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Evaluating Zotero, SHERPA/RoMEO, and Unpaywall in an Institutional Repository Workflow

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This article has been accepted for publication in the *Journal of Electronic Resources Librarianship* published by Taylor & Francis.

Evaluating Zotero, SHERPA/RoMEO, and Unpaywall in an Institutional Repository Workflow

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Abstract: East Tennessee State University developed a workflow to add journal publications to their institutional repository and faculty profiles using three tools: Zotero for entering metadata, SHERPA/RoMEO for checking copyright permissions, and Unpaywall for locating full-text documents. This study evaluates availability and accuracy of the information and documents provided by Zotero, SHERPA/RoMEO, and Unpaywall for journal publications in four disciplines. The tools were less successful with works authored by arts and humanities and education faculty in comparison to works authored by medicine and health sciences and social and behavioral sciences faculty. The findings suggest that publisher practices contributed to the disciplinary differences.

Keywords: Zotero, SHERPA/RoMEO, Unpaywall, Institutional Repositories, Faculty Profiles

NOTE: This is the preprint of an article that has been accepted for publication in the *Journal of Electronic Resources Librarianship* published by Taylor & Francis.

Evaluating Zotero, SHERPA/RoMEO, and Unpaywall in an Institutional Repository Workflow

Institutional repositories (IRs) and faculty profiles are common methods for institutions to showcase their researchers' scholarly output (Givens, Macklin, & Mangiafico, 2017; Luthor, 2018). For many institutions, sustaining IR collections and profiles is a challenge, particularly for library staff who are responsible for them (Luthor, 2018). Rising to the challenge, libraries have semi-automated their workflows by using various resources. These workflows can be separated into three main parts: entering metadata, checking copyright policies, and locating full-text documents. For entering metadata, libraries have used reference management software (RMS) such as RefWorks and Zotero (Bull & Schultz, 2018; Childress, Hswe, & Cahoy, 2014; Flynn, Oyler, & Miles, 2013; Kipphut-Smith, 2014; Lyon, 2017; Marvin and Scala, 2017; Neugebauer & Murray, 2013; Rele & Young, 2017), application programming interfaces (APIs) from publishers (Russell, Wise, Dinsmore, Spear, Phillips, & Taylor, 2016), integrations with publication systems such as Current Research Information Systems (CRIS) (Afshari & Jones, 2007; Siciliano, Schmidt, & Kinzler, 2014), and self-made harvesting tools (Anuradha, 2005; Powell, Klein, & Sompel, 2017; Roy & Gray, 2018). For checking copyright permissions, SHERPA/RoMEO has been the database of choice for over a decade (Afshari & Jones, 2007; Bull & Schultz, 2018; Flynn et al., 2013; Hanlon & Ramirez, 2011; Hazzard & Towery, 2017; Kipphut-Smith, 2014; Lam & Chan, 2007; Lyon, 2017; Macan 2014; Mackie, 2004; Madsen & Oleen, 2013; Marvin & Scala, 2017; Powell et al., 2017; Rele & Young, 2017; Siciliano et al., 2014; Sutradhar, 2006; Tosaka, Weng, & Beh, 2013; Walters & Daley, 2018). For locating full-text documents, libraries have used publisher APIs (Russell et al. 2016), 1Science (Rele & Young, 2017), and oaDOI (now Unpaywall) (Powell et al., 2017).

Example of a Workflow with Zotero, SHERPA/RoMEO, and Unpaywall

Following in the footsteps of other libraries, Charles C. Sherrod Library at East Tennessee State University developed a semi-automated workflow during Spring Semester 2017 to quicken the addition of journal publications to the faculty works collections and SelectedWorks faculty profiles in their institutional repository Digital Commons@East Tennessee State University (<https://dc.etsu.edu/>). Sherrod Library decided to use Zotero for entering metadata, SHERPA/RoMEO for checking copyright permissions, and Unpaywall for locating full-text documents. They primarily choose the tools because they were free and open-sourced, which allotted more flexibility in their uses.¹ The workflow consists of the following actions:

1. **Receive Request:** The Digital Scholarship Librarian (DSL) receives a curriculum vitae from a faculty member requesting a SelectedWorks profile.
2. **Import Data into Zotero:** Student assistants search in Google for journal publications attributed to East Tennessee State University faculty in the CV. When they find the work on a journal website, they click on the Zotero Connector for Chrome plugin icon to add the work to Zotero for Windows.
3. **Collect Copyright Policies from SHERPA/RoMEO:** Student assistants periodically add copyright policies from SHERPA/RoMEO to Zotero by activating the SHERPA/RoMEO to Zotero Import Tool.²

¹ Charles C. Sherrod Library currently pays \$120 per year to have unlimited data storage in Zotero, which was decided after using the software for months.

² East Tennessee State University adapted a SHERPA/RoMEO to Zotero Import Tool that matches the ISSN or journal title from Zotero to a record in SHERPA/RoMEO and sends the available copyright policies to Zotero. More information on this integration is available in Github (<https://github.com/sherrodlibrary/zotero-sherparomeo>).

4. **Export and Edit Data from Zotero:** Student assistants export the data from Zotero to a CSV file and copy the data to a Digital Commons batch upload Excel spreadsheet. They edit and add data for local fields (e.g. author institutions) not available in Zotero.
5. **Locate Full-Text Documents with Unpaywall:** The DSL locates documents through the Unpaywall for Chrome extension icon that appears on the work's page in the journal website. The DSL downloads the documents that can legally be uploaded to an IR based on the copyright information from SHERPA/RoMEO.
6. **Upload Data and Documents to IR:** The DSL uploads the metadata and documents to the IR. Metadata is added whether or not a document can be uploaded.
7. **Import IR Records to Profile:** Student assistants import records from Digital Commons@East Tennessee State University to SelectedWorks profiles.
8. **Alert Faculty of Profile:** The DSL emails the faculty member to alert them that their profile is finished. In the email, information on how to enhance the profile is given (e.g. adding post-prints).

The workflow can be conducted in another order depending on the preferences and availability of the personnel. After the workflow was solidified, Zotero (2018) announced its Unpaywall integration. This integration would simplify the workflow because the DSL would not need to visit the work's online page to activate the Unpaywall for Chrome extension. Instead, the DSL could simultaneously access Unpaywall's and SHERPA/RoMEO's information in Zotero.

Evaluation of a Workflow with Zotero, SHERPA/RoMEO, and Unpaywall

The outlined workflow represents a scenario in which Zotero, SHERPA/RoMEO, and Unpaywall work perfectly. Unfortunately, Charles C. Sherrod Library realized that all three tools required back-up workflows. When Zotero does not properly add a record, student assistants

manually enter the metadata. When SHERPA/RoMEO does not have a journal listed in their database, the Digital Scholarship Librarian (DSL) reviews the journal website for copyright policies and emails the journal for permissions if needed. When Unpaywall fails to detect a document that can be legally uploaded, the DSL searches Google and Google Scholar for documents and requests the publisher version through Interlibrary Loan if needed. The DSL and student assistants observed that the need for back-up workflows depended on the primary discipline of the faculty's research. The tools were not as useful when creating profiles for humanities and education faculty in comparison to science faculty. In order to inform workflow changes, the author conducted an evaluation of the availability and accuracy of information and documents provided by Zotero, SHERPA/RoMEO, and Unpaywall for peer-reviewed journal publications in four disciplines: arts and humanities, education, medicine and health sciences, and social and behavioral sciences. In addition, the evaluation explores how the disciplines preference of publishers influence the usefulness of Zotero, SHERPA/RoMEO, and Unpaywall. The study explores the following objectives for each discipline:

- To assess the capability of **Zotero** to import a work's metadata correctly and completely
- To gauge the breadth of the journals in **SHERPA/RoMEO** and the correctness of its records
- To compare the **Unpaywall** browser extension to Google and Google Scholar when finding documents that can legally be uploaded to an IR or personal website

Literature Review

Literature regarding the use of Zotero, SHERPA/RoMEO, and Unpaywall to deposit faculty publications in institutional repositories (IRs) have not produced a thorough evaluation of the tools. Similarly, general product reviews, press releases, and blogs are plentiful for Zotero,

SHERPA/RoMEO, and Unpaywall but did not systematically test them. This literature review examines studies that go beyond a description or review by testing the availability and accuracy of the information and/or documents provided by Zotero, SHERPA/RoMEO, and Unpaywall and other similar types of products.

Zotero and Reference Management Software

Since the 1980s, scholars have studied reference management software (RMS). Only 13.5% of articles included a quantitative analysis of the software's accuracy between 1987 and 2014 (Tramullas, Sanchez-Casabon, & Garrido-Picaszo, 2015). Even fewer studies examined the importing functions of the software (Table 1) (Basak, 2014a; Basak 2014b; Gilmour & Cobus-Kuo, 2011; Homol, 2014; Sergiadis, 2018a; Sergiadis, 2018b). Importing is an essential function for IR managers as well as users collecting and organizing their research (Emanuel, 2013; Francese, 2013; Lisbon, 2018; Lonergan, 2017; Madhusudhan, 2016; Melles & Unsworth, 2015; Nariani, 2016; Nilashi, Ibrahim, Sohaei, Ahmadi, & Almaee, 2016). Studies that imported citations in order to compare RMS had mixed results on which one performed the best, but all concluded that no RMS is perfect (Basak, 2014a; Basak 2014b; Gilmour & Cobus-Kuo, 2011; Homol, 2014). These four studies provided a good foundational base for other research but have some limitations, specifically low sample sizes and the lack of analysis regarding the articles' disciplines and document types. A previous study on East Tennessee State University's IR workflow examined whether complete records were available in Zotero for publications of different document types and disciplines (Sergiadis, 2018a; Sergiadis, 2018b).³ The current study is a follow-up to this study, but concentrates on journal publications in order to provide an

³ A portion of the citations used in the study is shared with the current study.

evaluation of all three tools in the workflow, as SHERPA/RoMEO's and Unpaywall's services are geared towards journal articles.

Table 1.

Summary of Literature on Evaluating Importing Functions of Reference Management Systems (RMS)

Source	Data	RMS	Results Pertaining to Importing into Zotero
Gilmour & Cobus-Kuo, 2011	2 articles from 7 medicine and science databases (total of 14 articles)	CiteULike, Mendeley, RefWorks, Zotero	Zotero had the most success importing.
Basak, 2014a & Basak, 2014b	1 journal article	RefWorks and Zotero (2014a); EndNote, Mendeley, and RefWorks (2014b)	Zotero had the most problems importing (specifically publisher, ISSN, URL, and DOI fields).
Homol, 2014	47 journal articles	EBSCO Discovery Service (EDS), EndNote Basic, RefWorks, Zotero	N/A
Sergiadis, 2018a; Sergiadis, 2018b	595 of different material types in four disciplines	Zotero	Zotero had problems importing conference proceedings, music albums, and newsletter/magazine articles. Zotero could import books, but had issues importing book contributions. Arts/humanities and education had more trouble importing journal publications than medicine/health sciences and social/behavioral sciences.

SHERPA/RoMEO and Copyright Databases

Not only has SHERPA/RoMEO been the leading source of copyright policies for IR workflows (Hanlon & Ramirez, 2011), but researchers have used SHERPA/RoMEO as an authoritative database to explore research questions regarding copyright, self-archiving, and Open Access trends (Abad-García, Melero, Rodriguez-Gairin, & Abadam, 2013; Covey, 2009; Fathli, Lundén, & Sjögarde, 2014; Gadd & Covey, 2016; Gadd, Fry, & Creaser, 2018; Hansen, 2012; Jamali, 2016; Laakso, 2013; Lyons & Booth, 2011; Schultz, 2017a; Walters & Daley, 2018). Some of the research (often tangentially) included the limitations of SHERPA/RoMEO's coverage, which ranged from 4.8% to 26.0% of journals without a record or grade in

SHERPA/RoMEO (Table 2) (Abad-García et al., 2013; Covey, 2009; Fathli et al., 2014; Hansen, 2012; Jamali, 2016; Lyons & Booth, 2011; Walters & Daley, 2018). If eliminating the highest and lowest percentages, the range of journals without clear policies in SHERPA/RoMEO is closer to 10.0% to 15.0%. No definitive trend emerged within the studies' data to explain the difference in percentages nor did the studies address how different disciplines may affect these percentages. The current study addresses how journals' disciplines and their primary publishers may influence available records in the database and the accuracy of those records.

Table 2.

Summary of Literature on Unknown, Ungraded, Unclear, and Unavailable. Rights in SHERPA/RoMEO

Source	Data	Percentage of Unknown, Ungraded, Unclear, and Unavailable Rights
Lyons & Booth, 2011	452 articles from a variety of business and management journals	8.4%
Hansen, 2012	29,322 articles from five US universities	12.67% final PDF; 7.40% post-print; 12.01% pre-print
Abad-García et al., 2013	1,318 Spanish scientific journals in the fields of social sciences, health sciences, and humanities from DULCINEA	26%
Fathli et al., 2014	20,371 articles from SwePub (Sweden)	15%
Jamali, 2016	500 English articles in ResearchGate	4.8%
Walters & Daley, 2018	2,154 distinct serials with ISSNs or ESSNs from the Brunel University's Current Research Information System (CRIS)	16%

Note. Some percentages were not stated directly in a study, but derived based on the study's results. For example Fathli et al. (2014) and Walters & Daley (2018) stated the percentage of journals available in SHERPA/RoMEO, and the unavailability was determined based on that percentage.

Unpaywall and Open Access Finding Tools

The amount of literature published on Open Access (OA) is vast. Some studies evaluated or compared OA finders even though that may not be one of their main objectives (Table 3) (Chen, 2013; Lyons & Booth, 2011; Norris, Oppenheim, & Rowland, 2008; Piwowar, Priem, Lariviere, Alperin, Matthias, Norlander, Farley, West, & Haustein, 2018; Schultz, 2017b; Walters & Daley, 2018). Regardless of the composition (e.g. disciplines) of the studies' data, OA

finders such as Unpaywall did not locate as many OA versions of journal articles as manual searches in Google and Google Scholar (Chen, 2013; Emery, 2018; Lyons & Booth, 2011; Norris et al., 2008; Piwowar et al., 2018; Schultz, 2017b; Walters & Daley, 2018).

Table 3.

Summary of Literature on Open Access Finders

Source	Data	Tested	Results
Norris et al., 2008	2,519 articles in ecology, economics, and sociology journals	Google, Google Scholar, OAIster, Open DOAR	Google Scholar (68.04%) found the most documents followed by OpenDOAR (11.17%), both OAIster and OpenDOAR (9.62%), Google (8.79%), and OAIster (2.38%).
Lyons & Booth, 2011	Limited sample to decide which to use for their study	Google, Google Scholar, OAIster, OpenDOAR	Google had the most comprehensive access to OA articles.
Chen, 2013	471 articles in health sciences journals deposited in IRs	Google Scholar, PubMed, Scopus	Google Scholar, PubMed, Scopus could detect Gold OA (journals that make all articles open access). For Green OA (journals that allow self-archiving of previous versions), Google Scholar found 96%, PubMed found 29%, and Scopus found none.
Schultz, 2017b	609 publications from Web of Science (sciences social sciences, and humanities)	Google Scholar, Open Access Button, Lazy Scholar, Unpaywall	Google Scholar located the most open versions and discovered 22 more open versions than the other tools. Three tools had false positives: OAV with 35 false positives, Unpaywall with 20, and Lazy Scholar with 10.
Emery, 2018	671 articles/columns in library and information science journals	Open Access Button (OAB), Institutional Repositories (IRs)	The IRs had 38 publications not available through the OAB.
Piwowar et al., 2018	500 articles with CrossRef DOIs	Manual searches (including Google and Google Scholar), Unpaywall	Unpaywall recalled 77% articles in comparison to manual searches. When using Unpaywall, users encountered OA versions 47% of the time.
Walters & Daley, 2018	Provided examples of comparisons	Google Scholar versus CORE and Unpaywall	Google Scholar found more OA locations than Unpaywall and CORE for individual publications.

Besides research on OA finders, studies on the effect of disciplines on OA rates are also relevant, because they can affect how many documents Unpaywall can realistically detect. In terms of the disciplines covered in the current study, recent research has broadly concluded that medicine has high rates of OA, followed by social sciences, and lastly art and humanities (Archambault, Amyot, Deschamps, Nicol, Provencher, Rebout, & Roberge, 2014; Bosman & Kramer, 2018; Martín-Martín, Costas, van Leeuwen, & López-Cózar, 2018; Piwowar, et al., 2018). OA research either placed education in the social sciences field or did not focus on the discipline.

Connecting the Results

The common denominator for literature on reference management systems (RMS), copyright databases, and OA finders is that they are not from the IR management perspective. For example, if Unpaywall located an article on a publisher's website that forbids self-archiving, previous research on OA documents may code this as a legally uploaded document. The current study would state that the document could not be legally uploaded to an IR. This change in perspective affects the research questions and methods, which ultimately influences the results and discussion.

Overview of Products

Zotero (<https://www.zotero.org/>) is an open-source reference management software that helps users organize, sort, and create citations individually or collaboratively. It is available as a Zotero Standalone for Mac, Windows, and Linux with an accompanying Zotero Connector for Chrome, Firefox, and Safari. While Zotero is free with a 300 MB storage limit, there is a cost (\$20 to \$120 per year) for higher storage limits. It was developed by the Center for History and New Media at George Mason University.

SHERPA/RoMEO (www.sherpa.ac.uk/romeo/) is a free, online database of publishers' policies on copyright and self-archiving for journal articles. RoMEO is a service of SHERPA based at the Centre for Research Communications at Jisc (formerly the University of Nottingham).

Unpaywall (<https://unpaywall.org/>) is a free, open database developed by Impactstory that helps users legally find Open Access content. Unpaywall has several products in addition to the Chrome extension that uses their data including the database snapshot, data feed, REST API, simple query tool, and Firefox extension as well as the Web of Science and Library link resolver integrations.

Methods

The study evaluated Zotero, SHERPA/RoMEO, and Unpaywall as tools to semi-automate depositing faculty works in an IR. The author compiled works (articles, reviews, poetry) in peer-reviewed journals published between 2011 and 2016 from thirty-six SelectedWorks profiles in the institutional repository (IR) Digital Commons@East Tennessee State University. The chosen SelectedWorks profiles highlighted the works of faculty from four disciplines based on the [Digital Commons Disciplines Taxonomy](#): arts and humanities (AH), education (ED), medicine and health sciences (MHS), and social and behavioral sciences (SBS). The author selected nine SelectedWorks profiles for each discipline based on the faculty's research interests. In addition, profiles were selected based on the faculty's rank in order to represent the publishing patterns of different career stages. For each discipline, the author analyzed the profiles of three assistant professors, three associate professors, and three full professors. The selection process resulted in 372 total works after eliminating duplicates: 89 in AH, 77 in ED, 86 in MHS, and 120 in SBS. After compiling the sample, the author tested the availability and accuracy of importing the works' metadata into Zotero, finding their journals' copyright policies in SHERPA/RoMEO, and

locating their full-text documents through Unpaywall. The author tested the tools off-campus between August and November 2018 to ensure that library subscriptions would not affect the results.

Zotero

The author imported works into Zotero 5.0 for Windows by clicking on the Zotero Connector for Chrome plugin icon in the browser and then coded whether or not a record was available for each work. The author coded works as available if the plugin could detect and generate a record for an individual work. To test its accuracy, the metadata was coded as available/correct, available/incorrect, unavailable, or not applicable for the following categories: title, author, abstract, publication, volume, issue, pages, digital object identifier (DOI), keywords, publication date, International Standard Serial Number (ISSN), and Uniform Resource Locator (URL). Information on the journal website determined whether or not it was correct. The fields of publication dates, ISSNs, and URLs required additional coding when multiple data was available on the journal website, but only one was available in Zotero. The data included individual works' and journal issues' publication dates, print and online ISSNs, and DOI permalinks and URLs. Consult Appendix A for descriptions of the coding categories related to Zotero.

SHERPA/RoMEO

The author searched for each work's journal in SHERPA/RoMEO and coded their availability in the database. Duplicate journals were treated individually in order to account for hybrid journals. Works from hybrid journals can be published under a paywall or open access, which could cause inaccuracies in SHERPA/RoMEO. Records available in SHERPA/RoMEO were compared to the copyright policies on the journal websites. Based on that comparison, the

SHERPA/RoMEO policy was coded as correct, incorrect, or unclear due to unknown or vague policies. For journals unavailable in SHERPA/RoMEO, the author searched and coded the copyright policies on the journal websites. If the copyright policy was mentioned, the author noted if it conformed to SHERPA/RoMEO's format with policies for pre-prints, post-prints, and publisher versions. If the copyright did not conform, it was decided if an email to the publisher would be required to know if the published version could be uploaded in an institutional (IR). Consult Appendix B for descriptions of the coding categories related to SHERPA/RoMEO.

Unpaywall

The author visited each work on its journal website and coded if the Unpaywall for Chrome extension (Version 3.87) detected a document. Then, the author coded the version Unpaywall discovered (previous or published version), the legality of archiving it in an IR or personal website, and where the works originated (journal websites, personal websites, or repository/database storing copies of previous or published versions). Although Unpaywall does not harvest from personal websites (e.g. ResearchGate) (Unpaywall, n.d.), they were included in the coding to correspond with the results from Google and Google Scholar. The author searched in Google and Google Scholar for works that Unpaywall failed to locate a version that could be legally uploaded. Documents detected by Unpaywall from journals with unclear archiving policies were not searched in Google/Google Scholar. For each work, the author searched the work's title (with and without quotations), the journal's title (then browsed for the work), and the author for their personal websites (then browsed for the work). As with Unpaywall, it was noted which version Google and Google Scholar discovered, the legality of archiving it in an IR, and where the works originated. If multiple versions were available for a single work, the "best" version (publisher followed by post-print and preprint) that could legally be uploaded was

counted in the study. Consult Appendix D for descriptions of the coding categories related to Unpaywall.

Types of Publishers

While collecting and organizing the data, there was evidence that the types of publishers commonly used within the disciplines affected the availability of information and documents from Zotero, SHERPA/RoMEO, and Unpaywall. The author compared the publishers within each discipline to available records in Zotero and SHERPA/RoMEO as well as documents found by Unpaywall. The types of publishers that emerged in the study were commercial or for-profit publishers, aggregators that hosted the primary copy of the work, university presses, universities that hosted journals but had no formal press, learned societies that hosted journals on their website, and others that did not fit into any of these categories. Consult Appendix D for descriptions of the coding categories related to publishing websites.

Results

Each section (Zotero, SHERPA/RoMEO, Unpaywall, and Types of Publishers) focuses on the results in relation to four disciplines: arts and humanities (AH), education (ED), medicine and health sciences (MHS), and social and behavioral sciences (SBS).

Zotero

The Zotero Connector for Chrome plugin was able to import 64.0% of AH works, 54.5% of ED works, 99.0% of MHS works, and 100.0% of SBS works (Figure 1). For works that could be imported into Zotero, ED had the highest percentage (29.6%) of fields with incorrect and unavailable metadata followed by AH (13.9%), SBS (12.7%), and MHS (9.6%) (Figure 2). AH and MHS had almost equal amounts of fields with errors and missing data, but ED and SBS had significantly more fields with missing data than errors. The publication date field had the most

inaccurate and missing metadata, and the title and URL fields had the least. Individual fields generally corresponded with the overall results (Figure 3a-1). In half of the individual fields, ED had the most errors and missing metadata and MHS had the least. Within all disciplines, Zotero imported more journal issue publication dates over individual work publication dates and print ISSNs over online ISSNs. For AH, MHS, and SBS, a significant portion of URL fields did not import the DOI permalinks when the work was assigned a DOI.

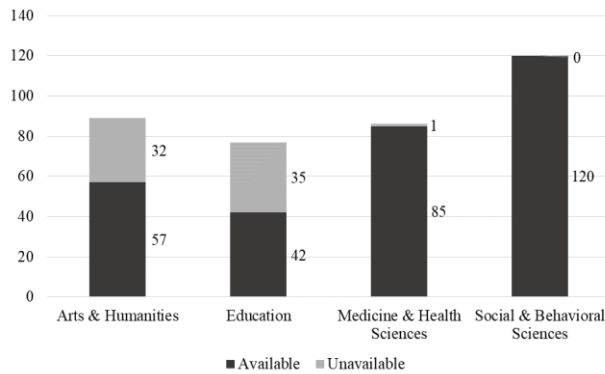


Figure 1. Availability of records in Zotero.

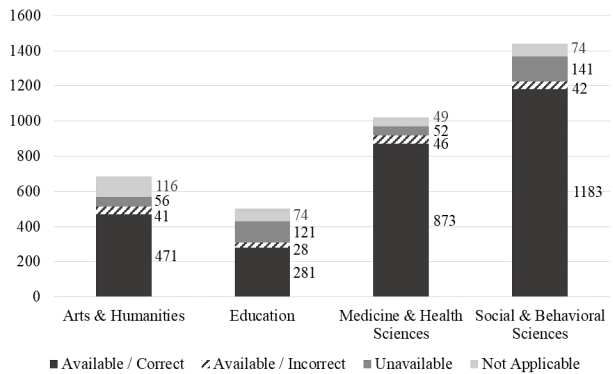


Figure 2. Availability and accuracy of metadata in Zotero for all fields.

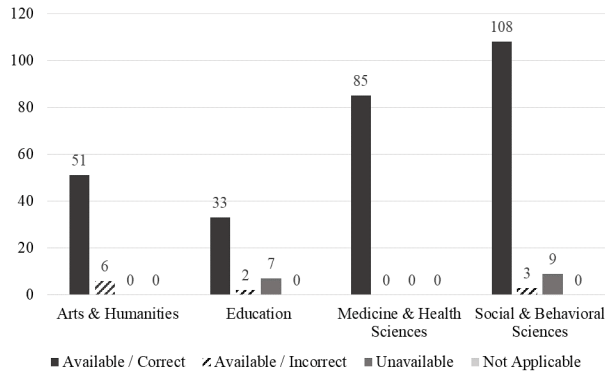


Figure 3a. Availability and accuracy of metadata in Zotero for the title field.

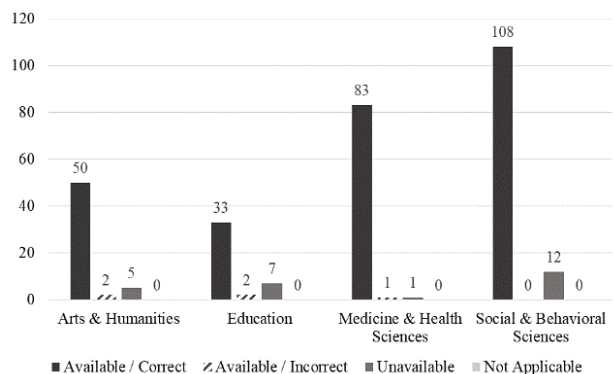


Figure 3b. Availability and accuracy of metadata in Zotero for the author field.

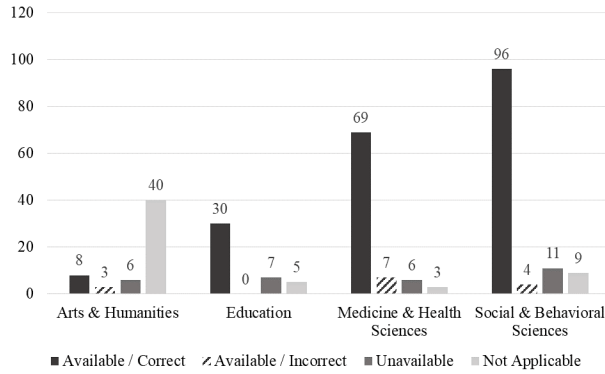


Figure 3c. Availability and accuracy of metadata in Zotero for the abstract field.

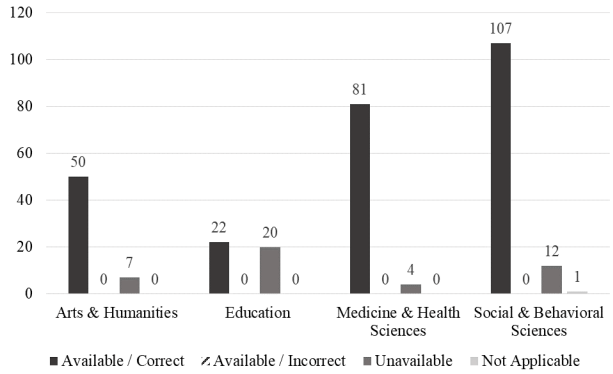


Figure 3d. Availability and accuracy of metadata in Zotero for the publication field.

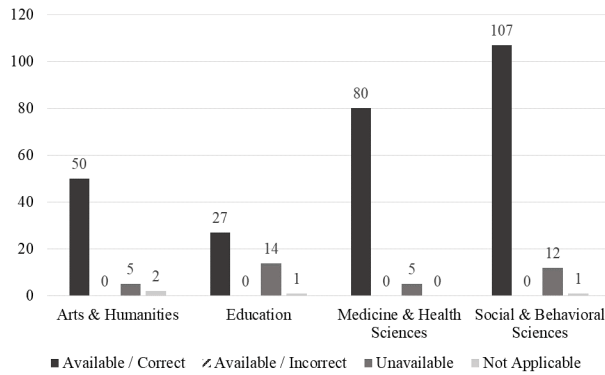


Figure 3e. Availability and accuracy of metadata in Zotero for the volume field.

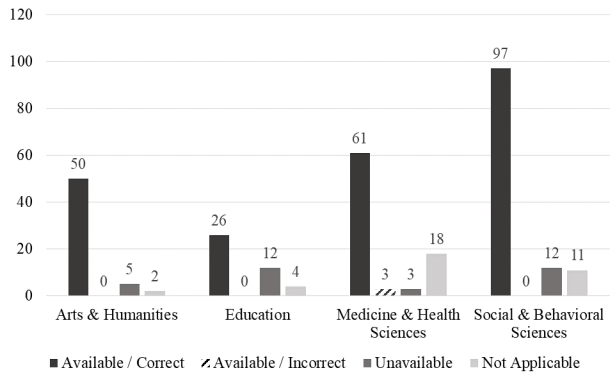


Figure 3f. Availability and accuracy of metadata in Zotero for the issue field.

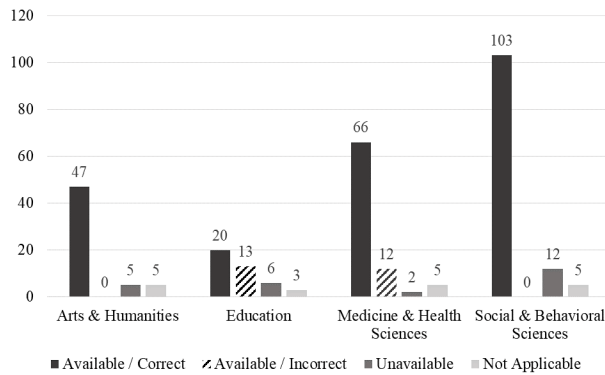


Figure 3g. Availability and accuracy of metadata in Zotero for the pages field.

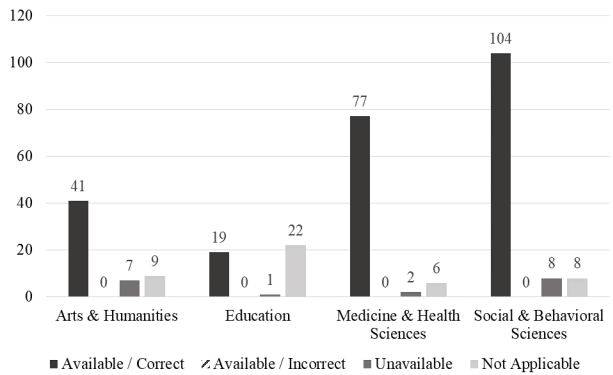


Figure 3h. Availability and accuracy of metadata in Zotero for the DOI field.

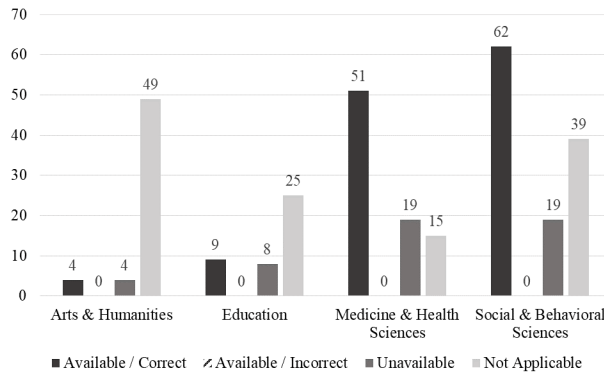


Figure 3i. Availability and accuracy of metadata in Zotero for the keywords field.

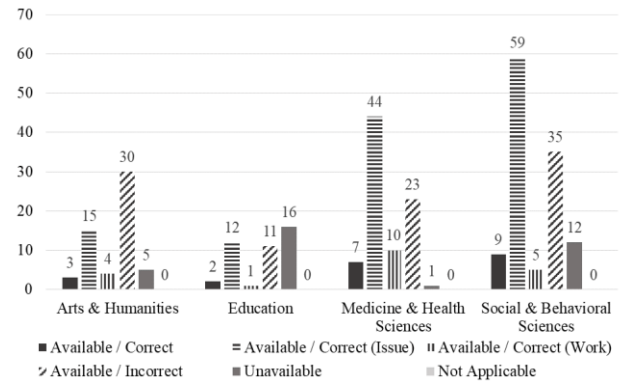


Figure 3j. Availability and accuracy of metadata in Zotero for the publication date field.

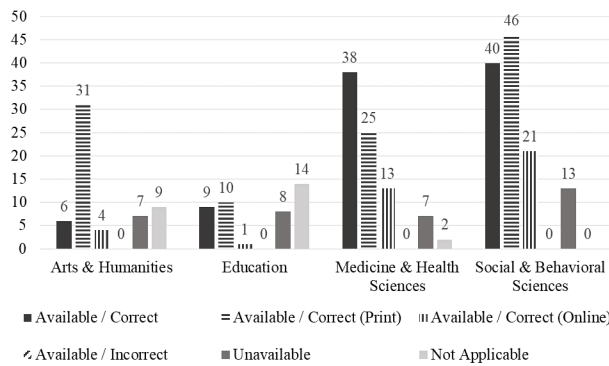


Figure 3k. Availability and accuracy of metadata in Zotero for the ISSN field.

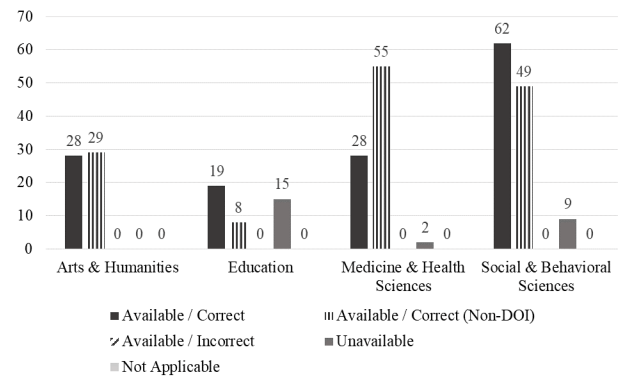


Figure 3l. Availability and accuracy of metadata in Zotero for the URL field.

SHERPA/RoMEO

In SHERPA/RoMEO, the majority of copyright policies for ED and AH journals were unavailable (77.9% and 60.7%, respectively) in contrast to MHS and SBS journals (11.6% and 6.5%, respectively) (Figure 4). SHERPA/RoMEO had more incorrect records for ED (11.8%) and MHS (11.8%) journals in comparison to the AH (2.9%) and SBS (0.9%) journals (Figure 5). Due to unclear copyright policies on the journal websites, it was unclear if the SHERPA/RoMEO records were correct for approximately 12% of AH and MHS journals, 5.9% of ED journals, and 2.7% of SBS journals. For journals without graded policies in SHERPA/RoMEO, approximately half of AH and ED journals had no copyright policy (Figure 6). Most of AH and ED journals with a copyright policy did not conform to the SHERPA/RoMEO format and would require the

IR staff to contact the journal to ask for permission to deposit the published version in IRs. All MHS and SBS journals not in SHERPA/RoMEO had copyright policies. For MHS journals, none conformed to SHERPA/RoMEO’s policies and the majority of those journals would need to be contacted to know if the final version could be deposited. Half of SBS journals’ policies corresponded with SHERPA/RoMEO’s format and the other half of policies clearly stated whether or not the published version could be deposited.

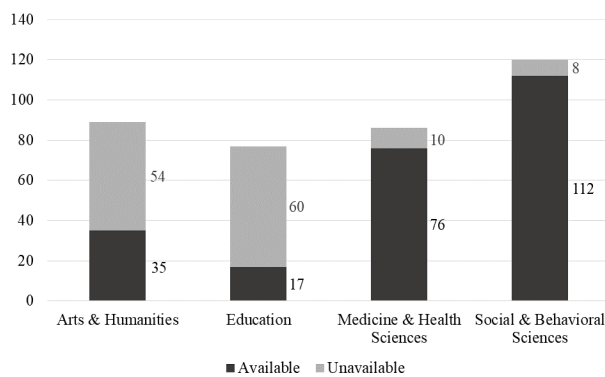


Figure 4. Availability of journals in SHERPA/RoMEO.

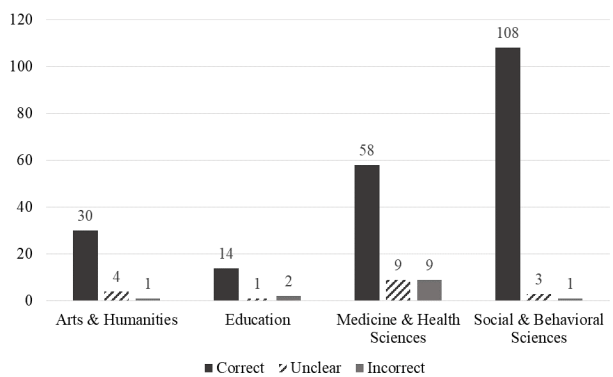


Figure 5. Accuracy of SHERPA/RoMEO records.

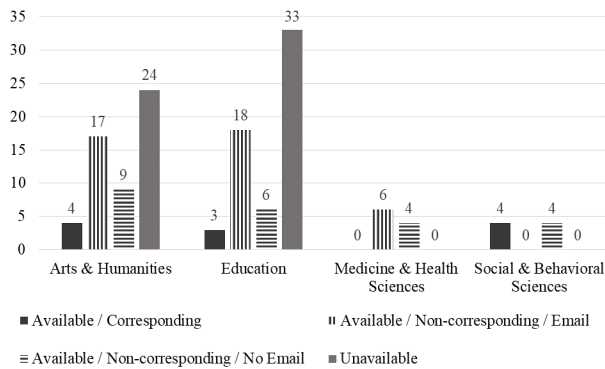


Figure 6. Copyright policies of journals not listed in SHERPA/RoMEO.

Unpaywall

Unpaywall detected open access documents for 1.1% of AH works, 3.9% of ED works, 32.6% of MHS works, and 19.2% of SBS works (Figure 7). The OA finder located more

published versions of the AH, ED, and MHS works, but more pre-prints and post-prints of the SBS works. Unpaywall found documents from journal websites as well as repositories and databases for MHS and SBS works, but only from journal websites for AH and ED works (Figure 8). More MHS documents were from journal websites, but more SBS documents were from repositories and databases. For AH, MHS, and SBS works, the majority of the full-text detected by Unpaywall could be deposited in an IR unlike for ED works (Figure 9).

For works that Unpaywall could not locate a document to be legally uploaded, Google and Google Scholar found documents for the majority of ED (69.7%), MHS (52.1%), and SBS (77.2%) works, but not for AH works (17.0%) (Figure 10). Most of the documents were the published version. The author found more AH and MHS documents through Google and Google Scholar from journal websites, followed by personal websites, and repositories/databases (Figure 11). ED documents primarily came from journal websites, but SBS documents primarily came from personal websites. Approximately half of the AH works could be deposited into an IR with the other half having an unclear depositing status (Figure 12). ED and MHS had higher rates of documents with an unclear depositing status followed by documents that could be uploaded legally. SBS had very high rates of documents that could not be legally deposited into an IR followed by documents that could.

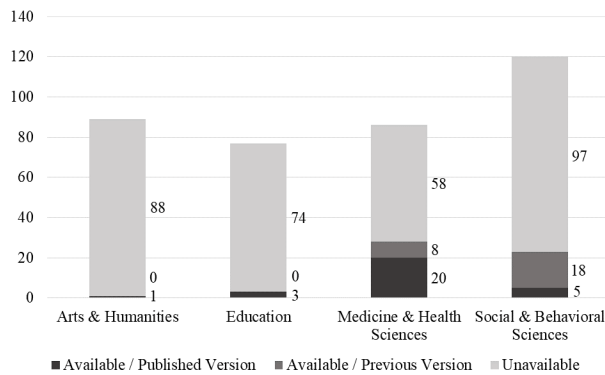


Figure 7. Availability of documents detected by Unpaywall.

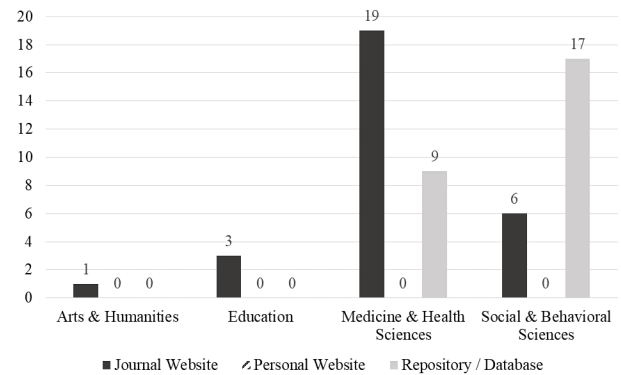


Figure 8. Location of documents detected by Unpaywall.

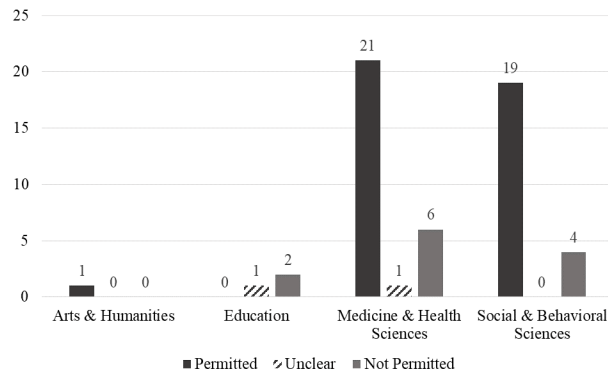


Figure 9. Permissions to deposit the document detected by Unpaywall.

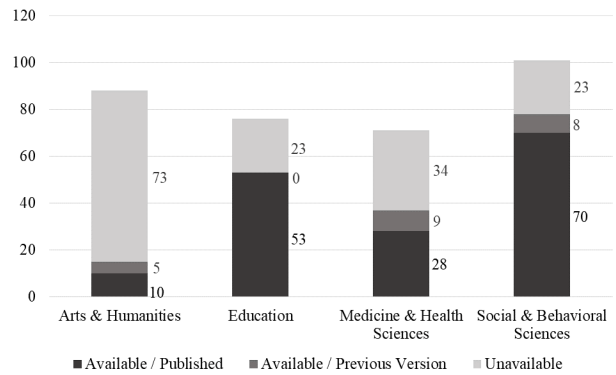


Figure 10. Availability of documents through Google and Google Scholar that Unpaywall could not detect a version to be legally deposited.

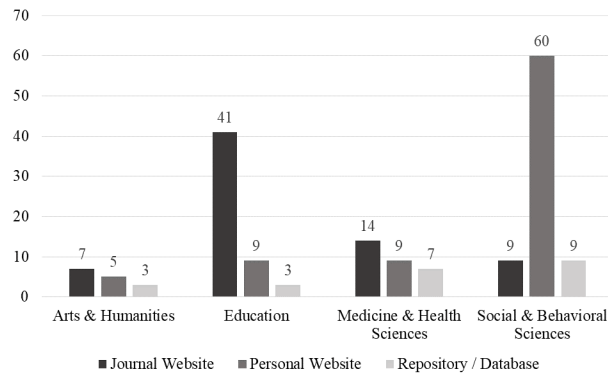


Figure 11. Location of documents discovered through Google/Google Scholar.

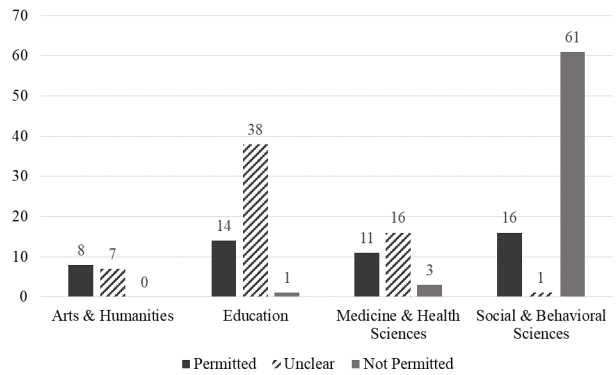


Figure 12. Permissions to deposit the document discovered through Google and Google Scholar.

Types of Publishers

The majority of MHS (84.9%) and SBS (79.2%) works were published on commercial publisher websites over aggregators, university presses, university websites, and learned society websites. In contrast, the majority of ED works (62.3%) were published on learned society websites over commercial publishers, aggregators, university presses, and university websites. Works authored by AH faculty are more distributed among the different types of publishers.

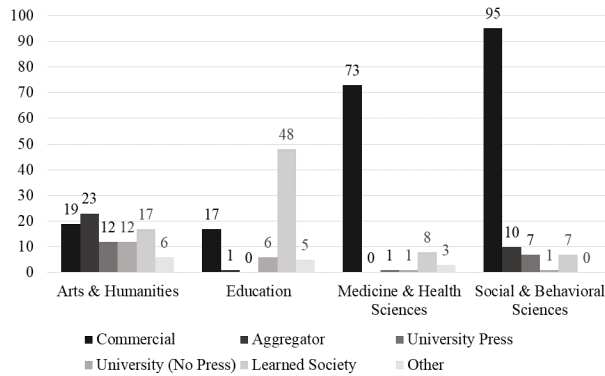


Figure 13. Types of publishing websites.

Works from commercial publishers across all disciplines had high rates of availability in Zotero, SHERPA/RoMEO, and Unpaywall. Specifically, Unpaywall primarily detected works from commercial publishers in comparison to other publishers. University presses also had a high percentage in Zotero and SHERPA/RoMEO, and aggregators had high percentages in Zotero. However, aggregators had low percentages for AH journals in SHERPA/RoMEO, but high percentages in the fields of ED and SBS. The availability rates varied based on disciplines for works published on university or learned society websites. For learned society websites, availability in Zotero was lower for AH and ED works than MHS and SBS works, but availability in SHERPA/RoMEO was lower for AH, ED, and SBS works than MHS works. For university websites, availability in Zotero was lower in AH and ED than MHS and SBS, but availability was low in SHERPA/RoMEO across all disciplines.

Table 4

Comparison of Available Information and Documents from Zotero, SHERPA/Romeo, and Unpaywall Based On Disciplines and Publishers

Type of Publisher	Art & Humanities			Education			Medicine & Health Sciences			Social & Behavioral Sciences		
	A	U	%	A	U	%	A	U	%	A	U	%
Zotero												
Commercial	19	0	100	17	0	100	73	0	100	95	0	100
Aggregator	19	4	82.6	1	0	100	0	0	-	10	0	100
University Press	12	0	100	0	0	-	1	0	100	7	0	100
University	2	10	16.7	1	5	16.7	1	0	100	1	0	100
Learned Society	4	13	23.5	22	26	45.8	7	1	87.5	7	0	100
Other	1	5	16.7	1	4	20.0	3	0	100	0	0	-
SHERPA/RoMEO												
Commercial	19	0	100	14	3	82.4	70	3	95.9	95	0	100
Aggregator	5	18	21.7	1	0	100	0	0	-	9	1	90.0
University Press	11	1	91.7	0	0	-	1	0	100	7	0	100
University	0	12	0.0	0	6	0.0	0	1	0.0	0	1	0.0
Learned Society	0	17	0.0	2	46	4.2	5	3	62.5	1	6	14.3
Other	0	6	0.0	0	5	0.0	0	3	0.0	0	0	-
Unpaywall												
Commercial	0	19	0.0	1	16	5.9	27	46	37.0	21	74	22.1
Aggregator	0	23	0.0	1	0	100	0	0	-	0	10	0.0
University Press	1	11	8.3	0	0	-	0	1	0.0	2	5	28.6
University	0	12	0.0	1	5	16.7	0	1	0.0	0	1	0.0
Learned Society	0	17	0.0	0	48	0.0	1	8	12.5	0	7	0.0
Other	0	6	0.0	0	5	0.0	0	3	0.0	0	0	-

Note. "A" is available. "U" is unavailable. % is the percent of availability.

Discussion

The results of the study indicate that Zotero, SHERPA/RoMEO, and Unpaywall would be the most useful when creating profiles for faculty within the fields of MHS and SBS, but least useful within AH and ED. The difference in results may have been due to the types of publishers most commonly used within each discipline. The following discussion examines these findings within the context of other research and its real-world effects.

Zotero

Zotero had the most success importing MHS works followed by SBS, AH, and ED works. However, Zotero did not perform perfectly, as almost a tenth of the MHS fields had missing or incorrect metadata. The findings correspond with other studies that concluded that the

importing features of reference management systems (RMS) are never perfect (Basak, 2014a; Basak 2014b; Homol, 2014; Gilmour & Cobus-Kuo, 2011). This indicates that users across disciplines cannot rely on the importing function of Zotero or other RMS to be consistently accurate. In particular, users should pay close attention to fields that selectively import metadata such as the publication date, ISSN, and URL. For example, the Charles C. Sherrod Library staff decided that Zotero's propensity to use the issue's publication date and print ISSN was acceptable, but had issues with the lack of DOI permalinks in the URL field. The reaction could be different based on the use case.

The types of publishers corresponded with the amount of available records in Zotero within each discipline. MHS and SBS works were published on commercial websites which featured each work on an individual webpage. In contrast, AH and ED journals had a significant portion of works on university and learned society websites that published issues as a single PDF or had little to no information about the work on the website. This drastically affected which works could realistically be imported into Zotero. In terms of accuracy, the author noticed that the work's publisher influenced what metadata was imported. For example, Elsevier publications imported the non-DOI URL, but SAGE publications imported the DOI permalink into Zotero. Homol (2014) also observed that metadata quality in RMS was due to the source of metadata rather than the RMS. Zotero requires that publishers expose bibliographic metadata on their website through Zotero-compatible OPA software packages, embedded metadata, Coins, unAPI, and a Zotero web translator (Zotero, n.d.). Therefore, publisher practices has an impact on availability and accuracy of records in Zotero.

Although the RMS had issues with importing works in the AH and ED disciplines, Zotero still may be a viable option for those users when considering the additional benefits of

Zotero. Zotero is particularly popular among those in AH, which can partially be attributed to Zotero's ability to handle multimedia objects (i.e. attaching images) (Chen, Hayes, Larviere, & Sugimoto, 2018; Lonegran, 2017; Rempel & Mellinger, 2015). In addition, Zotero has been tested against other RMS and have shown its flexibility in importing from different sources, which is needed for AH and ED works (Gilmour & Cobus-Kuo, 2011). Furthermore, there is not a strong alternative as all RMS have similar problems importing works (Basak, 2014a; Basak 2014b; Gilmour & Cobus-Kuo, 2011; Homol, 2014). As demonstrated in this study, this may be caused by publisher practices which would affect all RMS, not just Zotero.

SHERPA/RoMEO

As with Zotero, ED and AH works were less represented in SHERPA/RoMEO than MHS and SBS works. However, comparisons to previous studies were not as apparent as with RMS research. Over one third of the journals' copyright policies were not listed in SHERPA/RoMEO, which was ten percent more than the highest rate of unavailability in other studies. ED and AH journals were the cause of the higher percentage, as MHS and SBS journals had closer rates of unavailability to other research findings. While this indicates a possible trend between disciplines, it may also show the limitations of the current sample size. In terms of disciplines, the publishing practices affected the amount of records available in SHERPA/RoMEO. Commercial publishers and university presses used by MHS and SBS had consistently high rates of being in SHERPA/RoMEO in contrast to university and learned society websites used by AH and ED.

For graded journals, SHERPA/RoMEO was accurate across all the disciplines, reinforcing the database's authority to be used in research and workflows. For those not listed in SHERPA/RoMEO, most AH and ED journals did not have copyright policies that included if

authors could deposit pre-prints, post-prints, and published versions of their journal publications in an institutional repository (IR). In comparison, a small percentage of journals with policies that matched SHERPA/RoMEO's format were not in the database, which indicates that SHERPA/RoMEO is comprehensive for journals that have developed policies. Once again, the lower rates can be attributed to the journal or publisher rather than SHERPA/RoMEO, as the database cannot include policies that do not exist.

SHERPA/RoMEO is an accurate database but not always representative of all disciplines, which needs to be a consideration when using the database in IR workflows. Perhaps more importantly, it needs to be considered when advising researchers to consult the database to determine the self-archiving policies of journals. Faculty have stated that uncertainty about copyright policies has prevented them from self-archiving their publications (Kim, 2010). Introducing SHERPA/RoMEO to faculty has been a solution to this problem (Kristick, 2008; Repanovici & Barsan, 2015). However, researchers on campus may become more frustrated if recommended a database in which their field is underrepresented. More research needs to be conducted on this topic so that librarians can confidently tell their patrons which disciplines are underrepresented in order to save that frustration.

Unpaywall

Unpaywall detected documents for one third of MHS works, one fifth of SBS works, and a very small percentage of AH and ED works. According to Priem et al. (2018), Unpaywall users only encounter 47.0% of OA documents, which is significantly higher than what was found in the current study. One reason for this difference is that Unpaywall users tend to search for newer articles and the publications in the current study was published between 2011 and 2016. However, the amount of documents found by Unpaywall do reflect other OA studies that state

medicine and health sciences have high OA rates followed by social and behavioral sciences and arts and humanities (Archambault et al. 2014; Bosman & Kramer, 2018; Martín-Martín et al., 2018; Piwowar et al., 2018). As with Zotero and SHERPA/RoMEO, the publishers influenced the results within the disciplines. For the Unpaywall for Chrome extension to detect an OA version, the work needs to be assigned a DOI, which is often the responsibility of the publisher. AH and ED works were at a disadvantaged because their publishers were less likely to assign DOIs than the MHS and SBS works.

Although Unpaywall finds legally uploaded documents for reading purposes, the majority of documents detected by Unpaywall in this study could also be uploaded to an IR. Even though Unpaywall found more documents for MHS works, Unpaywall was the most useful for SBS works from an IR manager perspective. The MHS documents that could be legally uploaded were primarily from publisher websites, which the author was already visiting to activate the Unpaywall for Chrome extension. In contrast, Unpaywall found more SBS pre-prints and post-prints from repositories and databases, saving the author time from having to search for these versions.

Manually searching Google and Google Scholar found many documents that went undetected by Unpaywall. Of course, this was to be expected based on the research that compared Google and Google Scholar with OA finders (Chen, 2013; Emery, 2018; Lyons & Booth, 2011; Norris et al., 2008; Piwowar et al., 2018; Schultz, 2017b; Walters & Daley, 2018). Approximately 10-15 of those works could be uploaded for each discipline, but ED, MHS, and SBS works had more versions that could not be legally uploaded. ED and SBS had high rates of discoverability from Google and Google Scholar, but this does not equate to a high number of deposits. ED had an overwhelming amount of documents from the publisher websites, which

went undetected by Unpaywall due to the lack of DOIs. SBS had an overwhelming amount of documents from personal webpages, which went undetected by Unpaywall because the tool does not harvest from websites such as ResearchGate. Neither Google nor Unpaywall were perfect products for finding documents to deposit in an IR. While Unpaywall supplied versions from reputable sources, it missed some documents that could have been uploaded. In contrast, Google and Google Scholar found a high number of documents that could not have been uploaded, which an IR manager would have to determine by dedicating time to review all those documents.

Effects on the Workflow

Ultimately, the results of this study represent the amount of time it would require staff to input the works into the IR. The measurement of time can be exemplified by integrating the results within the original workflow (Table 5). It would take the DSL and students assistants significantly longer to complete requests from AH and ED faculty than MHS and SBS faculty. The logical conclusion would be to continue to use the tools for the sciences, but reevaluate them for other disciplines. However, better tools may not exist given that most of the issues appear to be caused by publisher practices rather than the tools themselves. In addition, having multiple workflows based on disciplines can be difficult when training student assistants. Therefore, the Charles C. Sherrod Library decided to continue using the combination of the three tools, while passively searching for new and better solutions.

Table 5.*Differences of workflow for each discipline based on the results of the study*

	Arts & Humanities	Education	Medicine & Health Sciences	Social & Behavioral Sciences
Receive Request	N/A	N/A	N/A	N/A
Import Data into Zotero	Import 65% and manually enter 35% of works; Correct 15% of the metadata	Import 55% and manually enter 45% of works; Correct 30% of the metadata	Import all works; Correct 10% of the metadata	Import all; Correct 15% of the metadata
Find Copyright Policies in SHERPA/RoMEO	Find policies for 40% of journals in S/R; Search for policies for 60% of journals and contact 75% of those journals.	Find policies for 20% of journals in S/R; Search for policies for 80% of journals and contact 85% of those publishers.	Find policies for 90% of journals in S/R; Search for policies for 10% of journals and contact 40% of those journals.	Find policies for 95% of journals in S/R; Search for policies for 5% of journals and contact none of those journals.
Export/Transfer Data	N/A	N/A	N/A	N/A
Locate Full-Text Documents with Unpaywall	Find documents for 5% of the works through Unpaywall; Search for 95% of publications in Google.	Find documents for none of the works through Unpaywall; Search for all publications in Google.	Find documents for 20% of the works through Unpaywall; Search for 80% publications in Google.	Find documents for none of the works through Unpaywall; Search for all publications in Google.
Upload Data and Documents	N/A	N/A	N/A	N/A
Import IR Records to Profile	N/A	N/A	N/A	N/A
Alert Faculty of Profile	N/A	N/A	N/A	N/A

Limitations

The sample size of the study was dependent upon faculty who sent their curriculum vitae (CVs) to request a SelectedWorks profile. Although the study varied the faculty's rank to provide a comparable sample for each discipline, there was not enough SelectedWorks profiles requests to vary the sub-disciplines. For example, a third of the faculty in the social and

behavioral sciences (SBS) were based in psychology, which tends to have higher OA rates than other SBS sub-disciplines (Bosman & Kramer, 2018).

Conclusion

The study's findings identified possible trends that will need follow-up research to further evaluate Zotero, SHERPA/RoMEO, Unpaywall and related tools on various criteria such as disciplines and publishing practices. Studies in relation to these tools have such potential due to their multitude of uses beyond integrating in institutional repository workflows such as OA finders in interlibrary loan services and library discovery systems (Fahmy, 2018). Based on the study's results, Zotero, SHERPA/RoMEO, and Unpaywall work best with certain disciplines over others due to differing publisher practices. In order to work with Zotero, SHERPA/RoMEO, and Unpaywall as well as a multitude of other emerging tools, publishers will need to ensure open metadata practices, clear copyright policies, and assigned DOIs. These are important investments of time as these tools help in citing, disseminating, and locating journal publications, all of which increase the publications' usage and impact. Despite some of the disciplinary disadvantages, the study clearly indicates that these tools can improve a manual IR workflow and gives hope to further automate the depositing practices of IRs in the future.

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