A Comparative Citation Analysis Study of Master's Theses at the American University of Beirut, Lebanon

Keywords: citation analysis; collection development; master's thesis; biology; mechanical engineering; political science

ABSTRACT

Purpose

The purpose of this paper is to determine and compare the type and age of cited literature in master's theses of three academic disciplines at the American University of Beirut (AUB), Lebanon. It also aims to improve the existing monograph and serial collections at AUB.

Design/methodology approach

As theses and dissertations present a convenient source of bibliographies for examination, the authors conducted a citation analysis of all master's theses completed during the period 2004-2013 in the disciplines of biology, mechanical engineering, and political science. Bibliographic data was extracted from each citation in the reference list(s) and later analyzed using Microsoft Excel. Availability of all cited books and journals was checked against the library catalog.

Findings

This case study reveals the extent to which the AUB UL collections answer the research needs of graduate students. The findings show that engineering and biology students use a significantly greater number of scholarly journal articles than political science students, while all disciplines rely on recent publications.

Practical implications

This paper's findings will prove useful to develop lists of core journals for the AUB University Libraries (UL). The findings will help managing existing collections and provide a base for informed decision-making as regards journal subscriptions and cancellations.

Originality/value

Although many citation analyses of master's theses have been done around the world, this study is one of the few completed in the Arab world. Hence, it offers useful insight for collection development in Lebanon and the Arab world.

INTRODUCTION

With increasing pressure on collection budgets, academic libraries are facing difficulties in making selection, retention, and cancellation decisions. Are usage statistics obtained from vendors enough to decide whether to renew or cancel journal/e-book subscriptions? Should librarians depend solely on circulation and in-house statistics? To answer these questions, and in order to design a strong academic collection and determine its usefulness, collection development librarians rely on various methods including citation analysis.

Citation analysis is a viable tool for collection management and utilized by librarians to make informative decisions. Since this tool is based on scholarly activity, Enger (2009, p. 111) believes it to be a measurable "collection development method that could be used in all academic libraries". Hoffmann and Doucette (2012, p. 326) agree, confirming that "citation analysis is a relatively straight-forward tool for librarians to use to better understand their users or analyze their collections". Citation data from collection-focused activities can assist in "compiling lists of most-and least-cited journals and local holdings to make acquisition or cancellation decisions, and examining age of cited references to help develop storage and retention policies."(cited in Hoffmann & Doucette, 2012, p. 322).

This AUB study discusses the differences in use of library resources among three disciplines at a single academic institution with the aim to assess the usefulness of the UL collections to

graduate students. Smith (2003, p. 344) rightfully asks a crucial question: "Do we own the things our students use?" What may be of equal interest to librarians, however, is: should we keep the things we own? The things libraries own might not necessarily be the ones needed by patrons. Lack of space is a critical problem facing many university libraries. Due to this space problem and budget constraints AUB Libraries, like many other libraries in the region and the world, cannot afford to acquire and keep just in case materials that may be used one day by faculty and students. Instead, our libraries are investing more and more in e-resources by subscribing and purchasing journal and book packages for ease of access, discovery and use. Consequently, there has been a major shift from print to electronic journal access thus saving storage or shelf space. Services such as interlibrary loan and document delivery services are also utilized to satisfy the research needs of the AUB community. Hence, this has led to a budget shift from ownership acquisition (just-in-case) to access (just-in-time) based on article and book demand.

Deciding what to keep on the shelves and what to discard may be assessed by examining the resources used by library patrons. However, resources used particularly by students may not be the most suitable materials for research. Students have the tendency to choose and use easily available information sources over higher quality sources. Since convenience, speed, and ease of access are a preference for students, citation analysis studies may not be the best tool to use for collection development decisions. Nevertheless, this study was designed to answer the following research questions:

1. What percentage of citations in theses in each discipline is to books (monographs), to journals, to conferences, and to websites?
2. What proportion of cited books and journals is available at AUB UL?

3. What is the age range of book, conference, and journal citations?
4. Which are the most-cited journals in each discipline?

REVIEW OF SELECTED LITERATURE

According to Edwards (1999), theses and dissertations are a preferred sample material as graduate students form a large percentage of user groups of library resources for their academic research. Sherriff (2010) in agreement states that research-based theses and dissertations are excellent sources of relatively easy-to-access data.

The first citation analysis project dates back some nine decades, to a study undertaken by Gross and Gross. Since its publication in 1927, citation analysis has become an often-proposed tool for collection development, with numerous papers based on this strategy. Through citation analysis, appropriate collection-development decisions may be taken with regard to journal selection, retention, and cancellation within limited and/or reduced budgetary allocations to academic libraries. (Bolgiano and King, 1978; Leiding, 2005; Mercer, 2000).

Another purpose of citation analysis is to illustrate how usage of cited sources varies among different academic disciplines. For example, most studies that focus on disciplines in natural sciences report that the majority of citations is to journal articles, with a significant minority to monographs. This is underscored by findings in a study conducted by Glänzel and Schoepflin (1999) indicating that, when it comes to publications in the field of science, the tendency is to cite mostly journal articles, while the proportion of such citations in social sciences and humanities is comparatively smaller. Huang and Chang (2008), in their study, state that in the

humanities — although fewer books than journals are being published—scholars tend to cite books more often than other types of resources.

In their research on citations in political science dissertations, Buchanan and Herubel (1993, 1994) found that students to a greater extent rely on monographs than on other types of sources for their citations. Zhang (2007) also shows that scholars in international relations tend to cite books more frequently than journals; as does Knapp (2013), who based his research on forty doctoral dissertations in political science at Penn State University. He noticed that Penn State students nowadays also tend to rely more on books rather than journals. On the other hand, Kohn and Gordon (2014) reveal a tendency among undergraduate students in international relations to rely more on journals. This deviation might be explained by the fact that undergraduate students tend to rely on easily accessible materials more than graduate students do.

The literature contains a considerable number of citation analysis studies based on specific user groups, as example undergraduates, (Abeyrathne, 2015; Knight-Davis & Sung, 2008; Kohn & Gordon, 2014; Kraus, 2002; Leiding, 2005), graduates (Miller, 2011; Nabe & Imre, 2008; Walcott, 1994), and faculty (Currie & Monroe-Gulick, 2013; LaBonte, 2005, Salisbury & Smith, 2010; Wilson & Tenopir, 2008). Other research compares literature citations listed in faculty publications to those in papers written by undergraduate or graduate students (Kraus, 2005; Pancheshnikov, 2007).

Numerous studies examine a particular discipline, as example biology, (Brown, 2005; Miller, 2011; Nabe & Imre, 2008; Walcott, 1994) engineering, (Becker & Chiware, 2015; Bierman, 2012; Eckel, 2009; Edwards, 1999; Kriz, 1977; Williams & Fletcher, 2006; Yu, Sullivan &

Woodall, 2006), and political science (Buchanan & Herubel, 1994; Knapp, 2013); while some papers contain comparative data from various disciplines (Feyereisen & Spoiden, 2009; Fransen, 2012; Kayongo & Helm, 2011; Leiding, 2005; Wilson & Tenopir, 2008).

This AUB study, like other comparative research papers, offers an overview of journal and monograph use across different disciplines. Few studies that focus on reference lists generated from theses submitted to various academic disciplines have, till date, been done in the Middle East. This study is the first endeavor to collect data on citation analysis in Lebanon.

BACKGROUND

Founded in 1866, the American University of Beirut (AUB) is a teaching-centered research institution with close to 800 faculty members and a student body of around 8,000 (American University Of Beirut, n.d.). AUB currently offers over 120 academic programs leading to bachelor's and master's degrees, as well as MD and PhD degrees. There are six faculties: Agricultural and Food Sciences, Arts and Sciences, Engineering and Architecture, Health Sciences, Medicine, and the Olayan School of Business.

As a central supporting body of the university, AUB University Libraries (UL) includes the following institutions: Jafet Memorial Library; Engineering and Architecture Library; Saab Memorial Medical Library; and Science and Agriculture Library, with its annex AREC (Farm) Library. Together, these libraries have a rich collection of a total of 400,000 books and 6,000 print periodicals (2,000 in Arabic) in 180,000 volumes. The libraries also own 800,000 electronic books and provide access to 145,000 electronic periodicals and 800 journals on microfilm (600

in Arabic) (American University of Beirut Libraries, n.d.). All AUB theses and dissertations can be accessed online via authorized username and password.

METHODOLOGY

The goal of this analysis study was to compare literature citations in theses submitted by graduate students in three different disciplines to determine the characteristics of the sources cited. Three broad disciplinary areas — namely, engineering, sciences, and social sciences — were selected for this paper, with one department chosen within each. The authors selected mechanical engineering, biology, and political science as they are departments which can provide a large sample of theses. The source data comprised a total of 247 master's theses completed at AUB in those three departments during the period 2004-2013 (see table 1).

First, the theses were identified by conducting a search in the online library catalog. Then, citations were retrieved directly from the electronic copies of these theses. For every thesis, bibliographic information (title, author, year of publication, document type) was gathered for each individual citation in the reference list(s). Citations were analyzed using Microsoft Excel. The format of the cited source was recorded as journal, monograph, newspaper, website, thesis, report, patent, conference, or standard. If the format could not be verified, it was noted under the category labeled 'other'. Finally, all cited journals and books were checked for holdings in the library catalog and in electronic resources. The authors aimed at achieving a comprehensive and thorough analysis of the AUB UL collection; hence, they verified the availability of each citation classified under the categories 'book' and 'journal', regardless of the number of times cited.

(Insert table 1)

The total number of citations gathered from all 247 theses was 23,316. Theses in biology comprise 57.74% of all citations in the sample, mechanical engineering 14.56%, and those in political science represent 27.70%. Thus, the number of citations listed in the bibliographies varies by discipline and the nature of research. Theses completed in biology contain the largest number of citations, with an average of 140 per paper; followed by those in political science with 107, while theses in mechanical engineering list the lowest average of 37. Low use of citations in mechanical engineering may be attributed to a high dependence on mathematical modeling which doesn't need the use of many references as compared to biology and political science. Moreover, biological research evolves and grows at a higher rate than mechanical engineering research, and hence more work is published in biology than in mechanical engineering. In addition, mechanical engineering research is more focused and has a very specific objective; while biology and political science have broader objectives and deal with topics that are interrelated. On the other hand, there is great variation also within a specific discipline; as example, in biology, the briefest bibliography listing contains just 44 citations, while the most extensive 395.

As reported, the average number of cited sources per biology thesis in this AUB study is 140, compared to 164 in Walcott's (1994) research. Many studies confirm that scientists tend to cite more resources per publication than researchers in other disciplinary areas. In this AUB study, the briefest bibliography in a mechanical engineering thesis lists 15 reference sources and the most extensive 98, with the average being 37 citations per thesis. This compares to 32.62 in Williams and Fletcher's (2006) and 25 in Eckel's (2009) studies. As for political science,

according to this AUB study, the bibliography listings range widely, from a mere 18 to 420 reference sources.

The research guidelines for this study included the following points:

- Title changes or splits were recorded as separate journals. In most cases, all data and information, such as publication date, were used as cited in the reference or bibliography section(s) of the theses included in the sample without prior verification.
- Unknown titles and abbreviated journal titles were verified using Ulrich. This database was used also to verify the citation format or type whether journal, magazine, bulletin or newspaper.
- Point-of-time ownership was not taken into account (due to time constraint); that is, it was assumed that all sources gathered for this study had been accessible at the time of publication of respective thesis in the sample.
- Verification of format (print or electronic) of journals and books was not carried out.
- Duplicate citations within a bibliography or reference listing were counted once only.

RESULTS AND DISCUSSION

1. Type

The most common facet of citation analysis is type or format. What are the types or formats of cited literature or referenced sources represented in graduate research, and in what proportions? The responses to these questions can be used as primary input for decision making concerning collection development. Walcott (1994, p. 4) rightly states that it is imperative for librarians to

know "which forms of literature are the most cited and used by patrons in order to reflect this preference in their collection development process".

Biology:

Table 2 lists the frequency of all types of literature and reference sources cited by biology graduate students. They are ranked in order of most-cited to least-cited format. The findings show clearly the importance of journals in their citation material. Hence, "science librarians can feel justified in spending […] a high proportion of the acquisition budget on serials, as this is the part of the collection that is most cited and presumably most used" (Walcott, 1994, p.4).

Of all cited references in this discipline, 95% are to journal articles. This represents a very high proportion of serial citations and is in accordance with the "established theory that the majority of scholarly communication in the scientific community takes place in the journals" (Lascar & Mendelsohn 2001, p. 426). The findings in this AUB study are similar to those reported in LaBonte's (2005) study at Santa Barbara's University of California with 90% of faculty citations to journals; however, they are significantly higher than those presented in a study undertaken by Kayongo and Helm (2011) in Notre Dame University, indicating 78% of doctoral students' citations to journals and 14% to books. One might infer that master's students and faculty rely mainly on journal articles, whereas doctoral students depend on books because of the comprehensive nature of their research.

Websites, accounting for 0.3% of total citations, are mostly governmental (like *Centers for Disease Control and Prevention*), organizational (like *International Commission for Scientific Exploration of the Mediterranean Sea*), or educational (like *University of Melbourne*). Only a few of the cited websites are commercial which might reflect the faculty's strong

recommendations to their students to rely on academic sites. Website citation was much higher in 2004 theses (13) than in 2013 (only 2). Theses are cited 36 times; 30 of which are AUB master's theses in Biology and Chemistry, while the remaining 6 are international PhD dissertations.

(Insert table 2)

Mechanical Engineering:

As shown in table 3, journal articles (61%) are the most commonly-cited type of reference material also in mechanical engineering — a finding in accordance with numerous other citation analysis studies of theses and dissertations, both in engineering in general and in its sub-disciplines. Conferences (13%) and monographs (12%) are the second- and third-most cited formats, respectively, and their percentages support the findings of earlier studies of the continuing importance of these types of resources for engineering researchers. (Becker & Chiware, 2015; Bierman, 2012; Conkling et al., 2010; Eckel, 2009; Fransen, 2012; Kayongo & Helm, 2011; Kriz, 1977; Kushkowski, Parsons & Wiese, 2003; Uçak & Al, 2009; Williams & Fletcher, 2006).

Other types of reference sources used are, in decreasing order of frequency, master's and PhD theses, websites, reports, standards, software, and 'other'. Theses constitute 4% of the citations. 96 citations are to PhD dissertations and 41 citations are to master's theses; 18 of which are done by AUB students. Websites represent 3.62% of the citations with the majority being commercial websites that provide information on instruments, devices, and materials. Educational, organizational and governmental websites are used less and mostly relate to energy and

sustainable building construction. Website citation was relatively higher in 2004 theses (21) than in 2013 (only 15). Only one patent is cited, although this type of material should be an important source for mechanical engineering students. In comparison, Eckel (2009) reports a 2.5% and 1.5% patent usage by master's and PhD students in engineering faculties at Western Michigan University.

(Insert table 3)

Political Science:

Most studies reveal that, in social sciences and humanities, students rely more on monographs for their citations and references. In a recent study, Rosenberg (2015) found that books are the most frequently-cited resource type among graduate students in sociology and anthropology.

As shown in table 4, almost 40% of the political science citations recorded in this AUB study is to monographs, 17% to journals, and around 14% to newspapers and bulletins. These results underscore those in studies conducted by Buchanan and Herubel (1993, 1994), Knapp (2013), and Zhang (2007); however, they diverge from Kohn and Gordon's (2014) findings stating that undergraduate students in international relations tend to rely more on journals than books.

Also, it is important to note that citations to websites represent a significantly higher proportion of reference sources in theses presented in political science (12.71%), compared to those in biology (0.36%) and mechanical engineering (3.62%). Most of the cited websites are related to local political parties, governmental organizations, non-governmental organizations, and news channels. Website citation in political science theses increased significantly from only 7 in 2004 to 276 in 2013 with major fluctuations in between. This rise may be affected by the number of submitted theses during those two years; only 4 theses were submitted in 2004 while 16 theses

were submitted in 2013. Theses are cited almost as many times as in biology papers; however only 10 out of 35 are AUB master's theses.

(Insert table 4)

2. Availability

Biology:

Verifying the availability of cited books and journals in biology theses reveals that the various branches of AUB UL provide access to, in print or in electronic format, 65.63% of all cited monographs and 88.33% of all cited journals.

Mechanical Engineering:

According to the findings for cited sources in mechanical engineering theses, AUB UL provides access to 51.7% of cited monographs, and to 81.05% of cited journal titles.

Political Science:

For political science, the finding for the availability variable shows that 82.74% of cited monographs is part of the AUB UL collection. As for journals, the result shows that UL subscribes to the vast majority of titles cited (97.78%).

These results confirm that AUB UL provides access to a large number of cited monographs and to the majority of cited journals, whether in print or in electronic format. Of note is that the monographs were checked by the authors in the library catalog only; hence a more in-depth search might reveal that some cited literature may, in fact, be available in subscribed e-book packages.

To enhance the existing AUB UL collection, the generated list of unavailable books will be appraised by the Collection Development Department as to what items should be considered for future acquisition, while taking into consideration other preset criteria.

3. Age

Biology:

In the sample of biology theses for this study, the earliest-dated journal article cited had been published in 1901 and the most recent in 2013; while the earliest monograph dates from 1775 and the most recent from 2012.

The median age of all citations, regardless of format, in this discipline is 14 years. This is lower than reported by Nabe and Imre (2008) for PhD dissertations in plant biology and zoology of 18 and 16 years, respectively. On the other hand, the AUB study finding is considerably higher than those presented in other comparable studies. Brazzeal and Fowler (2005) report an average citation age of 10.6 years for master's theses in forestry; while Walcott (1994), in a study on dissertations in biological sciences, finds 50% of citations being from sources not older than 5 years (cited in Nabe & Imre, 2008). Walcott's (1994) finding is a fairly close match to that registered by Kuruppu and Moore (2008) in their study on 154 agriculture and biology theses, reporting the median citation age to be less than 7 years. In Smith's (2003) study, the average age of journal citations is 10 years, which compares closely to Kraus's (2002) study, with the reported 10.65 years, and the almost-identical finding of 10.8 years in Kayongo and Helm (2011).

Mechanical Engineering:

The earliest source cited in the sample of mechanical engineering theses is dated 1840 and the most recent 2013. The earliest book cited was published in 1952 and the most recent some sixty years later, in 2012. As regards conferences, the dates are virtually the same; the first having been held in 1953 and the most recent in 2012.

The median age of journal citations recorded in the sample of mechanical engineering theses is 13 years, which is considerably higher than 7 years as reported by Williams and Fletcher (2006) Uçak and Al (2009) report a median age of 8 years for all sources cited in engineering (physics, chemical, electrical and electronic, and computer). Musser and Conkling (1996), in their journal-citation study on selected engineering disciplines, report a median age of also 8 years. On the other hand, Eckel's (2009) study indicates a higher average citation age for journals of 11.8 years for master's theses in engineering disciplines, including mechanical and aeronautical.

With regard to conferences and monographs, citations register a median age of 12 and 16 years, respectively, in this AUB study. In accordance with Williams and Fletcher's (2006) research, conference is, on average, the most-recent format also in this study, with 75% of conference papers cited within 16 years of them having been held (delivered/published); while the equivalent proportion, or three quarters of journal articles and of monographs cited within 21 and 28 years of their publication, respectively.

Political Science:

For cited books in political science thesis, the years of publication span from 1890 to 2013, with the majority (37.78 %) having been published between the years 1992 and 2002. The median age of books cited is 16. The publication years for cited journals range from 1926 to 2013, with the majority (36.06%) also dating between 1992 and 2002. The median age of cited articles is 15.

The publication years for cited journals range from 1926 to 2013, with the majority (36.06%) also dated between 1992 and 2002.

In both types of literature there is high usage of sources that are under 20 years. The earliest journal article cited dates from 1928 and the most recent from 2013; while the earliest book cited had been published in 1890 and the most recent in 2012.

Age of journal articles and books cited varied according to discipline. Older materials were cited in plant science or botany, while more current materials were cited for cell or molecular biology. The oldest citation in this study (235 years), to *Descriptiones animalium, avium, amphibiorum, piscium, insectorum, vermium* by Peter Forsskal, a monograph in Latin from 1775 available at AUB UL as microcard, was found in a 2010 biology thesis. The oldest citation to a journal article (165 years), found in a 2005 mechanical engineering thesis, references an 1840 article in the Journal of the Franklin Institute available through one of UL's journal packages.

Tables 5 shows, for each of the three disciplines, the distribution of journal articles by range of years within which they had been published; while table 6 illustrates the distribution of monographs, again categorized under publishing period and discipline.

The results reveal that most sources cited, representing over 70%, register publication dates between the years 1992 and 2013. Citation of very early sources may have distorted these findings. Due to time constraint, the authors were unable to verify publication dates of all cited reference sources. Careful verification could have revealed errors which may have resulted in a distortion of these research results.

(Insert table 5)

(Insert table 6)

Table 7 illustrates the time period within which the conference (papers) cited in theses presented by mechanical engineering students had been delivered or published.

(Insert table 7)

4. Most-Cited Journals

Biology:

In the sample, the total number of journal citations numbered 12,809. After removal of duplicates, 12,747 cited references remained, representing 1,740 unique journal titles. In other words, 1,740 different serial titles were needed to cover 100% of the citations. To identify the dispersion of citations, the Law of Scattering was tested by the authors. This law lists the cited journals in order of decreasing citation frequency, and predicts that 80% of cited articles should come from just 20% of the journals used as reference. For the sample of theses in biology, the core list of journals fits Trueswell's 80/20 rule; 80% of the citations to journal articles occurred in the 358 most frequently-cited journal titles, representing 20.5%.

Mechanical Engineering:

According to Sinn (2005), engineering, mathematics, and geosciences do not follow the 80/20 rule. He states that these disciplines have "higher title dispersions since a higher percentage of journal titles is needed to account for a similar percentage of journal citations" (p. 33). High title dispersion was reported also by Indian space technologists (Sridhar, 1985) and the TAMU Aerospace engineering faculty (Stephens et al., 2013)

This AUB study shows that 12.26% of journals cited in mechanical engineering theses account for 59% of journal citations. These numbers are comparable to those reported by Sridhar (1985)

where 11% of the journals cited account for 59.96% of journal citations; and by Stephens et al. (2013), where 11.7% of journals cited account for 59% of journal citations.

Political Science:

The 80/20 rule does not apply in the case of political science theses. The explanation for this is best given by Kohn and Gordon (2014, p. 286), who state that when "citations are widely dispersed among many journals [… in other words] students are citing many different journals, and citations to specific journals do not repeat very often". Another reason might be the multidisciplinary nature of this field. In this research study, the ten most-frequently cited journals are related to political science in general, and to the Middle East in particular. AUB UL subscribes to almost every journal related to the Middle East and the Arab world. The regional nature of the most highly ranked journals is evident in the research conducted in the political science department resulting in the use of many Arabic publications in student theses. Finding Arabic titles is expected especially that the culture and the political situation in which education takes place can indirectly affect the nature of the topic as well as the cited references.

The following three tables — 8, 9, and 10 — rank the journals according to the frequency with which they were cited in the graduate theses, listing the 15 most-frequent titles. AUB UL, as a renowned institution, provides access to all of these well-established journals and holds what can be considered a core journal collection of high standing.

(Insert table 8)

(Insert table 9)

(Insert table 10)

It is quite evident from tables 8, 9, and 10 that most of the highly cited journals are subject specific in nature. In case of biology theses, the *Journal of Biological Chemistry,* which falls

under the specific category of Biochemistry and molecular biology, was cited much more than the multidisciplinary journals such as *PNAS*, *Science*, and *Nature*. In case of mechanical engineering and political science theses, the most cited journals are also highly specialized namely *Energy and Buildings* and *Journal of Palestine Studies* respectively. The current journal ranking might have been different if based on the number of citing authors instead of total number of citations.

The interdisciplinary nature of the cited journals by the three disciplines is also worth mentioning. Biology students have cited journals from the Food science and technology category (e.g. *International Journal of Food Microbiology*) similar to mechanical engineering students who have cited journals from the same category (e.g. *Food and Chemical Toxicology*) and from Sport science category (e.g. *Journal of Applied Physiology*); while political studies students have cited journals falling under the History and philosophy of science category (e.g. *NanoEthics*).

LIMITATIONS

Data gathering is a daunting and time-consuming process and this study faced several challenges and limitations, including the following issues:

- Inaccurate or incomplete citation and reference data (as recorded by graduate students). e.g. If a student used the wrong year for a book or journal publication, that wrong year was used for calculating the age of materials used.

- Inadequate time to verify all journal titles in Ulrich.

- Failure to differentiate between print and electronic formats as citations often omitted indication of which source had been used.

Ranking journals by number of citing authors may have proved more useful a criterion than basing it on total number of citations. Furthermore — rather than having selected a more manageable number — verifying and analyzing every single cited reference proved an extremely tedious and time-consuming task.

CONCLUSION

As the authors' main purpose was to find out what is being used and cited by those who use the AUB libraries, this study provides invaluable and previously unavailable insight into the strengths and weaknesses of the UL collection. The results show that the needs of graduate students in political science are better met than those of their peers in biology and mechanical engineering.

The findings confirm that serials are of paramount importance to all graduate students, which would justify spending in the region of 90% of the budget on subscriptions of periodicals and journals. The statistics indicate which serial titles are the most-frequently cited by graduate students in the three disciplines analyzed. On the other hand, books are found to be comparatively less-frequently cited, particularly in biology and mechanical engineering. The study also revealed differences between the three disciplines in the number of websites that students used. It is worth mentioning that there is no definite pattern in the use of websites between 2004 and 2013. This may be attributed to the different number of theses submitted each year by each discipline, the topic of research, and the fact that some faculty members stress on the use of scholarly materials rather than websites specifically commercial ones.

Moreover, this study indicates clearly that the most recent literature and material in the collection are of the greatest importance — especially so for resources in biology and engineering.

Examining the age of cited references will help determining obsolescence rates of monographs in the three disciplines. Removing old print volume collection would be justified to spare maintenance cost and create space. Collection development librarians should make use of the findings of this study to develop storage and retention policies, and to plan their budgets in times of extreme financial constraint.

When analyzing the study sample, the authors noted various inaccuracies in the bibliography and reference listings, including typographical errors and, for articles and journals, incorrectly-cited title and volume number, as well as omitted or incorrect publication year, etc. It is evident that students need more help and guidance in creating their reference lists and properly formatting their citations. Suggestions for future research might include analyzing errors in graduate theses to develop improved information skills sessions to help students produce complete, accurate, and error-free citations. This study has further implications for instruction and promoting bibliography managers such as RefWorks and EndNote.

A follow-up study might be done on sub-disciplines as the authors found that studying a discipline as a whole may not provide a good indicator of citation age — as was the case in this study for especially biology. Certain sub-disciplines, for example botany, might rely on older research than would cell or molecular biology. Investigation of sub-disciplines could provide more pertinent information about the various subject collections.

A future study might involve a comparison between master's and PhD students in one specific discipline. This was not possible at the time this study was done mainly because AUB does not offer a PhD program in political science, and because biology and mechanical engineering departments do not yet provide enough data set to perform such a study.

References

Abeyrathne, D.K. (2015), "Citation analysis of dissertations for collection development", *Collection Building*, vol. 34, no. 2, pp. 30–40, doi: 10.1108/CB-11-2014-0055

American University of Beirut (n.d.), *About us*, viewed 7 April 2016, http://www.aub.edu.lb/main/about/Pages/index.aspx

American University of Beirut University Libraries (n.d.), *About the libraries*, viewed 7 April 2016, http://www.aub.edu.lb/ulibraries/about/Pages/about.aspx

Becker, D.A. & Chiware, E.R. (2015), "Citation analysis of masters' theses and doctoral dissertations: balancing library collections with students' research information needs", *The Journal of Academic Librarianship*, vol. 41, no. 5, pp. 613–620, doi: 10.1016/j.acalib.2015.06.022

Bierman, J. (2012), "A citation study of engineering masters theses at the University of Oklahoma: comparing the years 1991 and 2011", *Science & Technology Libraries*, vol. 31, no. 4, pp. 412–425, doi: 10.1080/0194262X.2012.730461

Bolgiano, C.E. & King, M.K. (1978), "Profiling a periodicals collection", *College & Research Libraries*, vol. 39, no. 2, pp. 99–104, doi: 10.5860/crl_39_02_99

Brazzeal, B. & Fowler, R. (2005), "Patterns of information use in graduate research in forestry: a citation analysis of master's theses at Mississippi State University", *Science & Technology Libraries*, vol. 26, no. 2, pp. 91–106, doi: 10.1300/J122v26n02_05

Brown, C. (2005), "Where do molecular biology graduate students find information?", *Science & Technology Libraries*, vol. 25, no. 3, pp. 89–104, doi: 10.1300/J122v25n03_06

Buchanan, A.L. & Herubel, J.P.V. (1993), "Comparing materials used in philosophy and political science dissertations: a technical note", *Behavioral & Social Sciences Librarian*, vol. 12, no. 2, pp. 63–70, doi: 10.1300/J103v12n02_04

Buchanan, A.L. & Herubel, J.P.V. (1994), "Profiling PhD dissertation bibliographies: serials and collection development in political science", *Behavioral & Social Sciences Librarian*, vol. 13, no. 1, pp. 1–10, doi: 10.1300/J103v13n01_01

Conkling, T.W., Harwell, K.R., McCallips, C., Nyana, S.A. & Osif, B.A. (2010), "Research material selection in the pre-web and post-web environments: an interdisciplinary study of bibliographic citations in doctoral dissertations", *The Journal of Academic Librarianship*, vol. 36, no. 1, pp. 20–31, doi: 10.1016/j.acalib.2009.11.003

Currie, L. & Monroe-Gulick, A. (2013), "What do our faculty use? An Interdisciplinary citation analysis study", *The Journal of Academic Librarianship*, vol. 39, no. 6, pp. 471–480, doi: 10.1016/j.acalib.2013.08.016

Eckel, E.J. (2009), "The emerging engineering scholar: a citation analysis of theses and dissertations at Western Michigan University", *Issues in Science and Technology Librarianship*, doi: 10.5062/F4HD7SKP

Edwards, S. (1999), "Citation analysis as a collection development tool: a bibliometric study of polymer science theses and dissertations", *Serials Review,* vol. 25, no. 1, pp. 11-20, doi: 10.1080/00987913.1999.10764479

Enger, K.B. (2009), "Using citation analysis to develop core book collections in academic libraries", *Library & Information Science Research,* vol. 31, no. 2, 107-112, doi: 10.1016/j.lisr.2008.12.003

Feyereisen, P. & Spoiden, A. (2009), "Can local citation analysis of master's and doctoral theses help decision-making about the management of the collection of periodicals? A case study in psychology and education sciences", *The Journal of Academic Librarianship,* vol. 35, no. 6, pp. 514-522, doi: 10.1016/j.acalib.2009.08.018

Fransen, J. (2012), "Literature use in engineering and computer science research: an analysis of works cited in dissertations and theses", *Issues in Science and Technology Librarianship*, doi: 10.5062/F4Q81B1B

Glänzel, W. & Schoepflin, U. (1999), "A bibliometric study of reference literature in the sciences and social sciences", *Information Processing & Management*, vol. 35, no. 1, pp. 31-44, doi: 10.1016/S0306-4573(98)00028-4

Hoffmann, K. & Doucette, L. (2012), "A review of citation analysis methodologies for collection management", *College & Research Libraries*, vol. 73, no. 4, pp. 321-335, doi: 10.5860/crl-254

Huang, M.H. & Chang, Y.W. (2008), "Characteristics of research output in social sciences and humanities: from a research evaluation perspective", *Journal of the American Society for Information Science and Technology*, vol. 59, no. 11, pp. 1819-1828, doi: 10.1002/asi.20885

Kayongo, J. & Helm, C. (2011), "Relevance of library collections for graduate student research: a citation analysis study of doctoral dissertations at Notre Dame", *College & Research Libraries*, crl-211, viewed 7 April 2016, http://crl.acrl.org/content/early/2011/03/28/crl-211.full.pdf

Knapp, J.A. (2013), "Tracking changes in political science dissertations at Penn State: 1953–2010", *Behavioral & Social Sciences Librarian*, vol. 32, no. 3, pp. 155-175, doi: 10.1080/01639269.2013.817881

Knight-Davis, S. & Sung, J.S. (2008), "Analysis of citations in undergraduate papers", *College & Research Libraries*, vol. 69, no. 5, pp. 447-458, doi: 10.5860/crl.69.5.447

Kohn, K.C. & Gordon, L. (2014), "Citation analysis as a tool for collection development and instruction", *Collection Management*, vol. 39, no. 4, pp. 275-296, doi: 10.1080/01462679.2014.935904

Kraus, J.R. (2002), "Citation patterns of advanced undergraduate students in biology, 2000-2002", *Science & Technology Libraries*, vol. 22, no. 3-4, pp. 161-179, doi: 10.1300/J122v22n03_13

Kraus, J.R. (2005), "Comparing journal use between biology faculty and undergraduate students", *Issues in Science and Technology Librarianship*, doi: 10.5062/F4736NVN

Kriz, H.M. (1977), "Citation counting and the future of engineering libraries", *Engineering Education,* vol. 67, no. 7, pp. 707-710.

Kuruppu, P.U. & Moore, D.C. (2008), "Information use by PhD students in agriculture and biology: a dissertation citation analysis", *Portal: Libraries and the Academy*, vol. 8, no. 4, pp. 387-405, doi: 10.1353/pla.0.0024

Kushkowski, J.D., Parsons, K.A. & Wiese, W.H. (2003), "Master's and doctoral thesis citations: analysis and trends of a longitudinal study", *Portal: Libraries and the Academy,* vol. 3, no. 3, pp. 459-479, doi: 10.1353/pla.2003.0062

LaBonte, K.B. (2005), "Citation analysis: a method for collection development for a rapidly developing field", *Issues in Science and Technology Librarianship,* viewed 7 April 2016, https://repository.library.csuci.edu/handle/10139/244

Lascar, C. & Mendelsohn, L.D. (2001), "An analysis of journal use by structural biologists with applications for journal collection development decisions", *College & Research Libraries,* vol. 62, no. 5, pp. 422-433, doi: 10.5860/crl.62.5.422

Leiding, R. (2005), "Using citation checking of undergraduate honors thesis bibliographies to evaluate library collections", *College & Research Libraries*, vol. 6, no. 5, pp. 417-429, doi: 10.5860/crl.66.5.417

Mercer, L.S. (2000), "Measuring the use and value of electronic journals and books", *Issues in Science and Technology Librarianship*, pp. 1-8, doi: 10.5062/F4DF6P6J

Miller, L.N. (2011), "Local citation analysis of graduate biology theses: collection development implications", *Issues in Science and Technology Librarianship*, doi: 10.5062/F4RF5RZZ

Musser, L.R. & Conkling, T.W. (1996), "Characteristics of engineering citations", *Science & Technology Libraries*, vol. 15, no. 4, pp. 41-49, doi: 10.1300/J122v15n04_04

Nabe, J. & Imre, A. (2008), "Dissertation citations in organismal biology at Southern Illinois University at Carbondale: implications for collection development", *Issues in Science and Technology Librarianship,* doi: 10.5062/F46W980N

Pancheshnikov, Y. (2007), "A comparison of literature citations in faculty publications and student theses as indicators of collection use and a background for collection management at a university library", *The Journal of Academic Librarianship*, vol. 33, no. 6, pp. 674-683, doi: 10.1016/j.acalib.2007.09.011

Rosenberg, Z. (2015), "Citation analysis of MA theses and Ph.D. dissertations in sociology and anthropology: an assessment of library resource usage", *The Journal of Academic Librarianship,* vol. 41, no. 5, pp. 680-688, doi: 10.1016/j.acalib.2015.05.010

Salisbury, L. & Smith, J.S. (2010), "The use of Web of Knowledge to study publishing and citation use for local researchers at the campus level", *Collection Management*, vol. 35, no. 2, pp. 69-82, doi: 10.1080/01462671003597959

Sherriff, G. (2010), "Information use in history research: a citation analysis of master's level theses", *Portal: Libraries and the Academy*, vol. 10, no. 2, pp. 165-183, doi: 10.1353/pla.0.0092

Sinn, R.N. (2005), "A local citation analysis of mathematical and statistical dissertations", *Science & Technology Libraries,* vol. 25, no. 4, pp. 25-37, doi: 10.1300/J122v25n04_03

Smith, E.T. (2003), "Assessing collection usefulness: an investigation of library ownership of the resources graduate students use", *College & Research Libraries,* vol. 64, no. 5, pp. 344-355, doi: 10.5860/crl.64.5.344

Sridhar, M. (1985), "Citing patterns of Indian space technologists", *International Library Review,* vol. 17, no. 3, pp. 259-274, doi: 10.1016/S0020-7837(85)80004-2

Stephens, J., Hubbard, D.E., Pickett, C. & Kimball, R. (2013), "Citation behavior of aerospace engineering faculty", *The Journal of Academic Librarianship*, vol. 39, no. 6, pp. 451-457, doi: 10.1016/j.acalib.2013.09.007

Uçak, N.Ö. & Al, U. (2009), "The differences among disciplines in scholarly communication: a bibliometric analysis of theses", *Libri*, vol. 59, no. 3, pp. 166-179, doi: 0.1515/libr.2009.016

Walcott, R. (1994), "Local citation studies - a shortcut to local knowledge", *Science & Technology Libraries*, vol. 14, no. 3, pp. 1-14, doi: 10.1300/J122v14n03_01

Williams, V.K. & Fletcher, C.L. (2006), "Materials used by master's students in engineering and implications for collection development: a citation analysis", *Issues in Science and Technology Librarianship*, viewed 7 April 2016, http://soar.wichita.edu/bitstream/handle/10057/1589/preprint_of_Williamsa?sequence=1

Wilson, C.S. & Tenopir, C. (2008), "Local citation analysis, publishing and reading patterns: using multiple methods to evaluate faculty use of an academic library's research collection", *Journal of the American Society for Information Science and Technology*, vol. 59, no. 9, pp. 1393-1408, doi: 10.1002/asi.20812

Yu, F., Sullivan, J. & Woodall, L. (2006), "What can students' bibliographies tell us? Evidence based information skills teaching for engineering students", *Evidence Based Library and Information*

Practice, vol. 1, no. 2, pp. 12-22, viewed 7 April 2016, http://ejournals.library.ualberta.ca/index.php/EBLIP/article/viewFile/8/123

Zhang, L. (2007), "Citation analysis for collection development: a study of international relations journal literature", *Library Collections, Acquisitions, and Technical Services*, vol. 31, no. 3-4, pp. 195-207, doi: 10.1080/14649055.2007.10766165

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Table 1. Distribution of Theses by Discipline and Number of Citations

Discipline	Number of theses	Total number of citations	Average number of per citations thesis
Biology	96	13,463	140
Mechanical engineering	91	3,395	37
Political science	60	6,458	107

Table 2. Ranking of Reference Type [Format] by Number of Citations in Biology Theses (percentage)

(N=13,463 references, 96 journal articles)

Reference type	Number of citations	Percentage of total number of citations
Journal	12,809*	95.14
Monograph	503	3.74
Website	48	0.30
Thesis	36	0.27
Report	33	0.24
Conference	13	0.10
Miscellaneous	10	0.07
Patent	8	0.06
Standard	3	0.02

*This total includes 62 duplicates.

Table 3. Ranking of Reference Type [Format] by Number of Citations in Mechanical Engineering Theses (percentage)

(N=3,395 references, 91 journal articles)

Reference type	Number of citations	Percentage of total number of citations
Journal	2,072	61.03
Conference	448	13.20
Monograph	412	12.13
Thesis	137	4.00
Website	123	3.62
Report	104	3.06
Other (manual, guide, project, patent, tutorial, etc.)	70	2.06
Standard	24	0.71
Software	5	0.15

Table 4. Ranking of Reference Type [Format] by Number of Citations in Political Science Theses (percentage)

(N=6,458 references, 60 journal articles)

Reference type	Number of citations	Percentage of total number of citations
Monograph	2,578	39.90
Journal	1,126	17.44
Newspaper & Bulletin	886	13.72
Website	821	12.71
Miscellaneous	364	5.64
Reports	288	4.46
Magazine	236	3.65
Conference	68	1.05
Personal Communication	56	0.87
Thesis	35	0.54

Table 5. Distribution of Citations to Journal Articles by Year of Publication and Discipline (percentage)

Years of publication	Biology	Mechanical Engineering	Political Science	Biology	Mechanical Engineering	Political Science
Pre 1892	—	1	—	—	0.05	—
1893-1903	1	—	—	0.01	—	—
1904-1914	—	—	—	—	—	—
1915-1925	2	1	—	0.02	0.05	—
1926-1936	10	3	2	0.08	0.14	0.18
1937-1947	11	5	10	0.09	0.24	0.89
1948-1958	34	26	5	0.27	1.25	0.44
1959-1969	129	68	33	1.01	3.28	2.93
1970-1980	409	105	91	3.21	5.07	8.08
1981-1991	1,452	239	196	11.39	11.53	17.41
1992-2002	6,297	751	406	49.40	36.24	36.06
2003-2013	4,402	873	383	34.53	42.13	34.01
	12,747*	2,072	1,126			

*This number does not include the duplicates.

Table 6. Distribution of Citations to Monographs by Year of Publication and Discipline (percentage)

Years of publication	Biology	Mechanical Engineering	Political Science	Biology	Mechanical Engineering	Political Science
1770-1870	1	—	—	0.26	—	—
1871-1881	2	—	—	0.52	—	—
1882-1892	1	—	1	0.26	—	0.04
1893-1903	—	—	2	—	—	0.08
1904-1914	—	—	5	—	—	0.19
1915-1925	—	—	6	—	—	0.23
1926-1936	2	—	8	0.52	—	0.32
1937-1947	—	—	13	—	—	0.50
1948-1958	4	3	59	1.03	0.73	2.29
1959-1969	15	18	114	3.87	4.37	4.42
1970-1980	36	54	207	9.30	13.11	8.03
1981-1991	88	69	494	22.74	16.75	19.16
1992-2002	173	182	974	44.70	44.17	37.78
2003-2013	65	86	695	16.80	20.87	26.96
	387	412	2, 578			

Table 7. Distribution of Citations to Conferences by Year of Publication (percentage)

Years of publication	Number of cited conferences	Percentage
1948-1958	4	0.89
1959-1969	0	0.00
1970-1980	9	2.01
1981-1991	39	8.70
1992-2002	225	50.22
2003-2013	171	38.17
	448	

Table 8. Ranking of 15 Most-Cited Journals in Biology Theses

Journal title	Rank	Number of cited articles
Journal of Biological Chemistry	1	619
Proceedings of the National Academy of Sciences U.S.A. (PNAS)	2	434
Journal of Bacteriology	3	292
Cell	4	258
Oncogene	5	256
Cancer Research	6	253
Science	7	246
Nature	8	240
Journal of Cell Biology	9	194
American Journal of Physiology	10	168
Blood	11	129
Journal of Cell Science	12	125
EMBO Journal	13	120
Biochimica et Biophysica Acta	14	118
Molecular and Cellular Biology	15	112

Table 9. Ranking of 15 Most-Cited Journals in Mechanical Engineering Theses

Journal title	Rank	Number of cited articles
Energy and Buildings	1	100
ASHRAE Transactions	2	95
Building and Environment	3	59
International Journal of Heat and Mass Transfer	4	47
Mechanism and Machine Theory	5	39
Journal of Analytical and Applied Pyrolysis	6	32
ASME Journal of Mechanical Design	7	27
Numerical Heat Transfer, Part B	7	27
Applied Thermal Engineering	8	26
Solar Energy	8	26
Computer Methods in Applied Mechanics and Engineering	9	25
International Journal for Numerical Methods in Engineering	9	25
International Journal of Energy Research	10	23
Energy Conversion and Management	11	21
Journal of Applied Physiology	11	21
Journal of Fluid Mechanics	11	21
Journal of Computational Physics	12	20
Renewable Energy	13	18
Combustion and Flame	14	17
HVAC&R Research	14	17
Journal of Materials Processing Technology	14	17
Food and Chemical Toxicology	15	16
Materials Science and Engineering: A	15	16
Physics of Fluid	15	16

Table 10. Ranking of 15 Most-Cited Journals in Political Science Theses

Journal title	Rank	Number of cited articles
Journal of Palestine Studies	1	58
International Security	2	32
شؤون الأوسط (Shu‘un al-Awsat)	3	28
Middle East Journal	4	26
International Affairs	5	22
MERIP Reports	5	22
Middle East Report	5	22
Journal of Peace Research	6	20
International Journal of Middle East Studies	7	19
Middle Eastern Studies	8	18
Political Science Quarterly	9	16
World Politics	9	16
شؤون عربية (Shu’ūn ‘Arabīyah)	10	15
المستقبل العربي (al-Mustaqbal al-‘Arabī)	11	14
International Organization	12	13
Journal of Conflict Resolution	12	13
American Political Science review	13	11
Arab Studies Quarterly	13	11
International Journal	13	11
مجلة الدراسات الفلسطينية (Majallat al-dirāsāt al-Filastīnīyah)	13	11
British Journal of Middle Eastern Studies	14	9
Comparative politics	14	9
NanoEthics	14	9
Mediterranean Politics	15	8
Middle East Policy	15	8
Washington Quarterly	15	8