METHODS FOR JOURNAL COLLECTION EVALUATION IN ACADEMIC SCIENCE LIBRARIES

by
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The frustration many librarians feel when faced with cancellation decisions is understandable; at the time cuts are announced it is unlikely that a library will have fresh data reflecting journal value. If a number of practical methods for analysis can be shown to be effectively equal, librarians will be free to choose the method that is most appropriate to each particular situation. This study compares the main three methods used in most science libraries: reshelving data, citation analysis, and the ISI impact factor rankings. Using the Spearman correlation coefficient ρ, it is found that reshelving and citation analyses generate the most similar ranked lists of journals. It is recommended that librarians combine results from both methods in order to capture a more complete picture of journal value.

Headings:

College and university libraries – Collection development

Scientific and technical libraries – Collection development

Use studies – Serial publications

Citation analysis

Contents

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Introduction: The "serials crisis" and collection evaluation

Librarians sometimes believe that collection management is the careful purchase of serials, monographs, and other materials. However, librarians selecting but not deselecting materials are only doing half of their jobs. In times of low inflation, large budgets, and plenty of shelf space the librarian may be able to get away with keeping everything. However, this was not the reality of life in the 1980s and 1990s, especially in academic science libraries (Hill, Madarash-Hill, & Hayes, 1999). The inflation rate of journal subscription prices far outstripped US inflation in the 1980s (Christensen 1992). Not only are titles more expensive, but the sheer volume of materials being produced is on the rise. There are more specialists and subspecialists writing articles (Schoch 1994), and the average output of faculty across the country has increased this decade (Budd 1999). Libraries built in the earlier part of the last century are full, and must choose which serials to cancel and which to send to storage or withdraw. This is commonly called the "serials crisis", but it is really a "crisis of access to information" as more and more titles become unavailable to patrons (Budd 1999).

The need to cancel journals has led to a rise in interest in evaluating collections. Science journals do not follow traditional economic models (Schoch 1994). Since the price of a journal does not necessarily imply value of the journal (c.f., Bensman 1996; Christensen 1992; Nisonger 1993; Schwartz 1998), librarians have some hope of canceling journals which cost more than they are worth (Schwartz 1998). Studies have shown that price is strongly correlated with publisher type (Bensman 1996; Christensen 1992), journal size/output

(Bensman 1996; Nisonger 1993), language (Christensen 1992), and number of subscribers (Bensman 1996).

The theory that price is not correlated with value helps only slightly. It is now the job of the collection manager to determine which journals do not match worth with cost. But what does "worth" or "value" mean? There are many methods of evaluating journal quality in relation to its cost; some are objective and others consider the subjective "user interests, personal favoritism, and collection inertia" which may be the real determinants of library holdings (Youngen 1999).

Unfortunately, very few studies consider the implications of their methods in terms of the measurements taken. A collection's value may be inherently tied to the measure used to evaluate it. Librarians need to take care when selecting which method to undertake in relation to the type of collection desired. Libraries primarily supporting research and publication activities inherently value certain journal types more highly than teaching libraries.

A few things must be kept in mind when canceling or withdrawing journals. First, science is generally considered a journal-dependent field. While journals are used far more than monographs or other materials, one should not stop buying books to make up for a lack of journals funding. Second, all measures of journal value seem to follow the "Matthew Effect" (Bensman 1996; Youngen 1999). This effect gets its name from the Gospel of Matthew 13:12, "For to those who have, more will be given, and they will have an abundance; but from those who have nothing, even what they have will be taken away." High value journals tend to attract more attention while low-value journals get cancelled by libraries, dropped by individuals, and fall out of use. Statistical analyses of such patterns may be difficult, since they do not fit requirements for the normal distribution. Third, "saving money cannot be the goal in science serial cancellations…the goal is to determine each year what combination of (fewer) journals to purchase while spending approximately the same budget allocation" (Chrzastowski 1997). Fourth, any study measures only the past or, at best, current value of the item. Future value is unknown (Butkovich 1996). This means that decisions need to be weighed carefully using the best information and method for the situation.

No one method has been established as the best for academic science libraries. This study will compare three methods of study, reshelving data, citation analysis, and the Institute for Scientific Information Impact Factor (ISI IF), to determine how much practical difference exists among them. Do these methods return significantly different collections, that is, do they really measure different aspects of value, or do journals have inherent value? In order to have any hope of managing the best collection possible in our libraries, we must know what effect our collection tools have on decisions, and whether one method is interchangeable with another.

Literature Review

Local methods of determining value: Use Studies

A popular way to rationalize collections decisions regarding journal titles is by measuring individual journals' usefulness. Hard data on library usage helps in getting faculty buy-in on a cancellation project. Use statistics for interlibrary loan requests, off-campus holdings, and journals in other branches may justify additional funding for adding potentially valuable serials to the collection. As Chrzastowski and Olesko state, "Use data and cost-use ratios can demonstrate how cost-effective a high-use chemistry serial collection can be" (1997, p. 101). Use statistics are usually collected in time of crisis, especially when the collection must be cut due to budgetary restrictions or must be weeded for space on the shelves. Knowing which journals will not be missed is a big help in the librarian's decision-making process. In addition, use studies may help to justify previous cancellations as well as demonstrate which user populations have the heaviest library use (Butkovich 1996). Cancellations are often made based on a threshold figure of acceptable cost per use, which varies for each library.

The variety of methods for determining "use" of a collection is astounding. They generally fall into two categories: reshelving/circulation of volumes or citation analysis on a local scale. Several studies in each category are of particular note, as are a few studies that do not fall into either group, but still purport to study "use". Most of these studies describe a journal's value as a ratio of use to subscription cost. Butkovich (1996, p. 359) broadly defines use studies as "any method of data retrieval that answers, or helps to answer, basic questions regarding the acquisition, storage, and retention of materials in the collection."

It is difficult to compare results of use studies across institutions or even among branches of a single library system, since journal use varies by discipline and user base (Butkovich 1996; Kreider 1998). Studies often consider the usage patterns of only one or two segments of the library's market without looking at the entire picture (Butkovich 1996). Citation analyses usually do not measure the activities of teaching staff or students, and may count "uses" which involve non-library materials. Reshelving and circulation counts may not take into account users who reshelve materials, multiple uses of a single volume in one day, people who neglect to check out materials they remove from the library, users who access library materials remotely (including over the Internet) or who own personal copies of journal subscriptions (Butkovich 1996; Hill et al. 1999; Kreider 1998; Schoch 1994), and so on. The library might not care about personal copy use; if patrons do not need the library to own a journal, why should the library spend the money to do so? On the other hand, as will be discussed below, the fact that a person or institution chooses to purchase a title is yet another measure of its value (Bensman 1996). Use studies also tend to ignore the type of use to which each journal is put (Butkovich 1996).

Reshelving and Circulation Studies

Measuring direct use through reshelving and circulation counts is a very popular method of determining collection value. Unlike other methods, such studies measure the use of all types of patrons. Undergraduates and interdisciplinary researchers are usually left out of other study types, yet they are often the heaviest library users in academic settings (Dess 1997). Direct use studies usually do not address the effects that online journals have on reshelving/circulation of their print counterparts. As more and more scientists access journals online, it may appear that high-use titles are dropping in value because their reshelving statistics are falling. In reality, journals with electronic forms may be more valuable to the library because they are more accessible.

Reshelving studies vary considerably. They generally follow either the "sweep" or "check off" methods. In the sweep method, users are asked to leave used volumes in a designated place. In the check-off method, users are asked to make a tick mark on a sheet every time they use a volume. Both of these methods are subject to undercounting, largely for reasons mentioned above. Most studies last only a year, although several cover up to ten years at a time.

The 1997 paper by Chrzastowski and Olesko summarizes findings from a reshelving study at the University of Illinois-Urbana Champaign Chemistry Library. Data was collected in 1988, 1993, and 1996 at the same time as major cancellation projects. Although the study had some major methodological problems (particularly in terms of fluctuations in staffing and high user reshelving), the authors were able to identify patterns in use of the collection. They found that while the ratio of bound to unbound volumes rose, the ratio of bound journal usage to unbound journal usage decreased. That is, unbound journals are used in preference to bound ones, even though there are ever more bound journals. Even with successive cancellations, ILL requests did not significantly increase. However, in the authors' opinion, "There is no further room for canceling chemistry journals without seriously undermining the usefulness of the collection." At this point in their study, all of the easy decisions had been made. The major strength of this study is its longitudinal nature; journal use is counted over time, rather than in a snapshot image. This helps determine long-range effects of the collection, not just immediate usage.

Hill, Madarash-Hill, and Hayes studied reshelving statistics from a ten-year period (Hill et al. 1999). In their study of the Science & Technology Library at the University of Akron, volumes were marked with a colored sticker the first time they were shelved in a year. Subsequent uses were noted on the inside cover. This study collected information not only on title usage, but also on when during the study time they were used. This study found that 80% of uses were of only 24% of titles in the collection, close to the "80:20 rule". These uses were also concentrated in a few disciplines (polymer science, nursing, engineering, and chemistry). Use varied over time, both in volume and in particular titles/disciplines favored. Hill et al. concluded that the high-use disciplines are underfunded relative to their overall use. The authors suggested restructuring budgets to reflect the amount of use in each discipline. As with the previous study, the inclusion of longitudinal data supports the overall conclusions of the paper very strongly. However, it is not clear how the authors of this study view the value of the collection; underused areas of the collection are "overfunded" for their use, rather than "undervalued". In addition, a ten-year study is well out of the abilities of librarians concerned about one year's budget. While the length of the study strengthens its conclusions, it is not very likely to be replicated any time soon. Ongoing studies evaluated on a yearly basis in the context of past years are more feasible for most small libraries. Such studies return results quickly, yet also get the historical context and trends that make the long-term study so useful to the field.

In order to avoid the pitfall of canceling a high cost/use title that may be of great value to one subspecialty, most studies advocate clearing the cancellation list with the faculty. Charles Schwartz takes a different tack: compare the list of high cost/use titles with the low use titles (1998). The intersection of these lists is the set of most underused and overpriced titles. Perceptions of "high cost/use" and "low use" vary from library to library. This method avoids additional work on the part of the researcher by using the shelving data twice in the consideration. However, Schwartz may run into political trouble by not consulting his users, and could cancel the last easily available subscription to a low-use title. Since this study covered a relatively short period of time, it is possible that the low-use titles could be useful in the future because of a shift in the department's research or teaching focus.

Another way of validating results is to compare several studies using the same dataset (collection) with each other. Blecic (1999) compared in-house use, circulation, and faculty citations for the University of Illinois at Chicago Library of the Health Sciences. She found that all three indices return approximately equal rankings of journals, which is heartening, especially for librarians only able to perform one of the three at a time. However, her methodology is very flawed for all three measures. The reshelving data covers only 59 days out of two years; she counted journals once a week, not counting Decembers, from 1992-1994. While sampling is often a good idea, especially given the large amount of reshelving to be done in this library, it was not well-planned here. This methodology does not capture periodic changes in library use, especially effects of winter holidays. The citation analysis was incredibly complicated and dropped out non-faculty (this problem is discussed below). It is acknowledged in the paper that scientists tend not to check out journals, but rather to photocopy individual articles inside the library. This study needs to be replicated with stronger methodological rigor in order to verify the findings in a more trustworthy context.

Local Citation Analysis

Since journals are so crucial to scientific communication, measuring published use (articles and citations) can be useful for research libraries. According to Chrzastowski (1997), scientists cite journals more frequently than scholars in the social sciences or humanities do. In addition, data show that the most citation-happy scientists are chemists. 93.6% of chemists' citations come from journals. On the one hand, citation analyses can be done electronically, making them far less labor-intensive than reshelving studies. On the other, limitations of the database used to collect citation information (most often the ISI Science Citation Index or Current Contents) may skew results away from possibly useful, but not indexed, journals. Citation analysis may be done on either a local or global scale.

Local citation analysis has the major advantage of finding out which journals faculty, staff, and graduate students use for research and publishing (Dess 1997). However, such studies do not count non-cited use of journals, such as for browsing or continuing education, or use by nonpublishing students, staff, and faculty (Hill et al. 1999; Kreider 1998; Schoch 1994). Nisonger notes, "Some journals offer value for teaching and current awareness – purposes not measured by citation data. The quality of individual articles within a journal may vary" (1993). It is extremely hard to divorce individual article quality from journal quality in these studies, however, unless one measures each article as a unit unto itself. Such a study could be interesting but not particularly useful for collection management decisions.

Citation analysis is seen as a reinforcement for other collections studies. Journals with high citation counts tend to be the ones most often reshelved. Since most faculty tend to publish in and cite from only a few journals, there may be a large number of journals with no data points for study. These journals are not necessarily not used; they are just not cited (Dess 1997). In the 1997 study by Dess, only five journals out of 97 had both zero citations and zero reshelvings. Dess speculates that this lack of correlation between the two measures is a reflection of the different user populations studied, and the effects of prolific specialists or very popular papers and review articles. This study of all Rutgers University science articles covering just over two years found that faculty only published in 30% of the titles held by the Science Research Libraries, and cited from only 62% of available titles. The remaining 60 titles (roughly 30%) were not used at all in publishing.

Kreider (1998) supports these findings with her study of local and global citations at the University of British Columbia Library in science and social science fields. She notes that her data is not helpful for gauging interdisciplinary studies. This is a major problem with most use studies, and ties into the concern of who is using journals for what. The Kreider and Dess studies each have much smaller sample sizes than reshelving studies, which partially accounts for the large number of zero citation journals. This, coupled with the lack of interdisciplinary citations, weakens their findings, as they have lost a large amount of data that could possibly alter their conclusions.

Other Local Use Studies

While most local use studies involve either reshelving or citation counts, a few researchers have tried novel approaches to finding collection strengths and weaknesses. Butkovich describes a number of “non-use” studies that only determine whether a volume has been reshelved during a period of time (1996). These studies may be useful for determining the density of use by title and volume, but they do not measure relative importance of titles. This type of study is only useful for finding the zero-use titles for cancel or withdrawal.

Youngen (1999) suggests that librarians consider faculty interests when they judge their collections' relevance. To do this for the Physics/Astronomy Library at the University of Illinois at Urbana-Champaign, Youngen analyzed references collected through the library’s current awareness/selective dissemination of information (SDI) program for 1997.

As expected, this study supports findings from previous studies: most "hits" come from a few journals (81% from 16% of titles), and some journals receive little or no use (57% of titles had only 6% of the hits). The study defines a core collection of journals to keep rather than identifies titles for cancellation or acquisition. As with local citation studies, this study had a very small dataset drawn from the most elite patrons (faculty able to set up an SDI). Interestingly, Youngen claims that this method helps determine "the usefulness and relevancy of the journal collection" but that it "is not a measure of quality of journals or their articles." This conclusion is, to my mind, contradictory.

In her 1996 review of user studies, Butkovich mentions a number of alternatives used in large humanities and social science libraries. Some of these are photocopier logs, requests for in-house article copies, requests for items in storage, and patron observation by both obtrusive and unobtrusive means. The last method is very expensive and time-consuming. It is also difficult because observers may not be able to determine which titles are being used, and may frighten off patrons. Watching user habits in the stacks or asking them survey questions does produce some very interesting results. For instance, two studies found that patrons reshelve more than 80% of the volumes that they use (Ross 1983, cited in Butkovich 1996; Wynne and Clarke 2000).

Local methods of determining value: User Surveys

One of the best ways to find out what aspects of library service are most useful and/or important to patrons is to ask them. Libraries use surveys to evaluate all aspects of their programs and products, including the strengths and weaknesses of the collection. While statistics may provide an objective picture of a collection's value, Bensman argues that these measures must be judged as they correlate with the subjective views of users, because "value is postulated as a construct of the human mind" (1996). While many of the studies base collection management decisions on objective statistics, they all recommend consulting at least the faculty before a final decision is made. This both forestalls problems with primary users and improves faculty-library relations by involving them in the life of the library.

As with objective measurements, subjective surveys have a downside. It is clear that people are influenced by a number of factors when they state their opinion on a matter (Butkovich 1996). An entire branch of the marketing literature is devoted to the disjunct between a respondent's stated preference and his action in the store. A review of such studies is beyond the scope of this paper; a good overview is in Bettman (1998). Opinions themselves may be influenced by factors other than the value of the information contained in the journal. Qualities such as electronic versus paper access (Hawbaker & Wagner 1996) and journal size have been shown to influence ideas of worth (Bensman 1996), as have the social status of authors and an estimate of the respondent's ability to publish work in the journal (Wilder 2000).

Most user preference surveys involve asking departmental faculty to rate journals. At what time they are asked, and which journals they rate, varies from study to study (Bensman 1996; Dess 1997). Most offer a list of journals available in the library, but others ask respondents to write down all journals that they find useful, regardless of whether the library subscribes to them. These studies do not measure use, but rather faculty perception of use. Asking only the departmental faculty is also problematic because it does not consider multidisciplinary value in the collection, value to collaborative universities, or use by non-faculty (Bensman 1996; Dess 1997).

The correlation of faculty-generated scores with objective scores also varies by study (Dess 1997). This is not particularly cheering, since it is hoped that each evaluation method will return similar results. It may be that faculty "value specialized titles that have little day-to-day practical value to the collection" and to which they own personal subscriptions, lessening the library's need to purchase more (Hill et al. 1999). Bensman found that faculty score correlates with a global measure which he calls "total citations", but does not correlate with the closely related "Impact Factor" (1996). These measures are discussed below. Dess (1997) found a relationship between faculty score and faculty citations, but not between faculty score and reshelving counts.

A much more involved way of involving users in collection management decisions is to do a needs analysis of the entire user population. Stankus and Littlefield suggest that librarians choose journals from the ACS core list based not on cost but on the needs of their chemistry departments (1988). These needs analyses include at least three factors: 1: the assortment of specialties and subspecialties in the department, 2: journals which provide basic coverage of the major specialties and formats (including letters and review journals) for undergraduates' coursework and research, and 3: journals which publish papers from small colleges and research institutions, so that students and faculty can see their works in print. To this list can be added the type of access to the journal (print vs. electronic). Such an analysis is incredibly time-consuming for the librarian, but is the most comprehensive means of developing a collection. It may not be feasible to do such an analysis every year at budget time. In the Stankus and Littlefield study, the results increase subscription costs in the short term because more journals are required, which is the opposite result desired by librarians facing the "serials crisis".

Global methods of determining value

It could be argued that every science library should hold certain journals. There may also be some journals without which the world would be better off. A librarian faced with sudden budget cuts may choose to consult global indicators of value in the interest of time and economy rather than undertaking an expensive and slow use study. Since it is clear that price and value do not correlate very strongly with use data, librarians may need to turn to other low-involvement means of determining value or lack thereof (Nisonger 1993). Unfortunately, external and internal data may also not correlate with each other, calling into question the efficacy of basing local decisions on global information.

Citation Analysis and Impact Factors

Most global studies involve citation analysis using the Science Citation Index from the ISI. Nisonger (1993) suggests that librarians care about is the "relationship between journal cost and research quality" and that the global citation record is a good indicator of research quality or value. Like local citation analysis, this method is inexpensive and fast. Global citation analysis falls prey to the same problems as local analysis as well: database limitations, lack of information for other patron groups, lack of information on non-cited use. As with almost all other value measurements, global citation data demonstrates the Matthew Effect, with most citations concentrated in a few journals (Kreider 1998).

The most popular global method of citation analysis is the ISI's Journal Impact Factor (IF) as reported in the *Journal Citation Reports* every year. A journal's Impact Factor is the fraction (number of citations to articles in that journal in the previous 2 years)/(number of articles published in the previous 2 years in that journal) (Garfield 1999). The IF is thus normalized for journal size, so that a large journal does not have an automatic advantage over a small one (Bensman 1996). Garfield originally proposed it in 1995 as a measure of quality of journals in the Science Citation Index (Garfield 1999).

The paradox is that "while impact factors provide a method to make a general comparison of journal titles, they cannot demonstrate the importance of specific titles to a library's clientele" (Hill et al. 1999). Correlation statistics for external and internal measurements vary. Hill et al. (1999) found a low correlation for external and internal citation analyses, as did Kreider (1998) and many of the studies reviewed by Butkovich (1996). Nisonger (1993) reviewed studies that found correlations between impact factors and paper acceptance rate, circulation, OCLC holdings, and the number of federal grants per paper. Other studies found no correlation with local usage or user surveys (ibid.). The problem may be that specialties and subspecialties in the library's user population may not be in line with the field as a whole (Butkovich 1996). For these reasons, Bensman (1996) rejected the impact factor "as a valid measure of scientific value." Garfield is now concerned that the IF is being overused both by librarians and by faculty choosing in which journals to publish (Garfield 1999). In addition, the IF is dependent on the limited sample size of the ISI's database. This problem is most difficult for journals appearing in two forms, one of which is an English translation. Marx (2001) determined that the IF for the German journal *Angewandte Chemie* is inaccurate in the 1998 *Journal Citation Reports* because the database only indexes *Angewandte Chemie International Edition* and not the German version.

Even with all of the controversy concerning IF, it is still a popular measure. While some studies consider journal lists ranked by IF (Altmann & Gorman 1998), most consider the further ratio cost/IF. Christensen considered cost in terms of cents per thousand characters in an effort to further normalize the measure of cost effectiveness for size (1992). He found that arranging journals by cost/IF resulted in a split along publisher type lines:

society journals were four times as cost effective as were commercially published titles. In addition, translated journals were both most costly and least cost-effective. In reality, dividing the journals collection by publisher type and locality is more and more infeasible as publishers merge or take over responsibilities for society publications.

Altmann and Gorman (1998) call into question the legitimacy of using IF for yearly collection decisions. They tested the stability of ecology journals' scores over a five-year period and found that, while many journals stayed constant over the short term, most fluctuated more than 20% from year to year. A few titles showed dramatic changes over the five year period; the authors suggest that titles which show marked decline over several years may be candidates for cancellation, but that "reliance on a single year's impact factor is hazardous." They suggest that the cost/total citations may be a more stable measure of value, but note that total citations to a journal may also change from year to year. Nisonger (2000) found that journal self-citation (as opposed to author self-citation) does not greatly influence rankings according to either total citations or impact factor. This is comforting to read, but since few researchers appear concerned about the issue, one wonders why he went to such efforts.

Other global citation measures than the Impact Factor are also used. Three use the ISI's database, and are, unfortunately, very math-intensive. It is unlikely that professional librarians will make the effort to derive the constants and variables needed for these analyses.

Stankus (1992, quoted in Altmann & Gorman 1998) suggested the Relative Impact Factor (RIF). The RIF expresses the ISI's IF of a journal as a percentage of the IF for the leading journal in that discipline. This compares similar journals, rather than all journals across disciplines (Butkovich 1996). Bensman (1996) proposed a variable called "total citations", which he expressed as "the total number of references received by a serial in the database" from articles in the database. This is essentially the IF without its normalizing denominator. Wilder (2000) extends the total citations measure by normalizing it for the journal's citation half-life, as determined by ISI, to create the Estimated Annual Citation Rate (EACR). Wilder argues that this measure can help libraries create a subject-specific core title list by ranking titles by the EACR.

Alvarez and Pulgarin (1996) suggest the Rasch Impact Factor as a means of showing "the relevance of each journal". This factor is a latent variable defined by four factors: 1: citations in year n+2 for articles from year n, 2: citations in year n+2 for articles from year n+1, 3: number of articles published in year n, and 4: number of articles published in year n+1. The authors claim that this mathematically complicated formula avoids the problem of ratios in the ISI's impact factor. With the ISI's IF, journals with a (low citation rate)/(few articles) equal ones with a (high citation rate)/(many articles), an obvious problem. It would be useful to discriminate between small, low use journals and large, high use journals. However, few librarians will be willing to derive the various factors for each journal in their collections, making this method nice in theory but impractical in real life.

Implications for collection management

The general conclusion of each of the reviewed studies is that it is increasingly important to use several methods at once, including reshelving counts, citation analysis, and user surveys (Butkovich 1996; Hill et al. 1999; Kreider 1998; Schoch 1994). These surveys often, but do not always, find correlations between different value measurements.

These studies have definite methodological and theoretical problems. Choosing the length of time to study and fully training study staff and participants in the goals of the study will greatly enhance results (Chrzastowski & Olesko 1997; Hill et al. 1999). Chrzastowski and Olesko further recommend making studies simpler, counting "every measurable library service", and doing multiple studies over time to get longitudinal data (Chrzastowski & Olesko 1997). The authors do not suggest how to create a simple study that covers every service.

Librarians must be aware of what they are measuring in order to be able to analyze their data. It may be inappropriate to compare statistics across disciplines or even across publication formats. Review journals and conference proceedings, for instance, may get much use from students or faculty on the fringes of disciplines, skewing the results towards digested information and away from primary literature (Youngen 1999). Retrieved information is not always relevant information. Some use may not reflect value in the collection, but rather a shotgun approach to research (ibid.). The good news is that what the study measures may not actually impact the results. If Wilder (2000) is correct, and journals have an inherent value based on more criteria than any one study can count, the method used to create the collection may not have a strong effect on the nature of the end result.

Research Methodology

This study focuses on the year 2000 current journal collection in the Paul M. Gross Chemistry Library at Duke University ("the Chemistry Library"). This collection includes 265 titles in a variety of chemical subfields, notably analytical, general, organic, and physical chemistry. The library is heavily used by the Chemistry Department for both laboratory research and classroom support. The journals collection accounts for the majority of the budget, physical space, and regular usage in the collection; the most used section after journals is the reference collection. There are approximately 20 tenure-track faculty in the department, 200 graduate students (MS and PhD), and 300 undergraduate majors (primarily BA). The library is managed by one full-time librarian, with 1 ¼ paraprofessional staff and 10-15 student assistants during the academic year.

In recent years the budget for periodicals has not kept pace with inflation, so the librarian has had to make cancellations. In an effort to make more informed decisions, an ongoing reshelving study began in the summer of 1999. Results from the 1999 phase of the study were the primary source of input for scheduled cancellations of 2001 subscriptions. This study uses the Duke Chemistry library largely because of the existence of this historical data. In addition, the library has a representative sampling of the major scholarly journals and is very well-respected among the faculty, a level of prestige which the library would like to preserve at almost any cost.

This study compares three collection analysis methods in the context of the Duke Chemistry Library. The author did not interview or survey users for several reasons, mainly a lack of time and a desire to look at the quantitative analysis methods. It is expected that most libraries consult the faculty for confirmation of candidates for cancellation identified using other methods. The assumption is that few libraries regularly survey their users to determine journal value directly. In addition, measures of cost, publisher status, and/or country of publication are not considered in this study. With the increasing number of package plans and society journals being published by multi-national commercial publishers, it is felt that cost, publisher, and location are fast becoming too complex of variables for such a relatively simple study as this one.

Formation of the Data Set

In order to compensate for the effects of name changes, mergers, and splits in titles, the list of journals was adapted by combining and/or dividing values for each of the data collection methods. Values for journals with name changes were added together, as are values for titles formed by mergers of older titles. Divisions in titles (i.e., when one title splits into two uniquely named journals or into subparts) combine the value for the new title with a portion of the value for the old title, split equally among the new titles. This method proved to be straightforward for all titles except for three: the *European Journal of Organic Chemistry*, the *European Journal of Inorganic Chemistry*, and *Physical Chemistry Chemical Physics*. These three titles are mergers of portions of journals formerly published by independent country-level chemistry associations in Europe, who now appear to be publishing jointly via the European Union. Several titles have morphed into two of the above titles, making record-keeping rather complex.

Once the list was corrected for these title changes, the titles which are no longer being received at the Chemistry Library because of cancellations and publication ceases were deleted from the final data set. This reduced the size of the data set from 445 unique titles to 265 unique titles, which greatly assisted in the processing of the data. However, data was collected for each title individually, without regard to title change, cancellation, or currency of publication. Because of this, it will be possible to revisit the data for other purposes if so desired.

Study Methods

The first method used is the analysis of reshelving data. The Chemistry Library employs the "sweep" process for data collection, in which books are collected from tables, carts, and the copier room before being counted. Each reshelving of a volume is counted by title. These counts are tallied at the end of each month to get monthly aggregate data, and then are combined at the end of the calendar year. This study did not use the 1999 data, but focused solely on 2000, because it is difficult to limit a citation analysis to one-half of a year. Had the Duke Chemistry Library started collecting these statistics earlier, this would have been a multi-year study. Such a study may help iron out fluctuations due to faculty and graduate student changes that could overly influence a single-year study. It would be interesting to repeat this study in a few years and see what differences arise.

While clearly posted signs request that patrons not reshelve journals, many still do. It is unclear how often users do this, and measuring self-reshelving would require an enormous output of energy and time which was not found necessary for this study. This study used usage ranks, rather than gross amount of use, so it should not be particularly influenced by the possibly high error rate due to self-reshelving. While it is possible that a heavily-used journal will not appear so in the ranks because the only person who uses it always reshelves after use, there was no way of measuring or preventing such self-reshelving beyond posting notices and reminding researchers in person. Several of the researchers were more amenable to not self-reshelving once they found out the statistics generated were "real data" for this study, not "just for library use." Librarians may need to look into alternative means of justifying reshelving studies to their faculty to minimize error in the data. Since students do most of the data collection, it was felt that the counting method should be as simple as possible. Thus, usage was not broken down by publication year, which would otherwise be very valuable both for this study and others.

The second method is citation analysis. While most studies focus only on the citation and publication practices of departmental faculty, this one looks at all scientists at Duke, whether they are in the Chemistry Department or not. This also includes graduate student work, which is otherwise often lost in analyses. By including multiple levels of scholarship and interdisciplinary studies, the study avoids some of the problems of earlier studies in which researchers focus too narrowly on one field or set of people. After all, graduate students and non-chemists use the library, so their use shows up in the reshelving data. The citation analysis used the ISI's Science Citation Index via the Web of Science and the SciSearch datafile (34) in Dialog Classic. First, all papers written by Duke affiliates that were published in Chemistry Library journals in the year 2000 were analyzed using the Web of Science. Then, citations to such journals by Duke affiliates in any paper written in the year 2000 were found and analyzed via the SciSearch file in Dialog Classic. Dialog has search features that made this process far less burdensome than it could have been, but it still involved a lot of time to gather data for all of the journals.

Finally, the two studies are compared to the ranked list of journals according to the ISI's Impact Factor (IF), as found in the Journal Citation Report. Again, this method includes interdisciplinary and non-faculty work. Unfortunately, the IF is usually two years behind the current year, so there was no matching year 2000 data for this analysis. The year 1998 data, which was available in February of 2001, was used instead. The Journal Citation Reports are available at the UNC Health Sciences Library on microfiche, and were relatively easy to transcribe into the format needed for this study. While the ISI indexes most journals in chemistry for the Journal Citation Reports, it does not cover all of them. Some journals held by the Duke Chemistry Library are not be in the SCI database, and thus cannot be used for the purposes of this research. Of all the methods, this one is expected to be the most different. While the other two methods measure usage in a particular situation, the IF is a global measure. Research and teaching libraries may have significantly different needs, and thus different use patterns, than corporate or other special libraries. However, this method may also be the easiest for librarians to use, since it requires very little time commitment for study. If the IF closely correlates with reshelving and citation data, that would indeed be significant for this study.

The author expects usage, measured either by reshelving or citations, to fit the 80:20 rule, and thus to fail tests for statistical normality. The Spearman coefficient of rank order is used to find statistical correlations between the rankings of each pair of methods. The Spearman test analyzes a data set using rank placement, not raw data. Results from the Spearman coefficient ρ represents the amount of agreement in ranking between each pair of methods along a scale from –1 (no agreement) to 1 (complete agreement). The test indicates whether the methods return similar collection results or not, and indicates which methods are most similar in results to each other. It is hypothesized that the reshelving and citation analysis methods will be more similar to each other than either is to the Impact Factor ranking, since they measure local, rather than global, value. The citation analysis will most likely be more similar to the IF ranking than the reshelving ranking will be, since the citation analysis and the IF use similar methodologies. It is expected that the IF and reshelving rankings will be most dissimilar, since they examine different populations using disparate methods of analysis.

Definitions

Chemistry library journal: A journal title held in the collection of the Duke University Chemistry Library.

Non-chemistry library journal: A journal title not held in the collection of the Duke University Chemistry Library.

Journal title: A serial standardized for all of its title changes, merges, and divisions over the course of its publication history.

Spearman correlation coefficient ρ *(rho):* A nonparametric, statistical measure of the correlation of two ranked lists. Values for ρ range from –1 to 1, where –1 is a perfectly inverse correlation, 1 is a perfect correlation, and 0 is no correlation at all.

A use: An instance of a journal title being counted as reshelved or cited.

Analysis of Individual Methods

Reshelving Study

For a relatively small, departmental library, the Duke University Chemistry Library seems to use print journals rather heavily. Over the twelve-month period of this study, the library shelved 11156 journal volumes, for an average of 31 uses per day and 42 uses per title. This occurred even though approximately half of current chemistry subscriptions are also held in electronic format.

As expected, reshelving usage is concentrated in relatively few journals, with exactly half of the titles receiving nine or fewer counts over the twelve month period of the study. What is most surprising, however, is just how perfectly this data fits the "80:20 rule"; 20.3% of titles (54 out of 266) account for 79.1% of uses (8824 of 11156). The twenty most popular titles account for 57.9% of use, and the top ten titles carry 46.6% of usage in the library. Even more significant is that the most heavily used title, the *Journal of the American Chemical Society* (*JACS*), had 1462 measured uses in 2000, which was 13.1% of total uses for the year, or approximately 4 uses each day. It is interesting that relatively few journals (18 out of 266) were not reshelved at all in 2000. This is very good news for the library, as it shows that most of the collection is touched at some point or another.

The most popular journals tend to be in general chemistry and biochemistry/organic chemistry. This may be because researchers on the fringes of chemistry, including but not limited to scientists at the Levine Science Research Center (environmental science) and in the Department of Biomedical Engineering, may use general and biochemical journals while other subfields are not as widely applicable to nonchemists. Top journals tend to be published by one of the two major chemistry societies, the American Chemical Society (ACS) or the Royal Society of Chemistry (RSC). These titles include *JACS*, the *Journal of Organic Chemistry*, and *Chemical Reviews*. In addition, a number of general chemistry journals from Europe and Asia are also in the "top twenty", including *Angewandte Chemie*, and the *Bulletin of the Chemical Society of Japan*. Three other significant chemical subjects (analytical, inorganic, and physical chemistry) are represented in these major journals with at least one significant journal, usually the one published by the ACS. Included in these are *Analytical Chemistry*, *Inorganic Chemistry*, and the *Journal of Chemical Physics*. It was expected that heavily used journals would include titles used both by researchers and by students: this theory is supported by the appearance of the *Journal of Chemical Education* (used heavily by undergraduates and teaching faculty) in the top twenty journals.

The journals that do not receive heavy use tend to be published by foreign societies in Asia and Eastern Europe (including India, Ukraine, and Uzbekistan), or duplicate more well-known titles in subfields of chemistry. Usage does not appear to be correlated strongly with age, nor with specific subfield. However, it is nearly impossible to determine whether titles in the low-usage set are being used more heavily in electronic form, since electronic usage data was not available for this study. It would seem advantageous to the library to find some way of getting these lower valued journals in electronic form only, to save storage and processing costs for the print versions. It is also likely that some of these journals received more use than is recorded in this study because of patron reshelving.

Citation Analysis

The citation analysis found that Duke affiliated researchers cited journals in this study 21,365 times in 479 articles. These articles appeared in 257 different journals, only 45 of which are themselves held by the chemistry library. The majority of articles with citations to chemistry library journals appear in biomedical journals and biochemistry journals, with the most articles in a single journal appearing in the *Journal of Biological Chemistry*. Departments listed for authors include chemistry, physics, engineering, the Nicholas School of the Environment, and the Medical School. This clearly shows the interdisciplinary power of chemistry journals in scientific research; had the study been restricted to papers written by chemistry faculty alone, many citations from non-chemists would have been lost, and, as will be shown, journals important for their cross-borders appeal would have been undervalued.

Articles in chemistry library journals account for only 17.5% of the total articles citing chemistry library journals, but for 67.9% of the citations to chemistry library journals. On average, chemistry library journals have 19.5 chemistry citations per article. In contrast, non-chemistry library journals in this study cite chemistry library journals only 3.05 times per article. It is understandable that the major source of citations to a subject's primary literature will come from that literature. It is surprising that nearly one-third of citations come from outside the primary chemistry literature. The citation analysis ranking is also strongly correlated to the ranking from chemistry library journals only (ρ=0.915), with a weaker correlation to non-chemistry library journals (ρ=0.760). There is an even weaker correlation, but still a significant one at the 0.01 level, between the chemistry and non-chemistry rankings (ρ=0.523), showing that the relative disagreement between the two sets is not significant.

In addition, it is important to note that while this method of collection analysis does capture non-print usage, it is impossible to determine whether articles were read from journals held by the Chemistry Library, or whether they came from other libraries, personal subscriptions, or reprints from the authors themselves. It is also possible that researchers cited an article without actually reading it, or that articles were cited as negative examples of a point. What kind of use, and from whence the material came, cannot be determined by citation analysis.

As with the reshelving data, citations are concentrated in a relatively small number of journals, with the majority receiving few, if any, citations over the course of one year. 80.2% of citations is found in only 16.6% of journals, showing a greater concentration of use in fewer titles than with the reshelving study. In addition, more than half of the journals (143) in this citation analysis had two or fewer cites over the course of the year. 84 journals have no citations at all; this is 31.7% of the total data set. This emphasis on a select few for citation purposes demonstrates one of the weaknesses of citation analysis for collection management purposes. While it is clear which journals have high value, it is difficult to distinguish which journals have low but some value (and should therefore not be cancelled).

Data for the two different sets of journals, chemistry versus non-chemistry, shows some striking patterns as well. In general, titles cited by chemistry library journals tend to emphasize fields in general chemistry and in areas not pertaining to medicine. Titles cited by the non-chemistry library journals tend to be in biochemistry/organic, environmental, medical, and analytical chemistry fields.

Whereas the top ten journals are the same for the chemistry and the total citations rankings, the order changes somewhat from the former to the latter. In particular, *Biochemistry* moves from a distant second to the *Journal of the American Chemical Society* (*JACS*), with 184 and 415 citations respectively in the chemistry library journals count, to a clear first, with 602 and 509 citations respectively in the total citations count. This is because *Biochemistry* is by far the most heavily cited chemistry library journal among non-chemistry papers, with 418 citations. The other title that moves position in the top ten is *Analytical Chemistry*, possibly because of citations to methods used by environmental chemists and engineers.

The next ten titles are somewhat more volatile. The two titles ranked 19th and 20th in the chemistry library journals count, *Analytical Chimica Acta* and *Organometallics*, are pushed out by *Bioconjugate Chemistry* and *Environmental Science and Technology*. Again, this shows the interdisciplinary nature of the latter two journals and the power outsider researchers can wield over usage. In general, overall ranking of journals can be predicted by rank in the chemistry library journal citation rank, but not always. Notable exceptions include the *Journal of Chromatography B*, the *Journal of Colloid and Interface Science*, *Chemical Research in Toxicology*, and the *Journal of Magnetic Resonance (JMR)*, and, of course, *Biochemistry*. This last journal received all 23 of its citations from non-chemistry library journals in 2000. The heavy interdisciplinary usage of these five titles suggests that they might be better located in the Biological and Environmental Sciences or Medical Center Libraries. *Biochemistry, Chemical Research in Toxicology* and the *Journal of Colloid and Interface Science* are duplicated in the Medical Center Library, and may be good candidates for cancellation at Chemistry.

As expected, titles emphasized by high citation counts tend to focus on research, whereas those with few citations tend to be newsletters or deal with less prescient work. The *Journal of Chemical Education*, which had been near the top of the list for reshelving, received only five citations in 2000, all of which were from chemistry library journals. Infrequently-cited journals include news journals and magazines, foreign society publications (other than the ACS and the RSC), and other low-research interest publications such as *Die Pharmazie*. There are also a number of journals that are trying to compete with better-known ACS publications for some subfields, including a myriad of (seemingly superfluous) organic and inorganic chemistry journals.

Impact Factor

The Impact Factor (IF) study is severely hampered by the ISI's inability to index all journals in chemistry, including some that might return interesting results. Out of the 265 total journals, only 223 are included in the 1998 *Journal Citation Reports*. This excludes 15.8% of chemistry library journals from the study. Of the 42 titles that have no data, only six are new publications beginning in 1998 or later, explaining their absence from the dataset. Seventeen of the titles are non-ACS or RSC society publications, which may also account for their exclusion. However, the remaining half of the non-indexed titles have no obvious reason for being left out of the data set. Of these, five have significant usage according to the reshelving and citation analyses. These are the *Russian Journal of Organic Chemistry* (with 39 reshelvings, for a rank of 60), *Organic Letters* (with 29 reshelvings, for a rank of 75, and with seven citations, for a rank of 69), the *Journal of Peptide Science* (23 reshelvings, rank of 80), the *Russian Journal of Bioorganic Chemistry* (19 reshelvings, rank of 94), and the *Journal of Fluorescence* (14 reshelvings, rank of 110; five citations, rank of 81). The exclusion of these relatively popular titles implies that it is impossible to use IF to determine relative value of the remaining journals with any measure of certainty. In addition, the fact that a title is or is not indexed by the Institute for Scientific Information does not appear to be a strong indicator of usage as measured by either of the other two methods.

In addition, the IF data has some surprising differences from the other two studies. Some journals have extremely high values, such as *Chemical Reviews*, that do not seem to mesh with data from the other two studies. It is possible that one or two papers in *Chemical Reviews* from 1996-1997 had a strong, immediate impact on the field of chemistry. This may account for the high number of citations relative to the number of articles published in the year. Studies have shown that a journal's impact factor may fluctuate significantly from year to year, calling into question the efficacy of using one year's ranking for collection decisions. It may be more useful to examine average IF statistics from a group of years, in an effort to limit the effect of such high- and low-impact articles(Altmann and Gorman 1998).

Another possible explanation for the surprising data may be linked to the formula for calculating the Impact Factor. ISI normalizes citations to articles by the number of articles published. This is understandable, since it means that large journals with many articles in a year are considered on the same scale as smaller journals with only a few articles every year. The ISI defines an article very narrowly, leaving out such citable items as editorials, news items, and letters. However, citations are counted regardless of what type of item is being cited, so it is possible that some journals will appear to have a higher IF than is warranted.

The results from this study show how strongly method can affect results. The top ten titles according to Impact Factor tend to have relatively poor ranks in the other two studies, including *Surface Science Reports* (reshelving rank 213, citation analysis rank 140, IF rank 3), the *Quarterly Reviews of Biophysics* (reshelving rank 173 citation analysis rank 108, IF rank 4), and *Chemistry: A European Journal* (reshelving rank 142, citation analysis rank 140, IF rank 10). Of these top ten journals, only one, the *Journal of the American Chemical Society (JACS)*, is also a top journal according to the other methods. *JACS* is at rank 9 according to the IF, whereas it is at rank 1 and 2 in the reshelving and citation analyses, respectively. In order to account for the top ten journals in the other two methods, one must include all journals to rank 66 in the IF analysis.

It is clear that the Impact Factor analysis has serious flaws as a collection management tool. Not only are significant chemistry library journals excluded from the study, but the journals that are included are very sensitive to time factors and to effects from the functional design of the method. This method would best be used as a confirmatory tool, perhaps more to buy new titles rather than to cancel current subscriptions.

Comparisons Between Methods: Correlation and Inspection

Ranked lists of journal titles were compared using the Spearman correlational test. The Spearman coefficient ρ indicates amount of agreement between lists on a scale from –1 (inverse correlation) to 1 (perfect correlation). The stronger the match between two ranked lists, the closer to 1.00 ρ will be. In almost every test of the ranked lists, the reshelving and citation analyses show the strongest correlation. Next strongest correlation is the citation and IF analyses. The weakest correlation is between the reshelving and IF analyses. This pattern holds true for all data manipulations but one, the top 25 titles in the reshelving analysis. In that case, the citation to IF comparison is slightly stronger than the citation to reshelving comparison. The Spearman tests using a null hypothesis of no correlation ($\rho=0$), and significance indicates that the value for ρ is significantly non-zero. In this study, all correlations were significant except for the case of the top 25 titles according to the IF ranking. For those titles, the correlations of the IF rank to the citation and reshelving rankings are not significantly different from 0, meaning there is no significant relationship of the top 25 titles in the IF ranking to those titles' ranks in the other methods' ranking.

Table 1: Comparisons of Analysis Methods using the Spearman Correlation

	Citation vs. Reshelving (ρ/N)	**Citation vs. Impact Factor (ρ/N)**	**Reshelving vs. Impact Factor (ρ/N)**
All data	0.678/265	0.534/223	0.363/223
Top half of titles according to reshelving rank	0.688/130	0.673/121	0.471/121
Top half of titles according to citation rank	0.653/122	0.479/118	0.376/118
Top 25 titles according to reshelving rank[!]	0.598	0.652	0.492
Top 25 titles according to citation rank[!]	0.789	0.614	0.524
Top 25 titles according to IF rank[!]	0.884	0.012*	-0.129*

[!]N=25 * Not significant at the 0.01 level

Only thirteen titles in this study have no reshelving and no citation data; eight of these titles are not included in the IF analysis. With only 3.0% of titles lacking any indicator of usage, the study has a good chance of demonstrating relative use for the remaining titles. Data in this study were examined in a variety of subsets based on the value assigned by each method. The top half of titles are estimated to be a "core collection" which the library would be least likely to cancel. The overlap between the top 130 titles according to the reshelving method and the top 122 titles according to the citation analysis is not exact, which in part accounts for the different ρ values for each method. The top 25 titles according to each method are expected to be the most valued journals according to traits emphasized in the methods. These titles are similar between the reshelving and citation analyses but each are very different from the top 25 titles according to the IF ranking. There are eleven different titles on the reshelving and citation top 25 rankings (44.0%) compared to fifteen different titles between reshelving and IF top titles (60%) and seventeen differences between the citation and IF top 25 (68.0%). The fact that there are so many supposedly "top" journals in chemistry is a little discouraging for those attempting to form a core collection.

Table 2: Top 25 titles in rank order, according to analysis method

Rank	Reshelving Study	Citation Analysis	Impact Factor Study
1	Journal of the American Chemical Society	Biochemistry	Chemical Reviews
2	Journal of Organic Chemistry	Journal of the American Chemical Society	Accounts of Chemical Research
3	Tetrahedron Letters	Analytical Chemistry	Surface Science Reports
4	Tetrahedron	Tetrahedron Letters	Quarterly Reviews of Biophysics
5	Synthesis	Journal of Organic Chemistry	Angewandte Chemie
6	Biochemistry	Journal of Chemical Physics	Journal of Magnetic Resonance
7	Analytical Chemistry	Angewandte Chemie	Chemistry & Biology
8	Chemical Communications	Inorganic Chemistry	Chemical Society Reviews
9	Inorganic Chemistry	Journal of Physical Chemistry A	Journal of the American Chemical Society
10	Angewandte Chemie	Chemical Communications	Aldrichimica Acta
11	Journal of the Chemical Society Perkin Transactions I	Chemical Physics Letters/ Journal of Organometallic Chemistry/ Journal of Physical Chemistry B	Chemistry: A European Journal
12	Chemical Reviews		Advanced Materials
13	Journal of Organometallic Chemistry		Biochemistry
14	Journal of Chemical Physics	Bioconjugate Chemistry	Analytical Chemistry
15	Synthetic Communications	Accounts of Chemical Research	Heterogeneous Chemistry Reviews/ Journal of Biological Inorganic Chemistry
16	Journal of Chemical Education	Langmuir	
17	Journal of Physical Chemistry A/ Journal of Physical Chemistry B	Tetrahedron	Natural Product Reports
18		Environmental Science and Technology	Journal of the Chemical Society Perkin Transactions I
19	Bulletin of the Chemical Society of Japan	International Journal of Quantum Chemistry/ Journal of Computational Chemistry	European Journal of Inorganic Chemistry
20	European Journal of Inorganic Chemistry		Microporous and Mesoporous Materials
21	Macromolecules	Journal of Chromatography B	Journal of Organic Chemistry

22	Chemical and Pharmaceutical Bulletin/ Journal of Colloid and Interface Science	Analytica Chimica Acta/ Carbohydrate Research	Journal of the American Society for Mass Spectrometry
23			Organometallics
24	Helvetica Chimica Acta	Chemical Research in Toxicology/ Journal of Colloid and Interface Science	Macromolecules
25	Canadian Journal of Chemistry		Chemical Communications

Journals with the same rank are divided by a slash (/). Such "ties" are given the average rank of all titles with that shelving/citation/IF value, rounded to the nearest integer.

Table 2 shows both the variability between methods and some patterns of titles with high value regardless of method. Two such titles are the *Journal of the American Chemical Society* and *Angewandte Chemie*, both of which show up in the top ten in all three methods. Other titles, such as the *Journal of Chemical Education*, *Environmental Science & Technology*, and the *Quarterly Reviews of Biophysics* only appear in the top 25 of one method. These titles are of the most interest for this study, as they demonstrate the differences between methods. A citation analysis, whether local or global, will not reflect the strong value of educational and news journals to browsers and students, but a reshelving study will show this value.

Discussion: Implications of the Study

The correlational patterns determined by this study demonstrate that the citation and reshelving analyses return the most similar collections, while the Impact Factor ranking is consistently different from both. This indicates that libraries that rely solely on one of the first two methods of collection analysis may have similar collections in the future. However, the relatively weak correlations among all three indicate that such reliance could have serious consequences for a library. It would be nice if a journal's inherent value to a collection was measured at the same relative level in each method, but that is patently not the case here. However, the fact that method results do correlate to some extent indicates that pairing methods could be very effective in collection development.

In particular, combining the reshelving and local citation analyses could be a very powerful tool for diagnosing relative value of a journal to the particular collection. The relative weight given to each ranking would depend on the individual library's goals. Libraries supporting teaching programs may wish to weight reshelving usage over citation usage; libraries supporting research programs dedicated to publishing research may weight citation usage more heavily.

Both methodologies would have to be trustworthy for this type of combination to work. The increasing push to electronic journals may result in a new value estimation method using publisher-supplied statistics. Until these statistics reach some kind of reporting standard, it will continue to be difficult to compare usage across products.

Publishers and libraries need to work together to determine what types of statistics are most helpful, including not only which journals are accessed, but also when during the day and during the year.

The Impact Factor may be a useful metric for some comparison of titles, but it is severely limited in utility by methodological flaws. Not having data for a significant portion of the collection makes it difficult at best to draw conclusions about relative value, even in comparison with other methods. In addition, the odd effects of time and the estimation formula make the IF a questionable method on which to base collection decisions. It may be that combining Factors from multiple years would help iron out some of the notable wrinkles in year to year variations. Another option, for libraries unwilling to invest the time and effort needed to perform reshelving and citation analyses, might be to try some of the alternate formulae noted above that use ISI citation data but supposedly avoid the pitfalls of uneven indexing.

In the end, however, collection managers already know that theirs is not an easy job. This job is predicated on making decisions, some of which will be very difficult. Why we would expect our diagnostic tools to be easy is unclear. While it would be nice to be able to rely on someone else's data (such as the ISI Impact Factor) to make decisions for us, it would seem that that would be a cop out. Global data simply does not reflect reality on a local level. But it would also be nice if we could use one method exclusively, thus releasing ourselves from the need to keep daily statistics or to plod through a citation database. Doing so ignores the implications that methods have for results, and will result in peaks and valleys among subject and format coverage in the library.

The value of a journal is not inherent. Every journal does not show the same value whatever the method. Since the tool forms the finished product, librarians must choose each tool very carefully, taking into account the purpose and goals of the individual library. Worth is subjective, yet we try to measure it objectively with statistics that only show one or two facets of the complete stone.

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Appendix: Chemistry Library Journal Usage Rankings

This list of usage ranks is arranged in alphabetical order by journal title for the 265 current titles held by the Duke University Chemistry Library in 2000. Titles for which there is no rank in the IF Rank column are not indexed by the Institute for Scientific Information in the 1998 Journal Citation Reports.

Journal Title	Reshelving Study	IF Rank	Citation Analysis
Accounts of Chemical Research 1968-	33	2	15
Acta Chemica Scandinavica 1946-	56	117	81
Acta Crystallographica Section A 1948-	149	61	32
Acta Crystallographica Section B 1968-	90	88	81
Acta Crystallographica Section C 1972- Crystal Structure Communications	96	194	81
Acta Crystallographica Section D 1993-	132	55	34
Acta Universitatis Szegediensis: Acta Physica et Chemica 1974-	249		182
Advanced Materials 1990- Chemical Vapor Deposition	49	12	65
Aldrichimica Acta 1970-	142	10	140
Analyst 1877-	90	72	27
Analytica Chimica Acta 1947-	60	81	22
Analytical Chemistry 1947-	7	14	3
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Chemical Physics Letters 1967-	43	53	11
Chemical Research in Toxicology 1988-	108	27	24
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Journal of Biomolecular Structure and Dynamics 1983-	100	87	81
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Journal of Chemical Information and Computer Sciences 1975-	213	42	182
Journal of Chemical Physics 1933-	14	30	6
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Journal of Chemical Technology and Biotechnology 1979-	183	166	108
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Journal of Electroanalytical Chemistry 1959-	90	77	74
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