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Comparison of Select Reference Management Tools

Yingting Zhang

ABSTRACT. Bibliographic management tools have been widely used by researchers to store, organize, and manage their references for research papers, theses, dissertations, journal articles, and other publications. There are a number of reference management tools available. In order for users to decide which tool is best for their needs, it is important to know each tool’s strengths and weaknesses. This article compares four reference management tools, one of which is licensed by University of Medicine and Dentistry of New Jersey libraries and the other three are open source and freely available. They were chosen based on their functionality, ease of use, availability to library users, and popularity. These four tools are: EndNote / EndNote Web, Zotero, Connotea, and Mendeley Desktop / Mendeley Web. Each tool is analyzed in terms of the following features: accessing, collecting, organizing, collaborating, and citing/formatting. A comparison table is included to summarize the key features of these tools.

KEYWORDS. bibliographic management software, bookmarking tools, citation managers, citation generators, Connotea, EndNote, EndNote Web, Mendeley Desktop, Mendeley Web, reference management tools, reference managers, reference organizers, research tools, Zotero

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BACKGROUND

Bibliographic management tools have been widely used by researchers and scientists to store, organize, and manage their references for research papers, theses, dissertations, journal articles, and other publications. The University of Medicine and Dentistry of New Jersey (UMDNJ) Libraries have been providing support and download license for EndNote to its affiliated users for over a decade. Librarians have played a very important role in helping faculty, students, and staff with their research by using EndNote as the bibliographic management tool. They offer classes, provide troubleshooting, and answer all kinds of questions on the use of this tool. It was not until recently that the author was questioned by users if there were any other reference management tools available to them other than EndNote. There are a number of reference management tools available. Some are stand-alone desktop programs, while others are web-based services, or even an add-on to a browser. In order for users to decide which tool is best for their needs, it is important to know each tool’s strengths and weaknesses. Charged with the desire to provide the best answer to the users’ question, the author started exploring other reference management tools that are freely available to the public. Exploration involved searching in the Internet; reading forum posts and messages on related mailing lists; visiting major medical libraries’ web pages; conducting literature searches in databases such as Academic Search Premier, ERIC, and Social Sciences Citation Index; and experimenting with
the tools. As a result, four reference management tools were selected for comparison. Except for one tool which is licensed by the UMDNJ University Libraries, the other three are open source and freely available. They were chosen based on their functionality, ease of use, availability to library users, and popularity. These four tools are: EndNote (including EndNote for the desktop and EndNote Web), Zotero, Connotea, and Mendeley (including Mendeley Desktop and Mendeley Web). Each of these tools was carefully analyzed, tested, and evaluated. This article describes the major functions and features of each tool, including strengths and weaknesses (see Table 1 for a comparison chart of the four reference management tools). Each tool is analyzed in terms of accessing, collecting, organizing/managing, collaborating, and citing/formatting, to clearly present the similarities and differences among the chosen tools.

[PLACE FIGURE 1 HERE]

Legend: FIGURE 1. Comparison of Select Reference Managers

ENDNOTE / ENDNOTE WEB

EndNote is a commercial bibliographic management program that can be purchased by individuals or site-licensed by institutions. Produced by Thomson Reuters, EndNote was first released in 1988. As a pioneer in this domain, it is one of the best known reference management tools. EndNote has been widely used by researchers, faculty, and students to collect, store, organize, and manage their references, images, and PDFs, as well as to insert references into their manuscripts and to place figures and tables anywhere in a Word or other word processing document. It also allows users to create subject bibliographies and reading lists. EndNote is
available in two platforms: a full-featured stand-alone desktop program and EndNote Web. EndNote Web serves as an online supplement to EndNote desktop, though it can be fully functional on its own. One does not have all the features of the other, and vice versa; they are complementary to each other.

**ENDNOTE FOR THE DESKTOP**

The EndNote desktop program is available for Windows and Mac. The latest version for Windows is EndNote X5 which was released in June 2011 (see Figure 2), while the latest version for MAC is X4.0.2. Its major functions are to collect and organize references from online resources; create a searchable database of references; find and cite references while writing; and make bibliographies that are formatted in a preferred style. It can also attach PDF files to references and store them in a corresponding data folder. EndNote has a large storage capacity. There is no limit to the number of libraries a user can create or how many references are stored in an EndNote library. It is often more convenient for users to insert references into their manuscript from one single library as a central collection of references rather than from multiple libraries, which can be confusing and tedious. Being a sophisticated bibliographic database management system, EndNote is not considered very easy to use for beginners. Initial training is very helpful.

[PLACE FIGURE 2 HERE]

Legend: FIGURE 2. EndNote Desktop
Accessing

A stand-alone desktop program, EndNote desktop can be downloaded and installed only on individual computers. It can only be accessed through the installed computer. If a user works with multiple computers, then he or she has to: (1) install EndNote on all the needed computers, then transport the libraries across computers by compressing and saving them to a flash drive or into Dropbox to be opened in the other computers, or e-mail the compressed library as an attachment to be opened elsewhere; or (2) open an EndNote Web account to transport libraries between EndNote desktop and EndNote Web, which lives in the cloud and is accessible wherever there is an Internet connection.

Collecting

Once an EndNote library is created, there are several ways to add references into that library. (1) Import references from an online database with an appropriate import filter directly or indirectly depending on the functions of the database searched and the browser used. (2) Search a remote database directly from EndNote desktop using an appropriate connection file, a distinctive feature of EndNote that many other major reference managers do not have. EndNote’s native search engine enables searching not only within the local reference library but also a remote online database and fetching the results directly into an EndNote library. (3) Create a reference by importing a PDF file or a folder of PDFs into an EndNote library, given they are embedded with DOIs (Digital Object Identifier). Metadata will be automatically extracted from the PDFs. It is not possible, though, to create a record from a scanned PDF article. 4) Add references
manually. This is the least desirable way to create records as it is time consuming and more prone to mistakes. However, there are times when this is the only option to use.

**Organizing**

EndNote library records can be organized by group sets and groups which can be created in the left navigation pane. Up to 500 group sets and 500 custom groups can be created in one EndNote library. Custom groups can be categorized by any type as you desire, such as by subject, year, reference type, and so on. Users can also create smart groups to build subsets of references automatically based on the search strategies that were previously set up. They are dynamically updated as references are added, deleted, or edited in the library. References can also be easily sorted, browsed, and searched. Duplicate references can be removed without difficulties. EndNote has the function to manage PDF and image files, which can be attached to references with a thumbnail icon displayed in an appropriate field, and the full size of the file is kept in the accompanying data folder. In the latest version, EndNote X5, a new built-in PDF viewer was added in the Quick Edit tab to allow users to preview, annotate PDFs, and search within a PDF full text. If more than one PDF is attached, users can choose what they want to work with. Another appealing feature in EndNote is the Find Full Text function which has been heavily used by researchers. Institutional users can quickly find full-text articles from the subscribed e-journals either within or outside their network. To find full text from outside the institution’s network users need to apply the OpenURL linking capabilities and a proxy server.

**Collaborating**
EndNote Desktop is a stand-alone reference management program. Its libraries are saved and stored locally; therefore, they cannot be shared with collaborators without being e-mailed or transported to the web version. They are definitely not able to be shared publicly. It is not possible for multi-users to work with the same libraries simultaneously.

**Citing**

One of the most powerful features of EndNote is CWYW (Cite While You Write). Like its name, it cites while a user writes a paper in a word processor. To use this feature, a plug-in has to be added to Word or other word processors. With 4,500 pre-loaded bibliographic reference styles residing in both EndNote and Word, users can easily insert references in a Word document in any style of choice. They can switch to another style at any time. If a desired style is not found, it can be created, though the process of creating a new style can be very daunting, requiring meticulous attention to details and organizational skills. Users can also create formatted bibliographies with a few clicks.

**ENDNOTE WEB**

EndNote Web is the web-based version of EndNote (see Figure 3), a supplement to the EndNote desktop program, though both can be used separately. The latest version of EndNote Web is 3.1.1. EndNote Web references can be easily transferred to and from an EndNote desktop library. Like the desktop, EndNote Web also collects, stores, and organizes references, but the storage
capacity is much smaller. It used to allow for up to 10,000 references stored in an EndNote Web library. However, users who register with EndNote X5 can enjoy up to 25,000 records in the web library and receive up to 1GB of web storage for file attachments which are not available for users of older versions.²

[PLACE FIGURE 3 HERE]

Legend: FIGURE 3. EndNote Web

Accessing

Institutions subscribing to Thomson Reuters Web of Science may have access to EndNote Web through the Web of Science database. The same account created for Web of Science can be used for an EndNote Web account. EndNote desktop individual licensees may access EndNote Web at <http://myendnoteweb.com>. Because it is web-based, EndNote Web can be accessed anywhere and anytime as long as there is an Internet connection. As mobile technologies are advancing at an accelerated speed, EndNote Web references can also be accessed on the go. Users simply login to the EndNote Web Mobile Site to access their references saved in EndNote Web. The site can then be added to the mobile device’s home screen for easy access at a later time. The mobile site does not have all the functions of the full EndNote Web version. It is designed for quick and easy access instead of conducting comprehensive work in the mobile device.

Collecting
EndNote Web users can collect references several ways: (1) search remote online databases directly from EndNote Web; (2) import references from EndNote desktop or online databases; (3) enter references manually; or 4) use the EndNote Web toolbar in a web browser to save online references or to capture web pages directly into a library. It is worth mentioning that the captured information of a web page reference is very limited. Basically only two fields are captured: the title field and the URL field. Users need to manually enter all the other metadata into the record before saving it into EndNote Web or a desktop library.

**Organizing**

EndNote Web references can be arranged in groups which can be shared with other EndNote Web users. The shared groups can be set for read only or read & write permissions. Users who are given the read & write permission can edit and delete references from the shared group but not from the owner’s EndNote Web library. Duplicate records can be identified and removed. Users who registered with EndNote X5 can now manage the file attachments in an EndNote Web library.

**Collaborating**

As mentioned earlier in the Organizing section, groups in an EndNote Web library can be shared with other EndNote Web users. Therefore, it is possible for users to collaborate their research work with colleagues and other selected people via EndNote Web. However, it is not possible to share research publicly.
Citing/Formatting

With a free CWYW plug-in in Word and over 1,300 output styles, EndNote Web allows users to insert references into a Word document. It can also create formatted bibliographies in a chosen style.

ZOTERO

Zotero is a free and open source bibliographic manager developed by George Mason University in 2006. It has two components: the free add-on for Firefox and a web account. Unfortunately Zotero does not work with other browsers. The latest stable version of Zotero’s add-on extension is 2.1.8, requiring Firefox 3 or later. Once it is downloaded, a Zotero button will be placed at the lower right corner of the Firefox browser screen (see Figure 4). Zotero’s unique interface makes it very convenient for users to grab resources online while surfing the Internet. It can easily capture a web page, a journal article or a list of references from an online database, a piece of news from a newspaper, or a book record from an online catalog. To transport libraries among computers, users need to register for a Zotero web account to make a copy of the library in the web space and synchronize it into another computer. As this article is being written, Zotero 3.0 beta version (a stand-alone version of Zotero, also called Zotero Everywhere software) was just released. Zotero Everywhere is an Andrew W. Mellon Foundation grant-funded initiative aimed at “increasing the accessibility of Zotero to the widest possible range of users” according to the Zotero Blog. Zotero 3.0 beta does not require Firefox to run and is available for Mac OS X, Windows, and Linux. However, “Zotero 3.0b1 and the Connectors are beta software! If you’re in
the middle of a project or not comfortable running beta software, use Zotero 2.1, the latest stable release of Zotero, instead.”

[PLACE FIGURE 4 HERE]

Legend: FIGURE 4. Zotero

Accessing

With the availability of the Zotero web account feature, users do not have to be confined to a local computer and Firefox only to access a Zotero library. They can have access to Zotero references anytime and anywhere as long as they have a Zotero web account and there is an Internet connection. Although Zotero offers a free web account for collaborative storage that allows users to synchronize their Zotero collections across multiple computers and to share files within a small group or publicly, the free web storage space is extremely limited. It can hold only up to 100 MB free space, which can be easily filled up. For more web storage space, users have to pay a fee to upgrade the account. The fee, however, is not significant. The fact that users have to pay to get a decent size of web space makes Zotero, which is supposed to be a free tool, essentially no longer free.

Collecting

As mentioned earlier, Zotero’s unique interface makes it very easy to add references from online resources. Like EndNote, Zotero allows several ways to add references into a Zotero collection:
(1) Easily capture a web page with not only the bibliographic information but also a snapshot of the web page. Users can then add any missing metadata or notes to any part of the captured web page. (2) Grab a citation or a list of citations retrieved from an online database, e.g. PubMed, by clicking the file or folder icon in the browser search box. (3) Some sites like YouTube, New York Times, etc. have their own site translators to allow the content to be imported into a Zotero collection. (4) Import references from other bibliographic management tools.

**Organizing / Collaborating**

Users can create folders to organize their references by subject, format, sources, or any other types. Groups of references can be created for sharing and collaborating. Users are allowed to attach PDFs, documents, and images to references. They can also add notes and tags in references. For web page references, users will not only capture most of the metadata but also the web page’s snapshot to which annotations can be added. Similar to a feature in EndNote, Zotero also allows users to access full-text articles from subscribed e-journals by configuring the OpenURL link resolver in Zotero preferences. As previously mentioned, Zotero references can be synchronized across multiple computers through a user’s web account where references can be shared within a small group or publicly.

**Citing**

Like EndNote’s CWYW, Zotero also works with several different versions of such word processors as Word and OpenOffice / NeoOffice. With Zotero plug-ins installed in the word
processor, users are able to insert citations or footnotes from a Zotero collection into their manuscript. They can also cite references easily by dragging and dropping references directly from a Zotero collection into a paper. Users can also easily create stand-alone bibliographies and reports. It is worth mentioning that although Zotero offers the major styles, it has much fewer pre-defined journal specific styles (1,624 at the time this article was written, http://zotero.org/styles) for users to choose from for citing and formatting references than EndNote, which provides 4,500 bibliographic styles. Nevertheless, Zotero supports CSL-based citation formatting. CSL stands for Citation Style Language which is an open XML-based language used to describe formatting of citations and bibliographies. Zotero as one of the CSL supporters shares the pool of over 1,000 styles hosted at the CSL website. It is expected that the style collection will get expanded quickly with an increasing body of the user community.

**CONNOTEA**

Connotea is a free web-based online citation management tool. It was developed by Nature Publishing Group in 2004, designed for use by researchers, clinicians, and scientists. Similar to Delicious, Connotea is a social bookmarking tool allowing users to bookmark links to the web sites that they are interested in. But Connotea functions as more than just a basic social bookmarking service. It has the capabilities to automatically extract the bibliographic information from a number of scientific, academic, and other scholarly resources, whether they are “the PubMed entry, the publisher's PDF, or even an Amazon product page for a book.” Compared to other reference management tools, Connotea offers a very quick and easy way to collect, organize, and share online resources with other colleagues and peers.
**Accessing**

As a web-based open source tool, Connotea is easily accessible. There is no need to download or install anything. Users just need to register for a web account at the Connotea website with some basic personal information and get started (see Figure 5). Since it is located in the cloud, users can access their Connotea library anywhere and anytime via a browser and an Internet connection.

![PLACE FIGURE 5 HERE](image)

**Legend:** FIGURE 5. Connotea

**Collecting**

Adding or saving an online reference into Connotea is extremely easy. There are several ways to save references into a Connotea library. (1) Users can use the “Add to Connotea” browser button to add an online reference including bibliographic information such as title, author as well as publication name and even PDFs, given the sites are recognized by Connotea, into their library. Clicking on the browser button or bookmarklet will open a pop-up window in which a populated form is displayed. Users at this point can assign keywords or tags, description, or comments for that source. (2) Connotea also allows users to add an article reference by entering the article’s DOI in the form. The complete metadata of the article will then be automatically retrieved. (3) For those web sources whose metadata are not recognized by Connotea, users can add them
manually in the Connotea generic form. (4) It is also possible to import a number of references or links to a Connotea library in one batch, including references from EndNote and other reference management tools. But some tweaking is necessary in order to import them properly. One of the major strengths for Connotea is that there is no storage limit. Users can store as many references as they want in their Connotea library.

**Organizing / Collaborating**

When the references are being bookmarked or saved, users will have the option to keep the links public or private. By default, the references will be kept public and will be shared with the general public. Those references that are kept private will be viewed only by the user. Another way of organizing a Connotea library is to create groups of references to keep them public or private. Notes and full-text articles are shared only in private groups, not in the public groups. Connotea provides RSS feeds which allow users to keep track of literature under related tags or research work of researchers in the shared discipline. It is possible to export references to EndNote and other reference management tools. OpenURL links can be enabled at the Advanced Settings so that full-text articles from subscribed e-journals can be retrieved.

**Citing/Formatting**

The major disadvantage of Connotea is that it does not support creation of bibliographies, nor does it allow users to cite references into a paper in any of the word processors. However, users can easily export their references into other reference management tools such as EndNote and
Mendeley is a free bibliographic reference management tool as well as an academic social network for researchers and scientists. Mendeley was launched in 2008. Based in London, its team consists of researchers, graduate students, and open source developers from different academic institutions. Similar to EndNote, it has two components: Mendeley Desktop application and Mendeley Web interface. Mendeley makes it easy for users to manage and annotate their paper collections, mostly PDF files, to collaborate with colleagues in their research work, and to discover relevant papers and statistics in their research field. Reference libraries from Mendeley Desktop (see Figure 6) can be easily and quickly synchronized and backed up in Mendeley Web (see Figure 7). Mendeley also offers a mobile app Mendeley - Reference Manager (Lite) for iPhone, iPod touch, and iPad. According to a few customer reviews, the app is not very stable and crashes often. Mendeley Desktop and Mendeley Web, despite their distinctive features, are dependent on each other to such an extent that it is impossible to analyze one platform without mentioning the other. Their functions are utilized to the maximum when used in combination, as their features complement to each other. Therefore, instead of addressing these two platforms separately, as done for EndNote, they will be analyzed together as a whole.

[PLACE FIGURE 6 HERE]

Legend: FIGURE 6. Mendeley Desktop
Mendeley Desktop can be downloaded free at its web site after signing up for a free web account for Mendeley Web. It is available for Windows, Mac, and Linux operating systems. The latest version is v.1.0.1. Researchers can use Mendeley Desktop to organize their references, store their collected papers, annotate and highlight them in the PDF viewer, share their research with others in the groups they joined, and cite references in a word processor.

Mendeley Web is a web-based service, freely available to the public. Users can register for a free web account at the Mendeley website. It offers 1 GB free web space with 500 MB for personal collections and 500 MB for groups as well as five private groups with 10 members in each private group. If a user needs more web space and more private groups, he or she has to upgrade the account by paying a fee. By installing the Mendeley importer, i.e., the “Import to Mendeley” button in the browser’s tool bar, users will be able to easily capture online references into Mendeley Web. Mendeley Web also helps users back up their libraries of references online and to harvest the research statistics such as the most read articles in all disciplines or in a particular area, e.g., Medicine, or the most read authors, allowing the users to know the research trends in their academic discipline.

Accessing

Like EndNote desktop, Mendeley Desktop is also a stand-alone local program. It is installed on an individual computer; therefore, the program itself can be accessed only via that installed
computer. However, its libraries can be synchronized with Mendeley Web with only one click. The libraries can then be accessed via the web platform wherever an Internet connection is available. They are also accessible on the go via the mobile app, though it is still at a preliminary stage.

**Collecting**

Mendeley is a great tool to collect and store articles in PDF. It can add references by dragging and dropping PDFs or a folder of PDFs into a Mendeley library. The metadata of these PDF articles will be automatically extracted and saved in the library. Any missing information will also be automatically retrieved from CrossRef and PubMed by entering the DOI or PMID. PDFs can also be added by using the “Add Files” “Add Folders” and “Watch Folders” features located in the left pane of the Mendeley Desktop interface. Another way to add references into the desktop version is to import references from existing EndNote/BibTeX/RIS databases. Unlike EndNote, which allows direct search in a remote database via its native search engine, Mendeley does not support Z39.50; therefore, searching external databases and fetching references directly from them is not feasible. However, with the help of Mendeley Web’s cross-browser Web Importer, users can quickly and easily grab references from websites and online databases into a Mendeley Web library.

**Organizing**

Mendeley is known for its strong features of PDF management. With the collected PDF articles,
Mendeley allows users to read, tag, annotate, and highlight the research papers in the built-in PDF viewer. Users can also search for any keywords in the full text of the articles, making it very convenient for users to locate their desired information. Folders can be used to categorize references.

**Collaborating**

Like Connotea, Mendeley’s ability to allow users to collaborate is very appealing. Researchers can share references by using groups to join other groups or create their own and invite collaborators. As mentioned earlier, with the free web account, a user can create up to five private groups with 10 members. Public groups allow the users to share references all over the world. Mendeley aggregates its users’ paper collections and pools them together, making it a constantly expanding research database available for the general public. According to the counter at the Mendeley website, there are over 106 million papers in its research catalog. Also like Connotea, Mendeley allows users to create profiles to share research interests. This concept is quite similar to another social networking tool, LinkedIn. Therefore, Mendeley Web is also a good place for users to get connected with other researchers who share the common interests.

**Citing / Formatting**

Mendeley has the capability to cite while you write. It provides plug-ins for Word and OpenOffice. Based on the author’s experience, the citing function in Mendeley is not as user-friendly as EndNote’s CWYW feature. Like Zotero, Mendeley also uses the CSL to format
citations and bibliographies in Word and OpenOffice plug-ins. Therefore, it provides the same number of pre-defined journal citation styles as Zotero does, much fewer than the 4,500 plus styles EndNote offers.

CONCLUSION

Each of the four bibliographic reference management tools described in this article has both strengths and weaknesses. None of them is perfect, and none of them can be used for all purposes. Users should make the best use of each tool’s strengths for their needs.

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