



When the Big Deal Gets Smaller: Use of ScienceDirect after Cancellations

Karen Kohn

abstract: This study investigates how article downloads from ScienceDirect changed after Temple University Libraries downsized its all-inclusive Elsevier big deal bundle to a selective custom package. After the libraries lost current-year access to nearly half of Elsevier's active journals, the total downloads from Elsevier journals declined by 16.2 percent over three years. Combined use of still-subscribed and open access journals fell 10.6 percent in the same three years, suggesting that the drop in total use is due not only to the loss of journals but also to factors that would affect the remaining journals, such as the COVID-19 pandemic and a slight decrease in enrollment. Patrons may have substituted articles from still-subscribed and open access journals for those that were canceled, though the data are not conclusive. Reliance on open access appears to have increased.

Introduction

For the last 20 or more years, libraries have often acquired online journal subscriptions as part of a big deal package, which allows them to pay a single price for a bundle that typically includes all the journals from a publisher. Traditionally, the pricing for these packages was based on the amount that the library already spent for print subscriptions, with the cost for the full online package set slightly above each library's existing spending.¹ While pricing might be renegotiated in later years, the initial selling point was that libraries could increase their journal offerings, sometimes dramatically, by paying only a slightly larger subscription cost. Asen Ivanov, Catherine Anne Johnson, and Samuel Cassady describe the initial appeal of the big deal as "a cost-effective solution that allow[ed] libraries to provide electronic access to large lists of journal titles at a fixed price based on an additional charge to the subscription price

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for print journals."² The first such package was offered by Academic Press (now part of Elsevier) in 1996.³ By 2014, almost 90 percent of North American libraries participated in one or more big deal agreements.⁴

In 2001, when big deal arrangements were relatively new, Ken Frazier advised libraries against such packages, due to their lack of flexibility. Libraries who entered big deal

The growth of big deal agreements has been closely followed by a parallel list of libraries exiting them.

agreements, he wrote, would "face the all-or-nothing choice of paying whatever publishers want or giving up an indispensable resource."⁵ While the choice was not always so stark, Frazier was correct that libraries might regret committing to such arrangements. The growth of big deal agreements has been closely followed by a parallel list of libraries exiting them. The first library system to cancel a big deal was the Triangle Research Libraries Network in North Carolina in 2003. Jeffrey Coghill notes that five large library systems, as well as

several small liberal arts colleges, canceled their big deals in that decade.⁶ The Scholarly Publishing and Academic Resources Coalition (SPARC) runs a Big Deal Cancellation Tracker, based on voluntary reporting.⁷ It shows one to three institutions per year reporting cancellations until 2015, when the number rose to five, then to six the following year. Thirteen institutions reported withdrawals in 2017 and the same number in 2019. Some dropped big deal packages from more than one publisher. In 2021, 12 libraries and related organizations reported cancellations.

These cancellations have a nearly universal cause, which is cost. SPARC reports that the prices of big deal packages typically rise by 5 to 15 percent a year, far above inflation,⁸ which has historically averaged 2.23 percent, according to the Consumer Price Index.⁹ The increase in the cost of big deal packages is also higher than the price hikes for individual journal subscriptions. *Library Journal's* Periodicals Price Survey 2021 predicts a 4 percent increase in journal prices for college and university libraries in 2022.¹⁰ Eighteen years after Frazier advised libraries not to sign on to the big deal, an article in *The Chronicle of Higher Education* claimed that a "tipping point" had come for libraries who subscribed to such agreements. The article quoted several leaders of research libraries, such as those of the University of North Carolina at Chapel Hill, the University of Virginia in Charlottesville, and Oregon State University in Corvallis, saying that they needed to make a change.¹¹ Although big deals can be considerably cheaper for smaller institutions,¹² annual price increases mean the cost of big deals can become an issue for them as well.¹³

Temple University Libraries in Philadelphia renegotiated its big deal package with Elsevier in 2018 and shrank its subscription bundle to a smaller set of journals. In the final year of the full big deal, the libraries had access to 3,733 journals, of which 2,160 were active. The smaller package contained 814 subscription journals. An additional 301 journals remained available to Temple patrons open access, resulting in a total of 1,115 titles for which access was unchanged, or roughly half of Elsevier's active journals. The University Libraries lost access to current years of the remaining journals on ScienceDirect, though some back files were available, as were open access articles in hybrid journals.



Having taken a step that many libraries are contemplating, Temple University has received questions from other institutions about how the change affected users. While big deal cancellations have become more common, scant library literature reports on the use of journals after the big deal. What literature exists has thus far focused mainly on post-cancellation increases in interlibrary loan, except for a few surveys or interview studies that investigate other strategies for obtaining articles. This paper, therefore, attempts to begin filling this gap in the literature, as well to answer questions that have come from peers.

This article uses reports from Elsevier, supplemented with Temple's enrollment data, to explore how article downloads changed after the shrinking of the big deal. It looks for patterns that might be expected if the university's patrons exhibited the responses described in the literature. One behavior common to undergraduates, and to a lesser extent faculty, is to use what content is readily available, either through a general Internet search or the library's remaining subscriptions, rather than taking an additional step to obtain an article via interlibrary loan or contacting an author or peer.¹⁴ Using the open Web to find articles is a common strategy for all types of patrons.¹⁵ Since the research for this study did not involve direct contact with users, many parts of user behavior are not captured, and this study cannot conclude with certainty whether download patterns indicate any specific behaviors. Nevertheless, the analysis offers some partial answers to a question that has become increasingly relevant, and it does so from a quantitative angle that has not yet been studied.

Literature Review

As the number of big deal cancellations has grown, libraries and related organizations have begun to study the effects of lost subscriptions on researchers. The Bibsam consortium of higher education and research institutions in Sweden canceled its Elsevier big deal on June 30, 2018. Six months after the cancellation, the consortium asked researchers at member institutions "Have you needed access to articles published by Elsevier that your institution didn't have access to since the cancellation?" Eighty-one percent answered yes.¹⁶ In the same survey, 54 percent of respondents indicated that the cancellations had affected their work negatively.¹⁷ In early 2020, the University of California (UC) system surveyed its faculty, staff, and students about the loss of access to Elsevier journals. Thirty-three percent reported that the cancellations had a significant impact on their work, and 44 percent reported some effect.¹⁸ In contrast, in 2020 Danielle Cooper and Oya Rieger interviewed 89 tenure-track faculty at 11 institutions recently withdrawn from big deals or considering such a change found that "they did not generally report a significant impact to their research."¹⁹

Quantitative studies that attempt to measure the effects of canceling a big deal tend to show little impact,²⁰ though they have almost exclusively studied the number of interlibrary loan (ILL) requests placed for articles from lost subscriptions. Focusing exclusively on ILL overlooks other possible negative effects, such as inconvenience to researchers or a lower opinion of the library. In addition, ILL constitutes only a small piece of the efforts library patrons, particularly faculty, make to obtain access to articles. Still, an increase in ILL is often a concern for libraries considering cuts to their journal packages, due to the costs involved.



The first study to look at the effects of cancellation on ILL was shared in a presentation by Jonathan Nabe and David Fowler in 2012.²¹ Their findings, which were echoed in almost all the studies that came after, showed the volume of ILL requests for canceled journals to be small compared to the use the journals had when the library subscribed. At Southern Illinois University Carbondale, where Nabe works, the library lost access to 242 journals after exiting the big deal. Of these journals, 38 percent were requested at least once on ILL in the year after cancellation.²² Five years later, two-thirds of the canceled journals had been asked for less than once a year. While Nabe and Fowler predicted—and found—that ILL requests would increase further out from the big deal, the number remained low.²³

Other institutions have seen similar results. Kristin Calvert and her colleagues reviewed ILL requests during a 12- to 18-month period after a major journals cancellation process at three North Carolina universities, ranging in size from a medium-sized, mostly undergraduate university to a large research institution. Calvert and her team found that only 1.8 to 4.6 percent of the canceled journals had been requested on ILL.²⁴ A presentation by L. Angie Ohler and her colleagues on big deal cancellations at three R1 institutions found “the common experience of ILL costs not reflecting the journal usage prior to cancellation . . . mirror[s] what other institutions have reported.”²⁵ One of these institutions, the University of Maryland in College Park, notes that use of canceled Taylor & Francis journals in the last year of subscription was 50 times the number of ILL requests placed in the first year post-cancellation. A poster by Susan Arnold and Traci Mays of the West Virginia University Health Sciences Library in Morgantown notes, “An expected increase in interlibrary loan requests for canceled journals has not materialized.”²⁶

The low ILL numbers might indicate that patrons did not really need the journals that were canceled. In some cases, even higher-level researchers do not bother pursuing an article that is not immediately available through the library because it is not essential for them²⁷ or because they can get by with only the abstract.²⁸ The seemingly high number of nonessential articles that patrons view led Nabe and Fowler to conclude that, in fact, the use of active subscriptions is inflated “by the mere convenience of the availability of the content.”²⁹ While the high cost of journals and librarians’ sense of being held captive to rising prices depend on the idea of each journal being unique and without close substitutes,³⁰ not every article download indicates that the patron needed that exact article. In Shannon Delaney’s survey at the University of North Carolina at Chapel Hill, 58 percent of undergraduates said that when they cannot access a desired article, their first step would be to seek a different one. Faculty and graduate students were less likely to substitute, but even so, 10 percent and 16 percent, respectively, listed an attempt to find an alternative as a first step.³¹

Many have speculated, however, that ILL numbers are low not only because patrons can often make do without articles not immediately available through the library but also because they find other ways to obtain the content.³² If users take upon themselves the task of seeking articles through nonlibrary avenues, this could explain why, despite so few patrons placing ILL requests for canceled journals, researchers do report that journal cancellations have had a negative impact.



One possibility is that patrons find more of the articles they need open access (OA). Heather Piwowar and her coauthors determined in 2018 that only 27.9 percent of articles with DOIs (*digital object identifiers*) were available for free online, but it is likely that most people doing Internet searches find many more than that. Using data from the Unpaywall browser extension (now called Unsub), which helps people find open versions of articles, Piwowar and her colleagues concluded that 47 percent of all articles sought by users of the browser extension were available OA.³³ Piwowar and her coauthors also note that the percentage of OA articles has been “growing steadily over the last 20 years.”³⁴ Piwowar and a smaller group of researchers estimate that by 2025, the total percentage of journal articles available OA will be 44 percent, and the percentage of viewed articles obtainable OA will be 70 percent.³⁵ Both the Bibsam survey and the UC poll found that researchers looked online for articles to which their library lacked access (42 percent and 27 percent of respondents, respectively).³⁶ Several of the respondents to Delaney’s survey noted that they only use the library if they cannot find a desired article free online.³⁷ William Walters’s survey of faculty at medium-sized universities found 23 percent of respondents considered the free Web to be their main source of journal articles or book chapters.³⁸ In addition to open access copies of the version of record, researchers sometimes obtain articles from preprint servers³⁷ or repositories.³⁹ Researchers and students may also find illegal copies that are freely available online.

The increased reliance on downloading articles from the open Web is due not only to more articles being available but also to the ways that Google and Google Scholar facilitate access to free sources. Studies of both students and faculty have found enthusiasm for these two search tools. In 2010, 16 of 20 students in a study by Lydia Dixon and her coauthors named Google Scholar as their first choice for finding a known article.⁴¹ Riki Greenberg and Judit Bar-Ilan used log files to show that patrons at the University of Haifa in Haifa, Israel, preferred Google Scholar to the library’s discovery tool. They cite studies reporting that both students and higher-level researchers have favored Google Scholar for 10 years or more.⁴² Carol Bailey, Hazel Bowley, and Jodi Withers conducted a small observational study of undergraduate and master’s level students and found that Google and Google Scholar together made up almost 43 percent of searches.⁴³ Kristin Antelman observed that “library discovery and delivery infrastructure does a poor job of exposing and delivering OA copies. Fortunately, Google Scholar handles this quite seamlessly.”⁴⁴ The frequency with which library patrons rely on Web searches to obtain articles is likely related to the ease of using Google to do so.

Another method of obtaining articles outside library channels, albeit one more common to faculty than students, is to ask an author or peer. A study led by Carol Tenopir and others found high levels of sharing between colleagues, either via e-mail or shared online folders.⁴⁵ Other studies have confirmed this behavior. The Bibsam consortium in Sweden found that 22 percent of respondents had contacted the author of a desired article asking for a copy, and 22 percent got materials from a colleague other than the author. Respondents noted, however, that they only turned to either source if an article was especially important.⁴⁶ The survey of the UC system found 37 percent of respondents asking a colleague at another institution and 11 percent contacting authors directly.⁴⁷

File sharing options that circumvent the licensing terms of libraries’ subscriptions have expanded as well. In their 2017 study of users of Web-based peer-to-peer shar-



ing platforms, Carolyn Caffrey Gardner and Gabriel Gardner mention the #icanhaz-pdf hashtag on Twitter, a user-created area of interest on Reddit called r/Scholar, and Facebook groups dedicated to sharing paywalled scholarly articles.⁴⁸ By far the largest platform for illegal sharing of journal articles is Sci-Hub. Founded in 2011 with the goal of providing free access to scholarly literature without regard for copyright restrictions, the site has been called “a seismic shift in access to scholarly literature.”⁴⁹ Use of Sci-Hub seems to be increasing. A 2018 article in *e-Life* quotes Sci-Hub founder Alexandra Elbakyan as declaring that the number of downloads from the platform grew from 42 million in 2015 to 75 million in 2016.⁵⁰ Sci-Hub covered 69 percent of all scholarly literature in 2018. The largest number of downloads come from Elsevier journals,⁵¹ of which 96.6 percent are available on the site.⁵²

Despite the wide availability of articles on Sci-Hub, responses from surveys related to journal cancellation found less use of Sci-Hub than these numbers would suggest. Of the Swedish researchers surveyed by Bibsam, only 14 percent reported using the site.⁵³ Cooper and Rieger observed that, while over half of their interviewees at a university in Berlin used Sci-Hub, “few interviewees from US institutions in our study admitted to using SciHub, and many reported that they had never heard of the site.”⁵⁴

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channels for accessing articles. The most prominent strategy, observed at all ranks of scholarship, is searching the open Web. Undergraduates, and to some extent higher-level researchers as well, often substitute another article if they cannot quickly obtain the one they originally wanted. While the current study does not look directly at means of retrieving articles that circumvent the library, it uses reports of downloads attributable to Temple University to shed light on some of the strategies just described: substitution and reliance on open access. Seeking evidence of these behaviors can begin to fill in a picture of how patrons respond to the shrinking of the big deal.

Background

Temple University is a research institution with an FTE of just over 34,000 and a current head count close to 36,000. Seventy-three percent of the students are undergraduates. In fall 2021, Temple had 2,286 full-time and 1,484 part-time faculty. The university offers 55 PhD programs and 13 professional doctorates.⁵⁵ Temple has a medical school, several other schools related to health professions, and a hospital. There is also a college of engineering and a college of science and technology.

In 2018, the Temple University Libraries spent close to a quarter of its collections budget on a big deal package from Elsevier, which included the Freedom Collection, a bundle of nearly all ScienceDirect journal titles that is only available to academic li-



braries. As the libraries had already trimmed other areas of the collections budget and needed to cut more, they could not exempt such a large allocation from consideration. Doing so would have made the collection unbalanced. The head of acquisitions and collection development considered reducing the size of the Elsevier package or switching to title-by-title subscriptions and decided to do so at the expiration of a two-year contract at the end of 2018. Over the course of that year, negotiations between Temple and Elsevier resulted in a reduced package, or “medium-sized deal,” that would save the libraries \$350,000. The libraries were granted discounted pricing as long as spending did not drop below a certain level. Library staff selected titles to include based on past use to form a custom bundle that would equal the required spending minimum. This article will use the term *shrinking the big deal* rather than *canceling* to refer to the specific changes Temple University Libraries made to its Elsevier package, though it does mention specific journals as being canceled.

In the year prior to the shrinking of the big deal, patrons had access to 2,160 active journals on Elsevier’s ScienceDirect platform, including subscription and open access titles. The smaller custom package included only 814 subscription journals. Three hundred one fully open access Elsevier journals were unaffected by the shrinking of the big deal and remained in the libraries’ A–Z list of journals and link resolver. Taken together, the still-subscribed and open access journals made up 1,115 titles for which patron access was unaffected by the shrinking of the big deal. These will be referred to in the analysis that follows as “continuous access.” In addition, some journals that were not open access at the time of the cancellations have since converted, and new open access journals have begun publication, so the number of journals to which patrons have current-year access is now somewhat higher. New journals or those that converted to open access after the shrinking of the big deal are not included in the continuous access category.

The libraries retained paid subscriptions to 49 percent of the health sciences journals that had been included in the big deal, with an additional 21 percent available open access. The total impact of the cuts on social sciences was somewhat greater than on health sciences. Though the libraries continued to subscribe to 51 percent of social sciences journals, only 7.5 percent were available open access, and so the total loss of access was larger. In the life sciences, the libraries maintained subscriptions to 32.5 percent of titles, with another 16 percent available open access. Physical sciences and engineering were the hardest hit, with only 15 percent of subscriptions retained and 11 percent available open access.

The big deal agreement had included certain journals designated as core titles, meaning the subscription payments counted toward the purchase of perpetual access to them. If a journal had previously been a core title, the libraries retained access to the archives after cancellation. For recent issues of select canceled journals, the libraries offer document delivery access via Get It Now (GIN). GIN is a service of the Copyright Clearance Center that offers delivery of articles to patrons via e-mail within 8 hours of a request.⁵⁶ Temple has set up GIN to be unmediated, meaning that patron requests are routed directly to the Copyright Clearance Center, without review from library staff. ILL is available for anything to which the libraries lack full-text access, regardless of whether GIN is also an option.



Both interlibrary loan and Get It Now options are available via the university's link resolver. In either scenario, a user searching on the ScienceDirect platform would see the phrase "Abstract only" on a results page. After clicking on an article, the patron would be offered the option to "Get Access" via a link at the top, accompanied by a PDF symbol. Someone searching Google Scholar, which is listed among the library's databases, might see a link that says "Find Full Text @Temple," but only for articles that could be matched with the link resolver. This would include articles available via GIN but not ILL. The link, whether from ScienceDirect or Google Scholar, would go to a landing page generated by the link resolver, which would offer either "Full text available at: CCC Get It Now Elsevier" or "Request articles from other libraries via ILLiad." Clicking on "Get It Now" takes the user to a page with the statement "This article will be emailed to you within 8 hours (normal delivery time is under 2 hours)." Clicking on ILLiad leads to a pre-populated request form. The user would thus be required to click several times before learning what the Get It Now service offers and might not realize that the ILL request form would be automatically completed on their behalf. The multiple clicks required to access either service might deter patrons from making requests.

Research Questions

The present study asks how patterns of article downloads from Temple University patrons have changed after the shrinking of the big deal. While the real question of interest is broader, namely how the cuts affected users, many effects are not measurable using the available data. The data do not show, for instance, the degree to which users obtain articles through informal or illegal means, or the effects of the cuts on their impressions of the library. The data do allow speculation about two behaviors: substituting an available article when the preferred article is not readily obtainable, and relying on open access. Without observing user behavior directly, the article attempts to identify broad patterns by asking the following questions:

- Did the total number of downloads decrease after the shrinking of the big deal?
- Did the total number of downloads drop in ways that would be expected due to the cancellation of subscriptions?
- To what extent can any observed decrease be correlated with changing enrollment?
- If the number of downloads did not decline as would be predicted by either the cancellation of subscriptions or diminished enrollment, have patterns of use shifted toward greater reliance on still-subscribed and open access journals?

Methodology

Total Downloads

In preparing for negotiations with Elsevier, staff at Temple University Libraries had already collected COUNTER JR1 reports going back to 2014. COUNTER (Counting Online Usage of Networked Electronic Resources) is a code of practice that standardizes the reporting of electronic resource use across different publishers and platforms.⁵⁷ This



study relied on reports covering use from 2016 through 2021. Although the COUNTER standard and report structure changed in 2019, this study used only reports that followed the previous standard, Release 4, allowing for consistency over a longer period than if the data had been limited to the new format. Most of this study is based on JR1 reports, which show total article downloads. Although these reports can inflate the number of downloads due to double-counting articles viewed in both PDF and HTML formats,⁵⁸ the degree of inflation is unlikely to have changed over the course of the study. There were no known changes to the ScienceDirect platform during this time, and a visual review of PDF-only downloads showed them to follow the same general pattern as the total downloads. Data sources are listed in Table 1. All data were collected by the author.

Decrease in Downloads from Canceled Journals

To answer the question of whether downloads dropped in ways that would be expected due to the cancellations, the author looked at how many downloads each year came from canceled journals and the change in the number of downloads over time. Journals were divided into five categories: (1) inactive at time of cuts, (2) continuous access (that is, access was unchanged after shrinking the big deal, either because the subscription continued or the journal was open access), (3) canceled titles for which the university retained access to archives, (4) canceled without access to archives, and (5) journals that began publication after the shrinking of the big deal. The expectation was that after the cancellation of subscriptions, total downloads would decrease by a percentage roughly equal to the percentage of downloads from journals to which the libraries lost access. The inaccessible titles would be those inactive at the time of cuts or canceled without access to archives.

Correlation with Enrollment

To estimate the effects of enrollment on patterns of downloading, the author used multiple regression to calculate correlations between the numbers of graduate and undergraduate students and the average number of downloads per journal from ScienceDirect. These calculations included only the 2,160 journals that were active when the cuts were made in 2018. Annual use of each journal was treated as a separate case. The resulting correlation coefficients show how much one would expect downloads per journal to increase, on average, when one person was added to the population in question.

Reliance on Still-Subscribed and Open Access Journals

To see if usage had shifted toward greater reliance on the continuous access journals, the author used calculations showing how much the absolute number of downloads in each category of access changed over time. This enables a comparison of the variation in the use of both continuous access and canceled journals to the yearly changes in total use. "Use" here is defined as full-text article downloads, the metric provided in the COUNTER JR1 report. This number includes both paywalled and open access articles.

A separate analysis isolated downloads of open access articles using the TR_J3 report from COUNTER Release 5, which includes downloads of both open access and paywalled articles. The open access content could be published in fully open journals or hybrid



Table 1.
Data sources used for this study

Data	Source
Full-text article downloads for all Elsevier journals, 2016–2021	JR1 report from COUNTER Release 4, downloaded from Elsevier's administrative portal, AdminTool
Number of gold open access downloads from all Elsevier journals, 2017–2021	TR_J3 report from COUNTER Release 5, downloaded from Elsevier's administrative portal, AdminTool
Enrollment, 2016–2020	Temple University Factbook

journals and could include journals that converted to open access after Temple canceled its subscription in 2018. Because Temple had not historically reviewed or saved these reports, the data collection was limited to what was available on Elsevier's AdminTool site; thus, the earliest year of analysis of the TR_J3 reports is 2017.

It is good practice to assume that open access downloads are always undercounted, as the COUNTER reports can only tie a download to an institution if the provider knows that the person doing the downloading is affiliated with that institution. Multiple studies found users turning to library resources only after they could not find an article on the free Web.⁵⁹ If a user searches the open Web and finds an article without being authenticated through the library, that download will not be included in the COUNTER report. The analysis considers these limitations.

Results

Total Downloads

The starting point of the analysis was a simple count of how many articles Temple's patrons had downloaded each year from ScienceDirect. These counts are shown in Figure 1. No information is available on how patrons discovered the articles. They may have searched on the ScienceDirect platform or clicked through from the library's discovery tool or from Google Scholar.

The number of downloads appeared to decrease each year from 2016 to 2020. Downloads in 2021 represented an increase from the previous year but were still less than 2019. The last full year of access to the big deal was 2018. Elsevier terminated access to canceled journals in March 2019, at which point Temple lost access to 1,048 active journals and current-year access to 243 active journals.

A review of monthly use showed February 2016, November 2017, and February 2020 to have unusually high use that was out of line with the rest of those years and

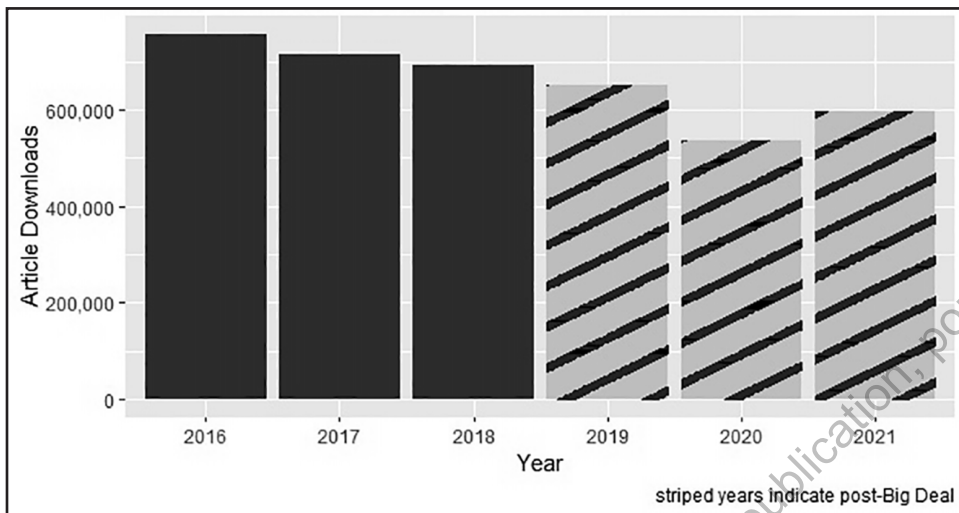


Figure 1. Total Article downloads on ScienceDirect.

with the same months in other years. There is no known reason for these spikes, which may represent unauthorized mass downloading. These downloads were still included in the analysis, as it is not possible to definitively conclude if they were due to illegal activity or to individual clicks.

Figure 2 shows the same numbers as Table 1, broken down by monthly counts of downloads. To make the graph more readable, the last three years of the big deal, 2016 to 2018, are averaged, and the line representing the average of the three years is bolded. The three years of the smaller deal are each represented by their own line to allow for observation of how changes in use correspond with the onset of the COVID-19 pandemic.

The shape of the graph shows a pattern common to electronic resources at a university library, with the highest use in October and another peak in March or April. (The "Average 2016–2018" line is especially high in February due to the spike in use in February 2016.) Monthly downloads dropped in March 2020, when the COVID-19 pandemic began to affect the United States. In 2019 and 2021, the number of article downloads in March was higher than in January and February, but in March 2020 it was much lower. Temple classes moved to online-only on March 16, 2020, and the library building closed a few days after, at the end of the day on March 19. Reference services remained available via e-mail and chat service without interruption, although reference librarians did not return to the building until August 2021. Classes continued online throughout this period as well. The author is not aware of any changes in assignments that would have caused a decline in use, though students' relocation off-campus would mean that many downloads of open access articles previously identified by IP address as coming from Temple users would no longer be attributable. Use remained low for the rest of 2020, although the curve thereafter followed the same shape as previous years. From March 2021 onward, use was stronger, though it remained lower than it had been before the pandemic.

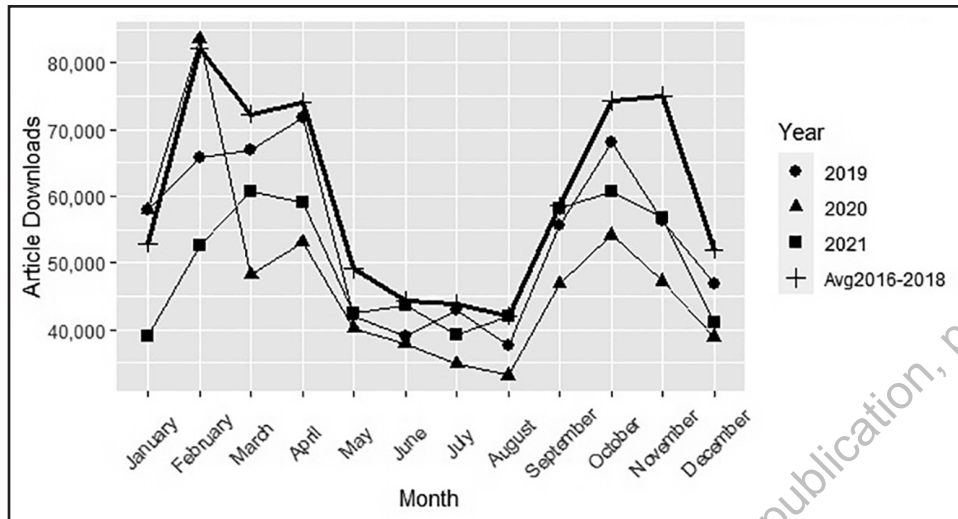


Figure 2. Article downloads from ScienceDirect by Month and Year

Decrease in Downloads from Canceled Journals

Table 2 explores whether changes in the total number of downloads from ScienceDirect follow a pattern that would be expected due to the cancellation of journals. It shows the percentage of the total downloads for each year that came from each category of journal access: inactive journals, continuous access, canceled core, canceled noncore, and new journals. The bottom line of the table shows how total downloads changed year to year. Because several of the post-big deal years were anomalous (access was not turned off until March 2019, and all use dropped in March 2020 at the start of the pandemic), the table includes an average of the three post-big deal years as well as the three last years of the full big deal to diminish the influence of the anomalous years on the analysis.

After shrinking the big deal, Temple lost access to journals comprising almost 10 percent of the use of ScienceDirect. In the last three years of the full big deal, 4.4 percent of downloads came from inactive journals and 5.4 percent from canceled noncore titles. An additional 9.4 percent came from canceled core titles, but since the institution retained access to archives from these journals, the impact of cancellation on the use of these journals was not expected to be felt until later. If patrons had continued using the still available (subscribed and open access) journals exactly as before, total downloads would show a decrease of about 10 percent. While total downloads dropped only 6.1 percent in the first year post-big deal, 2019, the average number of downloads in the three years after shrinking the big deal was 16.2 percent below the average of the previous three years. Decreases in downloads were seen across all journal categories, even those to which the libraries provided continuous access. Downloads from continuous access journals averaged 582,649 in the last years of the big deal and 520,678 in the years after, a decline of 10.6 percent.

Table 2.
 Article downloads from each category of journal access, as a percentage of total downloads, after Temple shrank the big deal

	2016	2017	2018	2019	2020	2021	Average 2016–2018	Average 2019–2021
Inactive at time of cuts	32,247 4.3%	32,375 4.5%	29,993 4.3%	21,764 3.3%	15,588 2.7%	15,591 2.7%	31,538 4.4%	17,648 2.9%
Continuous access (still-subscribed and open access at time of cuts)	601,096 79.5%	585,114 82.0%	561,737 81.0%	552,065 84.8%	489,369 85.0%	520,599 88.8%	582,649 80.8%	520,678 86.1%
Canceled core, retained archive	81,783 10.8%	59,772 8.4%	62,668 9.0%	55,404 8.5%	60,695 10.5%	37,880 6.5%	68,074 9.4%	51,326 8.5%
Canceled noncore, no archive available	41,330 5.5%	36,726 5.1%	38,907 5.6%	21,659 3.3%	9,165 1.6%	9,815 1.7%	38,988 5.4%	13,546 2.2%
New journals				318 0%	985 0.2%	2452 0.4%	n/a	1252 0.2%
Total	756,456 100%	713,987 100%	693,305 100%	651,210 100%	575,802 100%	586,337 100%	721,249 100%	604,450 100%
Year-to-year change in total downloads		-5.6%	-2.9%	-6.1%	-11.6%	1.8%		-16.2%



Correlation with Enrollment

Given that downloads appeared to decrease even before the shrinking of the big deal, the author wondered to what extent the numbers were influenced by changes in the university population. A multiple regression analysis compared the number of downloads from each Elsevier journal to undergraduate, graduate, and faculty head counts. The regression analysis considered only the 2,160 journals that were active at the time the big deal was shrunk.

Table 3 shows the regression model, while Figure 3 shows the size of each population. An increase in undergraduate students is correlated with a small rise in the number of article downloads. Each additional undergraduate student is associated with an expected increase of 0.0422 download per journal. Multiplied by 2,160 active journals, this would total 91.15 additional downloads from ScienceDirect. The regression equation shows a negative coefficient for graduate students and for faculty, indicating counterintuitively that more graduate students or faculty members would mean fewer downloads. Given the high p -values for both coefficients, however, it is more accurate to say there is no observed relationship between the number of graduate students or faculty and the number of article downloads, when accounting for undergraduate enrollment. As Figure 3 shows, graduate enrollment is much smaller than undergraduate and has changed little over the period under consideration, particularly compared to the change in undergraduate enrollment. The number of faculty is also small compared to the number of undergraduates. The adjusted R^2 value of the multivariate model is also very small, only 0.001. (R^2 values can range from 0 to 1.) This number indicates that 0.1 percent of the variation in article downloads can be explained by the change in the size of the university population. Enrollment and faculty counts are not strong predictors of the number of articles that patrons will download from ScienceDirect.

Reliance on Still-Subscribed and Open Access Journals

The next question was whether patterns of use had shifted since the cuts, in a way that would suggest still-subscribed and open access journals might have substituted for the canceled journals. Some preliminary insight into this question is found in Table 2, which shows that the percentage of downloads from continuous access journals (still-subscribed and open access) increased after other journals were canceled, going from 80.8 percent of all downloads in the last three big deal years to 86.1 percent in the next three years. Use of fully canceled journals (that is, canceled non-core journals) decreased from 5.4 percent to 2.2 percent of all downloads. While at first glance, it is perplexing that the canceled journals are used at all, most of these are hybrid journals, so some articles would be available regardless of subscription status. In addition, starting in 2020, Elsevier made articles related to COVID-19 available for free.⁶⁰

To investigate further whether the cancellations have been accompanied by heavier use of continuous access journals, Table 4 provides a more detailed look at how use of each category of journal access has changed year to year. Rather than looking at what percentage of all ScienceDirect downloads came from the journals in each category, it looks at the total number of downloads in each category and how the number has changed. As is logical, use of canceled journals with no archival access decreased much

Table 3.

Multiple regression of use of individual Elsevier journals on university population

	Unstandardized coefficients		Standardized coefficients		
	B	Standard error	β	<i>t</i>	<i>p</i>
Intercept				1.114	0.2654
Undergraduate head count	1071.9516	962.4363	0.0001	2.423	0.0154
Graduate head count	0.0422	0.0174	0.0756	-1.493	0.3743
Total faculty	-0.1399	0.0937	-0.0121	-0.888	0.1353
	-0.1445	0.1623	-0.0401		

R² 0.0012, adjusted R² 0.001
 Model *p*-value 0.0014

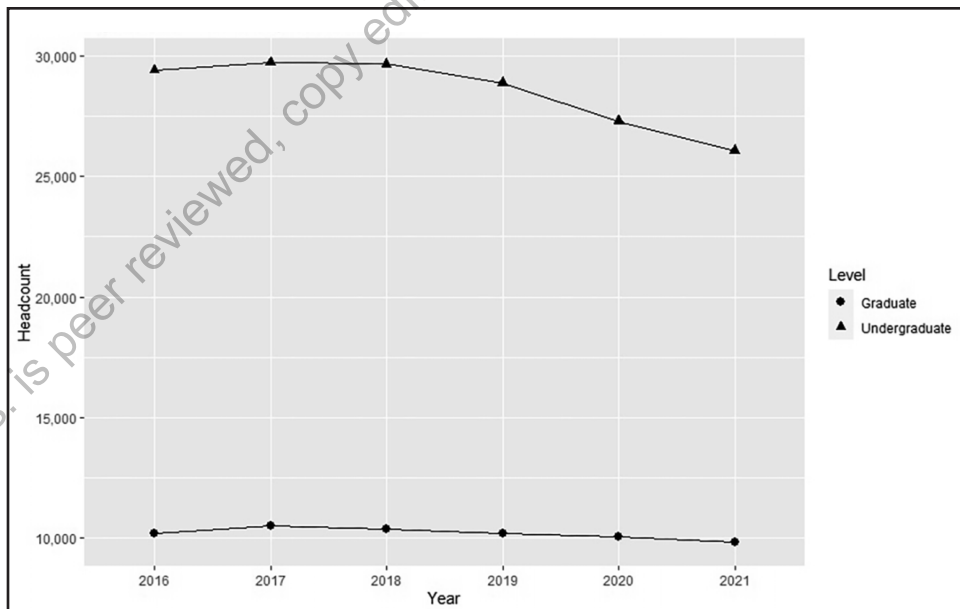


Figure 3. Enrollment by Student Level.



more than use of other journals, with downloads 65.3 percent lower in the three years after the cancellations than in the last three years of the big deal. Canceled journals for which the university has perpetual access to the archives declined 24.6 percent in the three years after their cancellation. Use of still-subscribed and open access journals dropped as well, though only by 10.6 percent. The largest decrease in use of continuous access journals was in 2020, the first pandemic year, when downloads fell 11.4 percent. In all other years, whether during the full big deal or the medium-sized deal, downloads from these journals declined between 1.7 and 6.4 percent per year.

Table 5 investigates whether use of open access journals has increased, which could be a possible compensation for the loss of canceled journals. While open access journals are a subset of what has been referred to in this article as “continuous access,” the data in this table also include open access articles in hybrid journals. Open access articles in hybrid journals may account for some use of journals that were canceled. The data in Table 5 are based on the COUNTER TR_J3 report, which compares downloads of paywalled articles to open access articles, whether from a fully open or a hybrid journal. Table 5 shows what percentage of the downloads from each category of journal were open access articles.

As shown in the bottom line of the table, the percentage of all article downloads that come from open access articles has increased, even with the presumed undercounting of OA downloads. The spikes in totals, if they in fact come from mass downloading, would most likely represent downloads of paywalled articles, leading to an overestimate of the total and an underestimate of the percentage of downloads coming from OA articles. The percentage of use from open access is therefore likely higher than the table shows.

The highest reliance on OA is in the categories of journals for which patrons would otherwise not have access, such as inactive journals (which Elsevier would only grant access to in the case of a prior back file purchase or an error) and canceled non-core journals, to which no access should be expected, although apparently, there is some. In the years after the shift from the full big deal to the medium-sized deal, 20.1 to 33.5 percent of downloads from inactive journals and 13.1 to 28.4 percent of downloads from canceled noncore journals were of open access articles. New journals that began publication after the cuts would be available to Temple users only if they were open access, thus the percentage of downloads from these journals that is open access is very high, 55.7 to 86.1 percent. Reliance on OA is lowest for those journals for which Temple users have had continuous access, even though this category includes fully OA publications. Only 7.1 to 9 percent of downloads from continuous access journals in the years since dropping the full big deal consist of open access articles.

Notably, the percentage of open access downloads from continuous access journals did not substantially increase after the shrinking of the big deal. The percentage of recorded use from open access for continuous access journals is only one and a half percentage points higher in 2021 than it was in 2018 (9 percent compared to 7.5 percent), whereas for canceled non-core journals it is 21.7 percentage points higher (28.4 percent compared to 6.7 percent).



Table 4.
Change in number of article downloads from each category of journal access

Year	Article downloads from all journals*	Change from previous year, all journals	Article downloads from continuous access journals (still-subscribed and open access)	Change from previous year, continuous access	Article downloads from canceled noncore journals, no archive	Change from previous year, canceled noncore	Article downloads from canceled core journals, retained archive	Change from previous year, canceled core
2016	756,478		601,096		41,330		81,783	
2017	713,987	-5.6%	585,114	-2.7%	36,726	-11.1%	59,772	-26.9%
2018	693,305	-2.9%	561,737	-4.0%	38,907	5.9%	62,668	4.8%
2019	651,210	-6.1%	552,065	-1.7%	21,659	-44.3%	55,404	-11.6%
2020	575,818	-11.6%	489,369	-11.4%	9,165	-57.7%	60,695	9.5%
2021	596,066	3.5%	520,599	6.4%	9,815	7.1%	37,880	-37.6%
Average 2016-2018		721,257		582,649		38,988		68,074
Average 2019-2021		607,698		520,678		13546		51,326
			-15.7%		-10.6%			-65.3%

*Total for all journals includes some that have been discontinued, as well as journals that began publication after 2018.

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Table 5.
Open access articles as percentage of total ScienceDirect downloads, by category of journal access

Journal category	2017		2018		2019		2020		2021	
	Open access downloads	Total downloads	Open access	Total downloads	Open access	Total downloads	Open access	Total downloads	Open access	Total downloads
Inactive at time of cuts	7,284 22.5%	32,396	7,865 26.2%	29,993	5,727 26.3%	21,764	3,113 20.0%	15,577	3,585 21.5%	16,646
Continuous access (still-subscribed and open access at time of cuts)	35,411 6.1%	585,114	42,312 7.8%	561,737	43,251 7.8%	552,065	34,716 7.1%	489,369	46,639 9.0%	520,599
Canceled core	1,897 3.2%	59,772	2,204 3.5%	62,668	2,055 3.7%	55,404	1,667 2.7%	60,695	2,266 6.0%	37,880
Canceled noncore	2,192 6.0%	36,726	2,600 6.7%	38,907	2,839 13.1%	21,659	2,005 21.9%	9,159	2,791 28.4%	9,815
New journal	n/a	n/a	n/a	n/a	177 55.7%	318	676 68.8%	982	10,000 89.9%	11,126
Total	46,784 6.6%	714,008	54,981 7.9%	693,305	54,049 8.3%	651,210	42,177 7.3%	575,782	65,281 11.0%	596,066

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Discussion

Total Downloads

Figure 1 shows that total downloads declined in the years post-big deal, though given the timing of the decrease and the fact that downloads had fallen even before the shrinking of the big deal, other factors besides the cancellations likely played a role. The only dramatic drop occurred in March 2020, a full year after Elsevier shut off access to the canceled subscriptions, and can be assumed to be related to the pandemic. Downloads rose again in 2021 but remained lower than they had been in 2019 or during the full big deal.

Decrease in Downloads from Canceled Journals

The loss of access to 1,048 active journals on ScienceDirect and 1,573 inactive journals might be expected to correspond with fewer article downloads. The findings here are ambiguous, though the ambiguity itself is notable. A straightforward result would have been that the number of downloads dropped dramatically when access to the canceled journals was removed. If patrons had continued using the same journals they relied on previously, downloads from ScienceDirect would have decreased noticeably, while ILL requests for the canceled journals would have substantially increased. Neither of these changes was observed.

It is not possible to say whether there was a sharp decrease in downloads due to the shrinking of the big deal. In the first year after the cuts, total use declined by 6.1 percent, but access was not shut off until March. In the following year, use fell 11.6 percent, but this was almost certainly related to the pandemic. The general pattern is that downloads from ScienceDirect have declined every year since 2016, with an unexplained increase of 1.8 percent in 2021. Library staff do not know what caused the overall decrease, especially as the pattern is not replicated in the COUNTER reports for other databases. One potential reason for the reduction in use would be a greater availability of open access articles, which users might obtain without their activity being attributed to the university.

Correlation with Enrollment

The decline also seems to correspond somewhat with enrollment, though it is not strongly correlated. The regression equation of downloads on student head count had a very small adjusted R^2 , indicating that enrollment explains very little of the variation in the number of downloads from ScienceDirect. This is expected, given that other factors, such as the COVID-19 pandemic and increasing availability of open access, likely also affected the number of downloads. Though enrollment has some relationship to downloads and should be kept in mind when reviewing the results of this analysis, it is far from the most important influence on the use of ScienceDirect.

Reliance on Still-Subscribed and Open Access Journals

Use appears to have shifted somewhat toward the journals to which Temple University still has full, immediate access. These continuous access journals naturally made up a larger portion of downloads in later years than during the big deal (86.1 percent in the three years of the medium-sized deal compared to 80.8 percent in the last three years



of the big deal). Even with the overall decline in downloads, the use of these journals did not decrease as much as others. Although the numbers are not definitive, greater reliance on continuous access journals may be part of the reason that overall downloads did not drop more sharply after shrinking the big deal.

Increased reliance on open access is both a possible explanation for overall declines in reported use and a hypothesized compensatory behavior for the loss of some subscriptions. It is, to some extent, a subset of the substitution behavior mentioned earlier, in which patrons might select a different article if a full-text version of the one that originally caught their interest was not immediately available—that is, if the ScienceDirect interface did not say “View PDF,” or if the student’s interpretation of Google search results was, rightly or wrongly, that the full-text was not available.

Open access downloads would likely grow regardless, as the number of articles available in the world of scholarly publishing at large has increased.⁶¹ As expected, the percentage of downloads comprised of open access articles has risen. Increases are most notable for the journals to which Temple lost subscription access, which is logical. If the only articles a person can access from a specific journal are open, of course OA articles will make up a large percentage of the downloads. The increase in OA downloads from continuous access journals is much more modest, going from 7.5 percent in the last year of the big deal to 9 percent in 2021. This may be surprising, given that many users likely begin with a general Internet search and would only turn to library subscriptions if the open Web (or what they perceived to be the open Web) could not deliver. When this behavior occurs outside of Temple’s IP range, however, the resulting downloads are not attributed to Temple and therefore do not show up in the COUNTER reports. The reports measure only downloads known to come from Temple patrons, which means the users are either on campus or have logged into the proxy server. It is not possible to get a clear picture of search behavior using the available data. Clearly, however, open access provides a way for patrons to obtain some of the articles from canceled journals.

Conclusion

The analysis here has several limitations, most notably a lack of information on other ways that users may access Elsevier articles besides via ScienceDirect. In some cases, users could download Elsevier articles via the library’s subscriptions to aggregators. Patrons might also use the strategies described by Carolyn Caffrey Gardner and Gabriel Gardner and by Lisa Olsson and her colleagues, such as sharing on social media platforms or requesting articles from an author or colleague.⁶² To this author’s knowledge, there has been no formal study of Temple University faculty or students’ means of obtaining articles to which the libraries does not provide immediate access, and no informal knowledge was mentioned by the subject liaisons who reviewed the preliminary findings of the study. More research on nonlibrary strategies for accessing articles, whether focused on faculty or students, would be useful.

Another missing piece of information is patrons’ feelings about being forced to pursue alternate means of accessing articles. Even if patrons meet their needs by substituting articles, searching the free Web, or sharing files with peers, these additional steps might contribute to negative feelings about the library. Cooper and Rieger note



that, even though the loss of subscription access does not seem to impede research, it could negatively influence researchers' perception of the library: "When researchers lose access through their institution to journals, the value of their institutional affiliation diminishes."⁶³ Ivanov, Johnson, and Cassady relatedly observe that "fear of backlash from faculty regarding cancellation decisions appears to be a universal concern," with the strength of the faculty-librarian relationship determining the extent to which this backlash influences subscription decisions.⁶⁴ Despite potential bad feelings, however, cancellations are often necessary. A worthwhile goal would be to communicate about cancellations in ways that would minimize backlash, including education about inter-library loan.

Despite these shortcomings, the data in this study begin to paint a picture of how ScienceDirect is used at Temple University now that fewer full-text articles are available to patrons on the platform. There is little reliance on ILL for content from canceled journals. Patrons download open access articles from canceled journals and may substitute articles from still-subscribed or open access journals for those they cannot access on ScienceDirect. Some unexpected availability of canceled journals is evident, as only 28 percent of downloads from fully canceled journals in 2021 were of open access articles. It is unclear how the remaining 72 percent of downloads of paywalled articles was possible. Nevertheless, the cancellations coincided with less use of these journals, at least that would be included in a COUNTER report.

There is more to the response to the shrinking of the big deal that this study cannot uncover. Nevertheless, the broad picture painted here is that patrons still turn to the library and may meet their requirements via substitution or reliance on open access. There is a need for more research on how patrons at all levels of the university respond to subscription cancellations, and the current study provides an outline that could ideally be fleshed out by future research.

The broad picture painted here is that patrons still turn to the library and may meet their requirements via substitution or reliance on open access.

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Karen Kohn is a member of the Editorial Board of portal: Libraries and the Academy and collections analysis librarian at Temple University Libraries in Philadelphia; she may be reached by e-mail at: karen.kohn@temple.edu.



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