

**TITLE:** Who is Citing Undergraduate Theses in Institutional Digital Repositories?: Implications for Scholarship and Information Literacy

**RUNNING HEAD:** Citations to Undergraduate Theses

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**ABSTRACT:**

Undergraduate theses are available through open access institutional repositories. Is undergraduate work being integrated into the larger body of academic research, and, if so, how? Institutional repositories containing undergraduate theses were selected and titles were searched using the forward citation feature in Google Scholar to determine if and where undergraduate scholarship is being cited. Results show that 24% of citations to senior theses were in peer-reviewed or refereed journals, and 33% in dissertations and theses. This paper addresses citation source and the potential value of undergraduate scholarship as well as the implications for information literacy instruction to senior thesis students.

**KEYWORDS** – Open Access; Information Literacy; Undergraduate Research; Institutional Repository; Citation Patterns; Downloads

## INTRODUCTION

Undergraduate research and theses are deposited in a number of open access (OA) institutional repositories (IRs). One benefit to depositing theses in IRs is that the research becomes available to everyone, including scholars. This potentially benefits both the scholarly community by making current research accessible and the students by giving them a venue through which their scholarship can be publicly accessed, digested, and utilized. Download statistics of undergraduate theses from the authors' own repository suggest extensive use. This paper explores what those download statistics mean and how or if theses are being used and integrated into the larger body of academic research. Are open access theses being used and cited in authoritative sources and scholarly journals? Where is the scholarship of undergraduates ending up?

This research developed due to two factors. One, the authors receive regular notifications on downloads from the institutional repository; downloads of senior theses seemed exceptionally high. For example, one popular senior thesis posted to the IR in January 2013 had been downloaded 3195 times and cited three times by December 2013. Two, the authors were analyzing senior theses in the IR and some displayed poor information literacy skills. Did the high download statistics correlate to citations to senior theses? What does this access mean about the value of undergraduate scholarship? What are the implications for information literacy instruction to senior thesis students? A highly relevant 2013 white paper from ACRL, *Intersections of Scholarly Communication and Information Literacy*, discusses issues that impact student work submitted to institutional repositories as well as the implications for information literacy instruction. Especially relevant is the concept of "publishing as pedagogy" (Association of College and Research Libraries 2013, 9). Students need to be "knowledgeable content consumers and *content creators*" [emphasis the authors'] (Association of College and Research Libraries 2013, 2). What are the ramifications for IRs to make undergraduate theses

available via open access? Is repository submission beneficial for both the authors of the theses as well as those citing them?

## **LITERATURE REVIEW**

As there are no systematic studies of citations to undergraduate theses in institutional repositories, the present study is unique. In addition to identifying who is citing the theses, the authors also wanted to explore any correlations between citation patterns in the present study and those reported in the larger body of citation analysis literature. Citation analysis has a deep and robust history. There is a significant body of work evaluating the use of and citation to materials in institutional repositories as well as open access publications. Of critical importance is examining what is known about correlations between citation rates versus download rates.

Institutional repositories can potentially provide critical information on the type and level of use of original information made available by a research library (McDonald and Thomas 2008). However, more standardized reporting methods are required in order to accurately quantify use of IR material in comparison with traditional scholarly materials. Both McDonald and Thomas (2008) and Needham and Shepherd (2010) address this issue. Critical to the present study and the information literacy ramifications of OA theses, Connell analyzes the use of items in the Ohio State University Knowledge Bank and finds that journal articles and undergraduate theses are the most used materials (2011, 266). Nolan and Costanza (2006) discuss the incentives and challenges of focusing on student work in the IR. They had an information literacy-related ulterior motive for putting senior theses into the repository: "We wanted students – and eventually faculty – to develop some conception of the issues surrounding copyright, fair use, licensing, and alternative publishing models" (Nolan and Costanza 2006, 92).

With the growth of OA repositories, whether there is an OA advantage regarding citation rates

and citation impact factors is well-debated in the literature. Relevant to the present study, Craig et al. (2007), in a review of the literature, cannot confirm a causal relationship between OA status and citations. Moed (2007), in studying ArXiv, finds no OA citation advantage but that OA status may accelerate citation because it makes papers available earlier rather than because they are OA. Norris, Oppenheim, and Rowland (2008), in a study of OA and subscription databases, find that OA articles have a mean citation count of 9.04 whereas the mean for paid access articles is 5.76 (1963). However, they are unable to determine a cause for this OA citation advantage.

Of studies that have shown an OA citation advantage, Soong (2009) finds that, of articles deposited in the Hong Kong University of Science and Technology Institutional Repository, 58% have a higher average citation rate after being deposited than they had prior to being available in the IR (3). Antelman (2004) examines articles to determine if making them Open Access increased their research impact. Across the four disciplines studied, philosophy had an increase in citations for open-access articles of 45%, 51% increase for electrical and electronic engineering, 86% increase in political science, and 91% increase in mathematics (Antelman 2004, 376). Results indicate that in disciplines that have embraced OA, OA articles are more heavily cited. According to Nagaraja and Clauson (2009), many OA pharmacy journals have shown increased Impact Factor over time (142). Xia, Myers, and Wilhoite (2011) find that multiple OA availability leads to higher levels of citation in library science literature (26). In another study, Xia and Nakanishi (2012) find that articles in lower ranked journals see increased citation rates in anthropology when available via OA (48). As with many studies in the citation analysis literature, whether or not there is an OA citation advantage seems to be largely determined by discipline. For the purposes of the present study, it is important to note that multiple studies have shown that OA articles receive more citations than those behind paywalls.

Highly relevant to this research is whether there is any correlation between citation and download rates. As mentioned in the introduction, download statistics from IRs would indicate that theses are highly used even if they aren't being cited. What does the literature say about correlations, or lack of correlations, between citations and downloads? Piper, Garcia-Dorado, and Martinson (2011) point out that while citations are a good indicator of lasting academic value, they do not reflect the currency or news value of a topic (1). For the *International Journal of Cardiology*, Coats (2005) compares the top ten cited articles to the top ten downloaded articles over a twelve month period. There is no correlation between the lists. The top cited articles are original research reports while the top downloaded are reviews of cutting-edge topics or about rare or unusual conditions (Coats 2005, 124). Bollen et al. (2005) reach a similar conclusion in their study which examines the ISI Impact Factor JCR database which contains a core set of approximately 6000 journals, determining that works that are cited differ from those that are downloaded. Sato, Tomimoto, and Itsumura (2009), in an analysis of downloads and citations of physics articles from three IRs, find no correlation between citations and downloads. Moed states that downloads and citations represent distinct phases of the research process (2005, 1096); scholars download a variety of articles but as writing progresses, only cite to the most valuable which might explain the difference.

Conversely, Schloegl and Gorraiz (2011) find a strong relationship between citations and downloads for pharmacology journals. Xue-li, Hong-ling, and Mei-ying (2011) find a highly positive correlation between download frequency and citation frequency. Jamali and Nikzad (2011) examine six Public Library of Science (PLoS) journals and find a positive correlation between downloads and citations. Subotic and Mukherjee (2014) conduct a similar study with psychology articles and also find that downloads correlated positively with citations. Lippi and Favaloro (2013), in the field of laboratory medicine, examine the Top 25 Hottest Articles downloads versus all article citations and find that the most downloaded articles are also more

likely to be cited.

Davis (2008), studying eleven journals published by the American Physiological Society, finds that open access articles are no more likely to be cited than subscription access articles but that open access articles receive 89% more full-text downloads than articles behind a paywall. In another study, Davis (2004), through a large-scale survey of HighWire journals, determines that the size of a user population can be estimated by knowing the total downloads for a journal. The relationship was consistent across institutions and over time and unrelated to the subject or size of a journal.

ArXiv is an OA repository primarily containing physics and mathematics articles launched in 1991 (Cornell University Library) on which several studies have been done. Davis and Fromerth (2007) study four math journals between 1997 and 2005 and find that those deposited in ArXiv received 35% more citations than articles not deposited in the OA database. However, ArXiv-deposited articles received 23% fewer downloads from the publisher's website, suggesting different uses for OA and publisher repositories. Shuai, Pepe, and Bollen (2012) analyze ArXiv downloads, early citations, and twitter mentions, and they find that the volume of Twitter mentions is correlated with downloads and citations.

Some authors have attempted to quantify how many downloads equal one citation. Chu and Krichel (2007) analyze download versus citation rates for RePEc, a digital library in economics. Per document, the average download count was double the average citation count from Google Scholar and three times the citation count from the ISI Social Sciences Citation Index (5). Moed (2005), in a study of one Elsevier journal, finds that in the three months after an article has been cited, the number of downloads increases 25% compared to what the expected downloads would be if the article were not cited. He also finds that for every 100 downloads, a paper is

cited once. Bonilla-Calero (2008), in an analysis of physics research in an institutional repository from 2000-2005, finds that the average number of citations is 66 per document, 17 per month; and the average number of downloads is 124 per document (711). A large percentage involves research that was available in other sources, such as Web of Science (77%) and ArXiv (6%) (Bonilla-Calero 2008, 704). Thus, important to the present study, there is no real consensus about a correlation between download statistics and citation rates nor is there any definitive answer as to an expected citation level based on the number of downloads.

## **METHODOLOGY**

In order to quantify where senior theses were being cited, fifty-five institutional repositories, including the authors' own IR, were selected from the Directory of Open Access Repositories (OpenDOAR). In order to be selected, repositories needed to meet the following criteria: they had to be in the United States; and, they had to have undergraduate theses collections that could be searched separately from the general collection. Many institutions highlight student work, but it is often organized or cataloged with faculty and graduate work, thus making searching impossible for the purposes of this study. Of the fifty-five repositories that met the criteria, four were disqualified because no results were found in Google Scholar, indicating that they were not indexed by Scholar (an issue addressed by Arlitsch and O'Brien 2012). A fifth repository was unusable because, although the undergraduate work appeared to be in a separate collection, it was actually interfiled with graduate work and the two could not be separated for searching. The sixth had no submissions to the repository and thus was excluded.

In the end, there were forty-nine viable repositories to search. They were split 51/49 percent (n=25 and n=24, respectively) between private and public institutions. Twenty-four percent (n=12) were members of the Association of Research Libraries (ARL), 14% (n=7) were Oberlin libraries, and 61% (n=30) were neither.



Repositories searched according to the Carnegie Classification breakdown included Associate's-Public Rural-serving Large, 2% (n=1); Baccalaureate Colleges-Arts & Sciences, 18% (n=9); Baccalaureate Colleges-Diverse Fields, 2% (n=1); Master's Colleges and Universities (smaller programs), 2% (n=1); Master's Colleges and Universities (medium programs), 8% (n=4); Master's Colleges and Universities (larger programs), 16% (n=8); Doctoral/Research Universities, 4% (n=2); Research Universities (high research activity), 16% (n=8); Research Universities (very high research activity), 31% (n=15).

For each of the forty-nine repositories, the forward citation feature of Google Scholar (Google Scholar) was used to determine the source of the citation for each thesis. The authors searched Scholar between October 2013 and February 2014. One of two methods was used to search in Scholar. First, if possible, a truncated repository URL was used to search Scholar and results were then reviewed to identify which theses had been cited. Second, if the truncated repository URL did not return results relevant to the size of the repository, then each individual thesis title was searched in Scholar. The first method was quicker but worked in far fewer cases. Most repositories required the more laborious title-by-title search method. Some scholars have concluded that Google Scholar is not a substitute for Web of Knowledge (ISI/Thomson) or SCOPUS (Elsevier) because there is not a strict quality assurance of citations associated with a publication (Aguillo 2012) nor is the h-index accurate (Delgado-López-Cózar and Cabezas-Clavijo 2012). However, for the purposes of this study, since all citations to a thesis were desired, quality of citations was not an issue, nor was h-index.

There is also a deep body of literature on the topic of whether citation counts are the best way to measure impact for an article (for example, Aksnes 2006, Bollen et al. 2005, and Karimi Elizee et al. 2012). However, citation counts are the best tested method at our disposal. While

download counts are valuable, for the purposes of this study, they do not indicate where the theses are being used; citations give that information.

## **DATA & RESULTS**

The forty-nine repositories contained a total of 20,024 undergraduate theses. Seventeen repositories (35%) containing 895 theses (4.4% of total theses) had no theses cited in Google Scholar. Of the total undergraduate theses, 811 (4%) were cited a total of 1,390 times.

### **Citations per Paper**

The number of citations per thesis ranged from one to forty-seven (mean 2). Of the top six most cited articles (cited 47, 43, 25, 17, 15, and 12 times, respectively) four are from ARL repositories. All six deal with applied interdisciplinary science, technology, engineering, and math (STEM) research. Specifically they include rapidly expanding areas of research such as Computer Science and Environmental Analysis which could be of greater interest to the larger scholarly community. Citation versus downloads of cutting edge research will be addressed in greater depth at the end of this section and in the conclusion. [See Figure 1 for citations by number of papers.]

Insert Figure 1 here.

### **Citations by Type of Publication**

When examining the type of publications citing to the theses, one sees that peer-reviewed journals cited theses the most (15.3%, n=212). Rounding out the top are: undergraduate theses (12.9%, n=180); journals (neither peer-reviewed nor refereed) (11.8%, n=164); dissertations (10.7%, n=149); master's theses (9.6%, n=134) and, refereed journals (9.3%, n=129). [See Figure 2]

Insert Figure 2 here.

When all types of published journals (peer-reviewed, refereed, and journals) were combined, they comprised the largest group of citations, 36.3% (n=505). When peer-reviewed and refereed

journals were combined, leaving out journals that are neither peer-reviewed nor refereed, they make up almost a quarter, 24.5% (n=341) of citations. All theses and dissertations (PhD, masters, and undergraduate) combined were the next largest group, comprising 33.3% (n=462) of citations. An explanation of why undergraduate theses were cited more often by journals than theses and dissertations is not apparent from the data and would require additional research outside the scope of this paper. Citations from conference publications made up 9.1% (n=126) of citations and books and e-books combined equaled 5.7% (n=79) of citations. Only about 5% (n=71) of citations were from government sources, patents, posters, presentations, reports, trade publications, websites, and unpublished sources combined. Fifty-one citations (3.7%) were unable to be categorized either because there was only a citation in Google Scholar with limited bibliographic information or because it was in a foreign script (e.g., Chinese) and the authors were unable to translate. Smaller citation totals were from: undergraduate papers (1.8%, n=25) and Open Access repositories (3.7%, n=52). A note about OA repositories: while many publications were found in OA repositories, if they were versions of other types of materials they were categorized as the non-OA material (e.g., a peer-reviewed journal article in an OA repository was categorized as peer-reviewed). Items available through an OA repository only were noted as OA. Self-citations were a small percentage of total citations (1.3%, n=18). A larger amount of citations (11.08%, n=154) were from the same institution as the cited thesis often cited in other undergraduate theses. Both self and institutional citation rates are much smaller than those reported in self-citation studies in other fields (for example, Aksnes 2003 and Trimble 1986). The rather low percentage of self-citations may be accounted for in a number of ways. Not all undergraduate students become professional academics. The student may complete a thesis and then either not attend graduate school or may go to graduate school but not continue research on the undergraduate topic. Additionally, some colleges require an undergraduate thesis in which case the topic may be of little long-term interest to the student but is simply a graduation requirement.

### **Citations by Carnegie Classification of Institution Type**

Could the institutional repository type (e.g., ARL, Oberlin, Carnegie Classification) be correlated to the type of work that cited an undergraduate thesis in the repository? [see Figure 3]

Calculating the percentage of total theses by type and comparing that to the percentage of citations by type, clear patterns emerge. ARL libraries contained only 27% (n=5341) of total undergraduate theses records yet they comprised 45% (n=631) of total citations. Similarly, institutions with a Carnegie Classification of Research Universities (very high research activity) (of which all but four were also ARL Libraries) accounted for 26% (n=5247) of total theses, yet made up 48% (n=668) of total citations.

Insert Figure 3 here.

### **Citations by Other Institutional Characteristics**

Conversely, libraries that were neither ARL nor Oberlin made up 51% (n=10172) of total theses but only 38% (n=531) of citations. Oberlin libraries were also less likely to be cited, comprising 23% (n=4511) of theses but only 16% (n=228) of citations. Interestingly, there was no difference between total theses and citation rates for private and public institutions. For both, the rates were almost exactly similar. Private institutions had 35% (n=6979) of theses and 34% (n=479) of citations. Public institutions had 65% (n=13045) of theses and 66% (n=911) of citations. [See Figure 4] It was also interesting to determine if the type of work (e.g., peer-reviewed, dissertation, book, etc.) that cited to an undergraduate thesis in the repository could be correlated to the repository. There was no statistically significant correlation between type of publication citing a thesis and the Carnegie or ARL/Oberlin status of the thesis' repository.

Insert Figure 4 here.

### **Citations by Year of Thesis Submission**

When analyzing year of theses that were cited, they ranged from 1972-2013. The mean was 2007. Years 2006-2011 were the most cited with 2010 receiving the highest percentage of citations at 17% (n=238). [See Figure 5.] Two repositories containing theses from 2012-present

and five containing theses from 2013-present had no material cited. These seven repositories comprised less than 2% (n=379) of total theses. Age of the repository may explain the lack of citations.

Insert Figure 5 here.

A final area worthy of exploration was a possible correlation between downloads and citations. As mentioned in the literature review, there have been several studies on this topic, some of which demonstrate a correlation between downloads and citations and others that do not, often dependent on discipline. Download data was available from the authors' IR only, and it may not be representative; however, results are interesting. In July 2013, the top ten theses had been downloaded 34,835 times. Four of the ten theses had been cited ten times. That would be a download:citation ratio of about 3500:1. That is a much lower citation to download ratio than either Bonilla-Calero (2008), who found an approximately 2:1 ratio with physics articles, or Moed's (2005) 100:1 ratio for articles in *Tetrahedron Letters*. The download:citation ratio for the authors' IR would suggest much lower citation rates for undergraduate theses than other types of materials.

Intriguingly, the large download rates might indicate something similar to what Coats (2005) found for the *International Journal of Cardiology*-- that the top downloaded articles were reviews of cutting-edge topics or about rare or unusual conditions. Indeed, many senior theses are about regional and local issues or cutting-edge topics both of which may have a dearth of publications in the mainstream scholarly literature due to interest and/or the scholarly publishing cycle which can take much longer than a one-semester senior thesis project. Lending credence to this, when broken down by broad discipline, of the 810 theses cited, only 7% (n=58) are to arts and humanities subjects; 49% (n=398) are to theses in the social sciences, and 44% (n=354) are to theses in the sciences and technology. However, more study is necessary to prove or disprove these download versus citation rates hypotheses, and they are, unfortunately,

outside the scope of this paper.

## **CONCLUSION**

This project demonstrates that senior theses are cited, and cited in authoritative, peer-reviewed journals, although not at the rate that scholarly material is cited. Since undergraduate theses are cited, it is vitally important that the work be of high quality. Recently, Dorner and Revell (2012) researched subject librarians' perceptions of institutional repositories as an information resource; they found that librarians are not promoting IRs as an information resource. One of the main reasons given was a lack of relevant content to patrons, especially undergraduates (Dorner and Revell 2012, 273). However, information in the IR is being used, whether or not librarians promote it. In the present study the second largest type of materials citing to undergraduate theses are graduate and other undergraduate theses.

What this research has found is that there are primarily two categories of materials citing to undergraduate theses: scholarly peer-reviewed or refereed publications; and dissertations and graduate and undergraduate theses. Scholars are more likely to be able to evaluate a thesis to determine if the material is authoritative and worthy of integration into scholarship. Students, on the other hand, are more likely to still be developing their information literacy skills, and they may not be as savvy evaluating information contained in an undergraduate thesis.

What are the ramifications for institutional repositories to make these works available via open access? Because theses are being cited, collaboration between scholarly communication librarians and instruction librarians is vital. One of the primary considerations to be made when making senior theses available via the IR is the necessity for that collaboration. Librarians need to make sure that they are reaching seniors well before they deposit their theses to discuss information literacy and make seniors knowledgeable about the larger conversation they are

entering into when making their theses open access. Especially important are citation, attribution, and permission issues that many students have not had to think too deeply about prior to their thesis.

Finally, is repository submission beneficial for both the authors of the theses as well as those citing them? Yes. Making theses available to the wider scholarly community brings students into the conversation about vital information use, publishing, and scholarship issues, and it allows scholars to benefit from often cutting-edge or niche areas of research.

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