IN ETDs

As noted before, the usability of any computer-based system, and certainly of an ETD retrieval system, is key to its success and acceptance. One study made the case that usability studies as such are actually evaluation methods, not research. It then attempted to remove the limitations of this evaluation method, qualifying it as a research method (Emanuel, 2013). However, it was found that more research would be required to achieve this goal.

Another recent study investigated the retention of information, understanding the content and the attention of users in an attempt to analyse user interfaces, and produce guidelines to designers of ETDs. It was found that further work would be required to accurately determine the attributes of the ideal ETD interface (Alonso, García, Martín-Moncunill, Sánchez-Alonso and García, 2014).

Both these sets of results underline the complexity of the nature of human-computer interaction, exacerbated by the intricate requirements for an ETD to be efficient, accurate and easy to use.

EASTERN ETD STUDIES

A large number of studies have been done on the implementation and use of ETDs in the eastern part of the globe. One of these specifically addresses the broader Asian context, claiming that the mere existence of an ETD will affect the ranking of the university hosting it (Ahmed, Alreyaee and Rahman, 2014). The authors considered seven crucial parameters (policy, language, discipline, country, types, software and content types). It was found that access to institutional repositories was often limited to the parent institution only. Also, the number of Asian universities offering ETDs was claimed to be

low, when considering the total number of universities. In conclusion, it was again claimed that an ETD can improve the ranking and impact of a university.

Another study was done on 41 higher education institutes in India, putting the country second in Asia (after Japan) (Lihitkar, 2014). DSpace was used by approximately 75% of the universities, and the PDF file format was commonly used. Some problems were also noted: access to these repositories was unreliable, due to Web servers being down, reconstruction and dead links.

Numerous other studies have been done specifically on Indian ETDs (Gupta and Gupta, 2014; Sawant, 2012; Veeranjanyulu, 2014; Sawant, 2011 and Swain, 2010). These have produced many useful results, including the following:

- A National ETD system has been created, titled Shodhganga.
- There is no shortage of guidelines on the creation and use of ETDs.
- A large amount of data exists on user opinions of Indian ETDs.
- Some ETDs serve specific sections of the community, e.g. Agriculture.
- Science and technology seems to be the field of choice for many ETDs.
- ePrints and DSpace are commonly used as platforms for ETDs.

Secondly, the Arab Gulf States seem to be trailing in ETD implementation and usage. In one such study, some problems were identified as being: plagiarism, a strong economy, younger societies, and low quality of theses (Mattar, Chern, Liew and Chawner, 2014). Other authors claimed that development of ETDs in the Gulf States is in an early stage (Ahmed and Al-Baridi, 2012).

Further afield, Taiwan, Japan and Iran are also represented with some recent ETD research results. Some of these include:

- Universities in Taiwan can choose from a variety of frameworks to manage their ETD systems (Chiang, Wang and Lin, 2014).
- Although there are no laws in Japan to force a student to present his/ her doctoral theses in an ETD, a national network is being formed to make this process easy (Shuto, Manaka, Nakayama and Uchijima, 2014).
- Since there are at least 119 universities in Iran offering masters and doctoral degrees, libraries are actively involved in setting up ETDs (Ardalan and Fezbaksh, 2011).

In summary, the use and implementation of ETDs in the Eastern section is rising. Although there are many positive signs, a number of issues seem to need attention. This is further motivation for the execution of this study.

WESTERN AND AFRICAN ETD STUDIES

Again, a large number of studies are evident in the Western area of the globe, and some in Africa. Some of the results from these studies are listed below as a brief summary.

- Theses containing URL references have increased dramatically over the past two decades (Phillips, Gelaw, Brenda and Ayala, 2014).
- The construction of an ETD system is made easier through collaboration with other universities, and between departments inside them (Feuer, 2014; Li, Theimer and Preate, 2014).
- The open publication of ETD documents through a range of access points increases the visibility of the system (Wang, Bulick and Muyumba, 2014).
- The magnitude of international traffic at US repositories is difficult to record, and presents problems for the globalization of these repositories (Fralinger and Bull, 2013).
- The majority of theses and dissertations in developing countries are still stored as hard copies (Ratanya, 2010).

SUMMARY

From the literature study it is clear that many universities are running an ETD system of some description, all over the globe. However, it appears to be no trivial task to successfully implement such a system, and to ensure that its contents can easily be found when needed. It has also become clear that GS, despite much support and criticism (Walters, 2007; Shultz, 2007; Gehanno et al., 2013) has become a de facto standard in terms of measuring academic exposure. These facts again support the motivation for this study.

METHODOLOGY

In an attempt to measure the exposure of Indian ETDs to the GScrawler, the top universities of India were identified from various global rankings—see Table 1. A random selection of 10 theses from these university ETDs would then be identified from their ETDs, a search done on GS for these theses, and the results recorded. An attempt would then be made to quantify their visibility to the GS crawler.

The scores for all Indian universities were taken from the six sets of rankings of Table 1, summarized and standardized, and an average was calculated. This average score is based on a ranking scale from 1 to 100, where 1 is best and 100 is worst. See Table 2 for these results.

Then the homepages of these universities were investigated, to identify those that had a digital repository and/or an ETD system. It was noted that most of the 16 universities did not offer a digital library or an ETD. Upon further inspection, a national database titled Shodhganga was again noted, and, since many Indian universities contribute to this body, it was decided to use Shodhganga as basis for this research (<http://shodhganga.inflibnet.ac.in/>). At the time of writing, this ETD contained 40,188 theses.

Next, a random sample of thesis currently in this ETD had to be selected. It was noted at this time that Shodhganga stores theses as separate PDF files, sometimes up to 20 files per thesis. From the sample theses selected, no single file was found containing any one complete thesis.

Since some search engine crawlers can take some time to index webpages (Zuze and Weideman, 2011), earlier submissions would be preferred, to remove the possibility that the crawler has not had the time to visit the webpages in question. A submission period window of the year 2010 was chosen, to ensure that ample time has been given for the crawler to visit. After specifying this factor, the theses on the Shodhganga SERPs were inspected one by one. Those in any language except English were skipped, and the remainder was filtered until 10 were found, which all had a title page, an abstract page, and a chapter 1. These pages were selected to ensure that enough metadata could be gathered to construct a reliable search query (see search query 2 below). A total of 153 theses had to be inspected to find the required 10 meeting the criteria.

Table 1: Summary of World University Ranking Bodies

Center for World University Rankings	http://cwur.org/
QS world university rankings	http://www.theguardian.com/higher-education-network/2015/apr/29/qs-world-university-rankings-2015-by-subject
Academic Ranking of World Universities	http://www.shanghairanking.com/
Times Higher Education World University Rankings	https://www.timeshighereducation.co.uk/world-university-rankings/2015/world-ranking#/
Top University Rankings	http://www.topuniversities.com/university-rankings
Ranking Web of Universities	http://www.webometrics.info/

Table 2: Averaged Ranking of Top Indian Universities

No.	Name	AVE	URL
a	Indian institute of science, Bangalore	30	http://www.iisc.ernet.in/
d	Indian Institute of Technology, Bombay	38	http://www.iitb.ac.in/
b	Panjab University	44	http://puchd.ac.in/
k	Indian Institute of Technology, Kanpur	49	http://www.iitk.ac.in/
n	Cochin University of Science & Technology	50	http://www.cusat.ac.in/
j	University of Delhi	57	http://www.du.ac.in/
g	Indian Institute of Technology, Madras	64	https://www.iitm.ac.in/
f	Indian Institute of Technology, Kharagpur	69	http://www.iitkgp.ac.in/
e	Indian Institute of Technology, Delhi	72	http://www.iitd.ac.in/
l	Tata Institute of Fundamental Research, Tata	80	http://www.tifr.res.in/
c	Indian Institute of Technology, Roorkee	82	http://www.iitr.ac.in/
h	Aligarh Muslim University	90	http://www.amu.ac.in/
o	Anna University	90	https://www.annauniv.edu/
i	Jawaharlal Nehru University	96	http://www.jnu.ac.in/
m	Indian Institute of Technology, Guwahati	98	http://www.iitg.ac.in/
p	Manipal University	100	http://manipal.edu/mu.html

Two search queries were constructed, based on prior research on query construction (Weideman, 2013). The search queries used were:

Search Query 1: The words of title only, lowercase.

Search Query 2: A string of keywords, separated by spaces, consisting of:

- surname
- year
- (from university name) two keywords
- (from title) three keywords
- (from abstract) first five words from first sentence
- (from chapter 1) first five words from first sentence.

On the GS SERPs, the first 10 results only were viewed. This decision was based on numerous research results on information retrieval research, proving that users mostly view only the first page of results (Weideman, 2009). Each result was followed, until the full-text of that thesis was found—either as a PDF document on the screen, or as an automatic download of that document. All results were recorded.

RESULTS AND DISCUSSION

The results of the study are summarized here, and they are discussed in detail. The two queries noted above produced search results on GS. In some cases, these results, when clicked on, lead to the full-text of a thesis.

RESULTS

One full set (one thesis) of such results are given in Table 3.

Table 3: Full Set of Results for Thesis Number 1

Thesis number	1
URL of source data	http://shodhganga.inflibnet.ac.in/handle/10603/1393
Title	Spectroscopic investigation of tooth caries and demineralization
Author	Thomas, Shiny Sara
Issue date	13-Dec-2010
Issuing university	Cochin University of Science and Technology
Successful search query	spectroscopic investigation of tooth caries and demineralization
Number of results found	2
Destination of click on result no 1	http://dyuthi.cusat.ac.in/xmlui/bitstream/handle/purl/1980/Dyuthi-T0456.pdf?sequence=22
Number of files	22

An extract of the results of all searches are listed in Table 4. The term Shodhganga is abbreviated to “S”. The “No” column is the number of each thesis, while the ‘Interpretation’ column contains a brief description of the interpretation of both the positive and negative meaning of the results of each search.

Table 4: Summary of GS Searching Results

No.	Search Result	Target URL	Click Result	Interpretation
1	2 results on SERP, select 1 st one	http://dyuthi.cusat.ac.in/xmlui/bitstream/handle/purl/1980/Dyuthi-T0456.pdf?sequence=22	Links to a non-S URL, and produces full-text of thesis.	+: does produce full-text -: the thesis document(s) in S not indexed by GS
2	1 result on SERP, select it	http://ietd.inflibnet.ac.in/handle/10603/1385	Links to a S related URL, which shows metadata identical to that of S.	+: does produce metadata -: the thesis document(s) in S not indexed by GS
3	1 result on SERP, select it	http://210.212.129.140/handle/10603/1324	Links to an apparently non-S URL. Shows metadata identical to that of S, URL very different.	+: the metadata is indexed -: the thesis document(s) in S not indexed by GS
4	2 results on SERP, select 1 st one	http://onlinelibrary.wiley.com/doi/10.1002/app.12812/abstract;jsessionid=FB1F15942FED6477E8952CA3DBB8A737.f03t02?userIsAuthenticated=false&deniedAccessCustomisedMessage=	Links to an article with the same title as thesis. Does not produce thesis full-text. Can preview article full-text, only 1 st page is legible, rest soft focus. Can purchase article.	+: the first page of the article is accessible -: the thesis document(s) in S not indexed by GS
5	1 result on SERP, select it	http://shodhganga.inflibnet.ac.in/handle/10603/1271	Links to the original S URL, which shows full metadata.	+: does prod S metadata -: the thesis document(s) in S not indexed
6	1 result on SERP, select it	N.A.	Does not link to another URL-downloads the full-text in searchable PDF format. Quality is noticeably lower than original.	+: does produce full-text -: the thesis document(s) in S not indexed by GS
7	1 result on SERP, select it	http://ietd.inflibnet.ac.in/handle/10603/1269	Links to a S related URL, which shows metadata identical to that of S.	+: does prod metadata -: the thesis document(s) in S not indexed by GS
8	1 result on SERP, select it	http://shodhganga.inflibnet.ac.in/handle/10603/1267	Links to the original S URL, which shows full metadata.	+: does prod S metadata -: the thesis document(s) in S not indexed by GS
9	1 result on SERP, select it	http://shodhganga.inflibnet.ac.in/handle/10603/1264	Links to the original S URL, which shows full metadata.	+: does prod S metadata -: the thesis document(s) in S not indexed by GS
10	1 result on SERP, select it	N.A.	Does not link to another URL-downloads the full-text in searchable PDF format. Quality is noticeably lower than original.	+: does produce full-text -: the thesis document(s) in S not indexed by GS

DISCUSSION

It is clear from Table 4 that some results produced identical interpretations; these will be grouped and discussed together. The theses are grouped for this purpose as follows:

- 1 (Group A)
- 2 and 7 (Group B)
- 3 (Group C)

- 4 (Group D)
- 5, 8 and 9 (Group E)
- 6 and 10 (Group F)

Not one of the thesis documents have been indexed as full-text by GS. In many cases, parts of the metadata of a thesis were indexed, and this data would lead to the full-text if the search action was progressed further.

Group A: In this case, the full-text of the thesis was found under a different domain from Shodhganga. The target domain is in the ac.in space, so it is assumed that this thesis was hosted at the home university website, where the GS crawler found it. This is a commendable finding, although it is unfortunate that the relevant Shodhganga page was not indexed by GS.

Group B: These two theses had their metadata indexed by GS, on a domain which appears to be part of the Shodhganga domain. The full-text was accessible if the search process was continued from this point through further clicks.

Group C: This result is identical to that of Group B, except that the URL is noted as an IP address. The comment here is the same as for Group B.

Group D: In this case, it appears as if the thesis has been published as a journal article—the title of the two was identical. The article has to be purchased to obtain the full-text, and only the first page was legible.

Group E: These three theses had their metadata indexed by GS, on the Shodhganga domain. The full-text was accessible if the search process was continued from this point through further clicks. Therefore, these three metadata webpages on Shodhganga were actually indexed by GS.

Group F: These two theses were indexed on an unknown domain. The full-text document of the complete thesis was automatically downloaded as a PDF file, although the screen quality of the document was inferior (but still legible).

The interpretation of these results is best summarized in point format.

1. It is a worrying trend that not a single full-text webpage in the sample from Shodhganga was indexed by GS.
2. Groups B, C and E had a metadata page indexed on what appears to be a derivative domain of the main Shodhganga domain, which aids in the process of making its content visible to a global audience.
3. Only in one case (Group A) was it evident that the full-text was hosted outside the Shodhganga domain, and was found and indexed by GS.
4. In the case of Group D, the thesis (or a contraction of the thesis) was published as a journal article, but it was not accessible without payment.
5. Another worrying trend is that GS produced so few results for each search—between one and two only.

6. The fact that Shodhganga stores theses as a collection of separate PDF files detracts from achieving a higher degree of visibility. The value of keyword rich text, one essential component in improving visibility, is now diluted and spread over many documents, rather than being concentrated in one only.

CONCLUSION AND SIGNIFICANCE

This research project had some limitations. Only 10 theses were used as a sample, while many more could have been included. However, the author is of the opinion that the pattern produced by a larger sample would be very similar to that produced by this study.

Many of the theses in the sample were from the same university – this was a result from the sequential way in which the list of theses from 2010 was processed by the author. It can be assumed that, in this case, that specific university submitted a large batch of theses on the same day; hence they were listed one after the other on the Shodhganga result screen. A better sample would include one or more theses from a large number of different universities.

A larger number of search queries could have been used, to determine if other queries could not produce better search results. Again, the author is of the opinion that the pattern of results would not be affected by this approach.

The most worrying result from this study is the fact that not a single full-text file from within the Shodhganga database was indexed by GS. Again, further studies could investigate whether or not this is true for a larger sample of theses. This probably means that no effort has been expended to follow the guidelines provided by GS (<https://scholar.google.co.za/intl/en/scholar/inclusion.html>). It is a relatively simple process to submit well prepared documents for inclusion to GS. A complete GS compliant system, showing the prescribed landing page, the HTML skeleton pages and the full-text PDF files can be viewed at <http://www.web-visibility.co.za/website-visibility-abstracts-seo.htm>. It must be noted that, if applied to a large collection of documents, the preparation for GS submission is a labour-intensive task.

In final conclusion, some recommendations to improve the visibility of theses stored in Shodhganga can be summarized as:

1. Store all theses as a single PDF document
2. Create a simple HTML landing page (or a set of pages), containing basic metadata for each thesis.
3. Link each one of these theses to a HTML skeleton page, with further metadata.
4. Provide a link from this HTML page to the single-file PDF document with the thesis full-text (already stored in Shodhganga).
5. Submit (manually) the addresses of these pages to the GS crawler.

This work is significant, since it provides valuable guidance to Indian universities for improving the visibility of their academic publications. No other similar study has been found in the literature search. Only very recent publications were referenced in this study. Fifty per cent of the references are from the past 18 months (at the time of writing), and 87% were five years old or younger.

Further research could be done to expand the body of knowledge on this topic. The limitations noted above could be addressed in a new, expanded study. Also a 'dummy' Shodhganga system could be created, according to the GS guidelines (only a few theses need be included), and used to experiment with GS indexing.

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