Citation Apps for Mobile Devices

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Title
Citation Apps for Mobile Devices

Abstract
Purpose
– The purpose of this paper is to evaluate the accuracy and functionality of a selection of basic Android and iOS apps for mobile devices designed to generate bibliographic citations.

Design/methodology/approach
– A number of inexpensive or free apps were installed on several different tablets and phones. Book citations in MLA and APA format were generated and evaluated for accuracy.

Findings
– Results show that the majority of the apps tested produced unacceptably inaccurate citations, and many had limited functionality. The best of the apps tested was EasyBib.

Research limitations/implications
– There are infinite combinations of operating systems, apps, citation styles, material types and devices. Testing for this study was limited to uncomplicated apps likely to appeal to undergraduate students. It did not include more sophisticated apps for managing reference libraries. The study investigated how well several Android and iOS apps installed on mobile devices functioned to generate MLA and APA citations for print books.

Practical implications
– As the role of mobile technology in education continues to grow, librarians need to remain aware of solutions that can help students manage their research. Librarians have an opportunity to provide feedback to developers by reviewing and rating apps.

Originality/value
– Undergraduate students face challenges in learning to appropriately acknowledge materials they have consulted in their research and writing. Librarians can play an important role in helping students select the most appropriate tools to make citing sources easier and more accurate.

Introduction
Mobile technology has had a significant impact on the way libraries deliver services. Libraries need to ensure their websites and services function well in a mobile environment. Instruction is increasingly being delivered in Bring Your Own Device (BYOD) spaces, where instructors teach students who may be experiencing different computing environments depending on the hardware and software each is using. Evaluation of new electronic resources for purchase or license may include examination of mobile functionality. Many libraries now purchase laptops and tablets for patron use, and this service may include the selection, installation and maintenance of software on the devices. Librarians need to be able to assess mobile technologies and make appropriate recommendations.

Increasingly, students interact with library materials through their phones and tablets. Apps, which are quickly downloaded and installed and are often free or inexpensive for users, are key to the mobile device experience. It is anticipated that the total number of apps (both free and paid) downloaded annually will increase by nearly 50% in the next two years to approximately 269 billion (Gartner, 2015a;
Apps have been developed for a variety of research and educational purposes, including library use.

The field of mobile apps is rapidly changing and individual apps may have a short shelf life. Apps come from a variety of sources, from the established firm to the single producer. Countless web tutorials are available to teach people with limited programming experience how to create their own apps. Given the low barrier to entry, the quality of the products can vary widely from the indispensable to the frustratingly buggy. Further, most apps are not successful, due to rapid growth in the number of new apps, lack of established production channels and the use of third party and independent developers (Kahn, 2015).

Librarians have long helped students learn to format citations using official style manuals and writing tools like the popular Purdue Owl website. They have also supported citation management software. Options range from proprietary desktop applications like EndNote to free, open source services like Zotero. Many research databases allow the export of pre-formatted citations in a variety of styles. Despite having access to a variety of tools that should make this largely formulaic and mechanical task easier, students continue to struggle with issues surrounding citations and bibliographies.

Many apps have been developed that promise to simplify the process of citing sources and generating bibliographies, but selecting or recommending an appropriate tool for student use can be daunting. There are a great many variables associated with the use of mobile devices, making it difficult for librarians to know which apps to recommend to patrons.

The variety of mobile operating systems with multiple versions existing for each one is an additional complicating factor. According to IDC, by 2017 the top two operating systems, Android and iOS, will capture 86.2% percent of the global market, with a 68.3% and 17.9% share respectively. Windows Phone is the third system forecast to have double-digit market share at 10.2%. Minor players include Blackberry and a variety of open source systems like Firefox, Ubuntu and Tizen (IDC, 2015).

Since the ultimate reason for using citation management software is to generate citations and bibliographies that can readily be incorporated into research projects, the accuracy of the output is paramount. Prior research has shown that citations produced by stand-alone programs and web-based citation management software can be highly variable and prone to error (Kessler and Van Ullen, 2005), as can be the citations formatted within research databases (Kessler and Van Ullen, 2006; Van Ullen and Kessler, 2012). Have mobile apps overcome these limitations? Is it still necessary for librarians to teach students about citation styles?

As different types of educational apps are introduced to the marketplace, librarians may see a need to evaluate them prior to adopting them as the functionality may be less predictable compared to software produced through more established channels. This study examines the performance of a variety of free or inexpensive citation apps on several different devices, both tablets and phones, to determine which apps offer acceptable functionality along with the highest available level of accuracy. The study focused on basic apps likely to appeal to undergraduate students wishing to simplify the citation process, rather than more sophisticated reference or PDF management apps suited to more advanced researchers. Because Android and iOS are likely to be the operating systems most students will be using for the next few years, this study is limited to apps operating on those platforms. While a few apps format citations in a variety of styles, most were limited to APA and/or MLA formats. Since APA and MLA are most commonly used in undergraduate work, these two styles were tested.
Literature Review

Much of the literature concerning bibliographic management tools has focused on web-based products. Homol (2014) compared the accuracy of electronic journal article citations produced by EndNote Basic, RefWorks, Zotero and the EBSCO Discovery Service (EDS). Error rates were similar for the first three tools and somewhat higher for EDS. All of the products introduced substantive error. Steeleworthy and Dewan (2013) evaluated Zotero, WizFiolio, Mendeley and RefWorks for ease of use and functionality, including the ability to use the tools with mobile devices, but did not examine the accuracy of the four tools. They found considerable variation in the features offered by the citation managers and suggested that users select the appropriate tool based on their own needs. In a 2005 study, Kessler and Van Ullen looked at the accuracy of citations produced by two web tools, EasyBib and NoodleBib, as well as the desktop version of EndNote and concluded students still need to understand citation formatting due to the errors introduced by all three products.

In her 2011 article, Hensley reviewed four popular citation managers, RefWorks, EndNote, Zotero and Mendeley. The study focused on the features and functionality of the standalone and web-based versions. Accuracy of the products was not explored, but Hensley provided practical recommendations for librarians who provide support for the use of citation management tools. She recommended that instructional materials created by other libraries or software vendors be utilized where possible. Hensley also suggested librarians look for opportunities to include citation management during library instruction.

Other researchers have written about library strategies to select and support appropriate citation management software. Emanuel (2013) presented the results of a campus survey done at the University of Illinois at Urbana-Champaign that identified approximately a dozen different citation management tools used by faculty and graduate students. In this study, she also found that researchers had mixed opinions about the level of support that should be provided by library staff and that responses seemed to be at odds with observed patron behaviors. For example, survey participants indicated that support from the library was not important in learning how to use citation tools, yet workshops offered by librarians were well-attended and reference desk staff reported answering questions about the tools. The survey also found that ease of use and integration with word processing software were the two factors most important to researchers.

In an attempt to understand how undergraduates use citation management tools, Salem and Fehrman (2013) conducted focus groups to explore how undergraduates managed citations and to have them compare RefWorks and EasyBib. They found that few participants were knowledgeable about the products and seemed reluctant to use citation managers, preferring to track references manually. Focus group feedback also indicated that there would be some advantage to supporting both a simpler tool like EasyBib and the more sophisticated RefWorks, given that the needs of students varied.

In a 2011 study, McMinn reviewed the websites of Association for Research Libraries (ARL) members to determine how libraries were supporting various citation management products. He found that the overwhelming majority of ARL libraries provided some support for either RefWorks, EndNote or both, and approximately half provided information about EndNote Web or Zotero.

As mobile technology has become more prevalent, researchers have looked at the ways apps can be applied to the library and information-seeking environment. Noting that apps have their own unique characteristics, Hennig (2014a) advocated for establishing guidelines for writing reviews of mobile apps,
and she supplied a useful outline for elements that should be included in a formal review. Further, she made suggestions for how apps can be integrated with library services, instruction and programming (Hennig, 2014b).

Mallon (2012a; Mallon, 2012b) wrote a two-part column highlighting several mobile apps that could be used in an academic public services setting. The apps included in the column were a somewhat eclectic selection, with applications ranging from social networking (Pinterest and Hootsuite) to content delivery (Centers for Disease Control and Prevention). Mallon also included a review of Mendeley, a mobile reference management app. Her review focused on Mendeley’s ability to read and manipulate PDF files, but did not discuss citation management.

Power, in her 2013 article, recommended a number of apps she found valuable as a librarian and as an information user. Power included a brief review of EasyBib, and mentioned its timesaving ability to generate citations by scanning ISBN barcodes with a device’s camera, but did not investigate the accuracy of the citations produced.

Mobile citation managers were the subject of a 2012 article by Glassman and Sorenson. This report provided an overview of the major features of a number of citation apps and mobile websites, including cost and mobile platform availability, and offered the reader some practical questions to ask in evaluating products. The article did not address the quality of the citations generated by the products.

**Methods**

Searches were performed in iTunes and Google Play for apps for citing sources and creating bibliographies. However, many of the results were not relevant. A more effective strategy was to search in Google and follow links found in the results to iTunes or Google Play. Ten apps were identified. However, three failed to work at the most basic level of generating any citation, so they could not be tested sufficiently to be included in the study. The seven remaining apps were selected for further examination, ranging in price from free to $4.99. The apps were Citations2go, CiteThis, EasyBib, iCite, iSource, QuickCite, and RefMe.

Three mobile phones which were readily available to the authors were used to test the apps. The mobile phones used were iPhone 5, and two Android phones, the LG Optimus Elite, and LTE Awe. In addition, an iPad 2 and two popular Android tablets, a Samsung Galaxy Tab 2 and a Nexus 7, were also used.

Unfortunately, many of the available apps do not produce citations for journal articles. Where it was possible to create a citation for a journal article on the mobile device, all data had to be entered into the device by the user. None of the apps was able to scan a Digital Object Identifier or other information to generate a citation. Given this significant limitation of the apps, testing was limited to creating citations for books. Five monographs were selected for testing. Each app tends to generate the same type of error in every citation for a given bibliographic style, so testing a larger number of titles would merely be redundant.

The bibliographic information for the books was entered by the preferred method for the app, usually barcode scanning. If barcode scanning was not possible for a given app, the order of entry tried was ISBN searching, text-to-speech, and lastly manual input. Citations were generated in both APA and MLA styles for all apps, except Citations2Go and iCite, which only support APA format. This resulted in 175 citations to examine.
Citations were reviewed for errors against the appropriate style manual: The *Publication Manual of the American Psychological Association*, 6th edition (American Psychological Association, 2010) and *MLA Handbook for Writers of Research Papers*, 7th edition (Gibaldi, 2009). Errors were recorded in a spreadsheet by category, app and style. The error categories used were punctuation, capitalization, syntax, use of italics/underlining, name, title, publisher, and date. Consistent with previous work, a syntax error was considered be “an error in which the order of the elements in the citation was incorrect, elements were missing, or elements were present in the citation that should not have been” (Kessler and Van Ullen, 2006: 25).

**Results**
Comparison of the features of the seven tested apps showed a range of data input and citation output features, styles, operating systems and citation accuracy.

**Overview of features**
Table 1 summarizes the cost, citation styles, and tested devices for each.
[INSERT TABLE 1]

The seven tested apps varied in significant ways, including the types of sources they were designed to handle, mechanisms for data input and methods of transferring citations from the device. Key features of each tested app are shown in Table 2.
[INSERT TABLE 2]

**Errors**
Table 3 shows the apps tested and the number of devices used for testing each app, along with the number of styles tested, the number of errors, citations, and errors per citation.
[INSERT TABLE 3]

In total, there were 525 errors in 175 citations, resulting in a mean number of errors per citation of 3.0. All of the apps tested had errors in the citations generated. Citations2go had the lowest number of errors per citation at 1.2, while CiteThis had the highest at 4.9 errors per citation. The remaining error rates varied from 2.0 to 4.5.

Table 4 shows the breakdown of errors by category.
[INSERT TABLE 4]

Of the 525 errors found, 170 related to the publisher information, and these accounted for 32.4% of all errors. The category with the next highest number of errors was italics or underlining with 79 errors, or 15.0% of total errors. Errors in the date were the least common, with 20 errors. In one case, the citation generated was for a totally different book than the one scanned, and was not evaluated.

Table 5 shows the number of citations, errors and errors per citation by citation style.
[INSERT TABLE 5]

Citations generated in APA style accounted for 319 of the 525 total errors, or 60.8%. However, since an equal number of citations in each style were not tested, the error rate per citation is a better measure to use to see if there is a difference in accuracy between styles. For citations in APA style, the overall error rate per citation for all apps was 3.2. For citations in MLA style, the overall error rate was 2.7.
Discussion

A prior study examined citations created in EndNote as well as two citation generators, Easy Bib and NoodleBib, and found an error rate of 2.12 errors per citation (Kessler and Van Ullen, 2005). A review of citation help in databases revealed an error rate of 4.4 errors per citation (Kessler and Van Ullen, 2006). A later follow-up found an error rate of 3.4 errors per citation (Van Ullen and Kessler, 2012). The present study found a rate of 3.0 errors per citation generated by the apps.

While this error rate appears to be comparable to previous studies, there are significant differences. The present study was limited to citations for print books. These are the simplest types of sources to cite in both APA and MLA styles and a lower error rate would be expected for this straightforward type of source.

The 2005 study looked at sources taken from actual student bibliographies and included print and online journal articles, books, and web sites (Kessler and Van Ullen, 2005). The two studies on citation help in databases focused on journal articles (Kessler and Van Ullen, 2006; Van Ullen and Kessler, 2012). Citations for journal articles are appreciably more complex than citations for print books and there are more elements required. In addition, citations for electronic journal articles can include database names, access dates, digital object identifiers, and retrieval statements. In these two studies, errors in the retrieval statement category were the single largest category errors, accounting for 46% and 49% respectively. Since none of the citations examined in the present study included retrieval statements, one would expect to see a lower error rate than in the previous studies.

Closer examination of the generated citations indicated that the reasons for errors are varied. In some cases, it appeared that the creator of the app lacked a basic understanding of citation formats. Data errors in databases such as WorldCat were carried into citations generated by apps that use barcode scanning. If data was entered manually, user error comes into play. Presumably, since undergraduates may be less familiar than librarians with citation styles, even higher error rates could be the result than encountered in the present study. Other errors appeared to be due to programming issues.

Error Examples

Some apps, including iSource, offer the option to easily switch from one style to another once data are entered. While this is a desirable feature, if the app doesn’t correct for differences in elements between styles, it is misleading to the user. The only entry mechanism for iSource is for the user to input data manually. The app offers no guidance or examples to follow. The app simply puts the elements input by the user in order, without correcting details like capitalization. Since title capitalization rules are different between APA and MLA, switching between the styles will force the introduction of errors in one style or the other, depending on how the user entered information.

For example, the APA citation for a book should appear as follows:


Displaying the iSource citation in APA format on an iPhone produced this entry:

In addition to introducing errors based on capitalization differences between styles, iSource requires the user to enter a page number and will not save a citation without one. The page number was then erroneously introduced into the citation for the entire print book. This shows a lack of understanding of the correct format by the app creator.

Programming errors produced other types of surprising errors. In some cases, the app mixed up elements from several searched or scanned books into one citation. Performing an ISBN search with the CiteThis app on a Nexus 7 tablet produced this citation, supposedly in MLA format:


This citation combined elements of the Sam Kean book with an entirely different book, Tasteofhome Cookies. It also introduced extraneous elements, like OCLC numbers and HTML tags. Similar results were produced with an ISBN search by the Citations2go app installed on the Optimus phone, where completely unrelated author information was inserted, in this case for books that had not previously been entered.

Of the apps tested, the one with the lowest error rate was Citations2go, with 1.2 errors per citation. Despite the low error rate, this app has limited utility. It is only able to format in APA style and it is not available for iOS.

EasyBib and iSource were the next most accurate apps tested, both having an error rate of 2.0 errors per citation. However, the iSource error rate is misleading. This app only allows manual input and provided users with no guidance on how to enter the data. It is reasonable to assume that most undergraduates have less familiarity with citation styles than librarians, so it is likely that the actual error rate when used by typical students would be much higher. In addition, iSource does not scan barcodes or search ISBNs, so it is not a timesaver. It was also by far the most expensive app at $4.99 per style with additional costs for style packs that expand the number of source types the app will handle.

Overall, the best app tested was EasyBib. It is available for iOS and Android, and switches styles easily between APA/MLA/Chicago. EasyBib is unique among the apps tested in that it can function on its own or in conjunction with a web citation and bibliography creation tool. The website for EasyBib has a free version that allows users to create and store bibliographies in MLA format. A paid version, EasyBib Pro, is available by subscription, and includes thousands of citation styles. The web version of EasyBib allows users to easily look up journal articles to obtain citations. It also allows users to input URLs to generate citations for websites.

Error rates for the EasyBib app as tested reflect a systematic artifact when citations were mailed from the device to an email account. At the end of each citation, a link was generated labelled “save to Easybib.” Because this phrase is not part of a standard citation, it was counted as an error. If the link is activated in an email message, it launches the EasyBib website in a browser window and will transfer the citation to the website if the user logs in.
Assuming that students would understand that the “save to EasyBib” link should be deleted if using the emailed citation list for a bibliography without utilizing the EasyBib website, the error rate for the app would be 1.0 errors per citation, making it the most accurate of the apps examined. However, the app would be improved if the link did not appear as part of the emailed references, allowing the app to be better used as a stand-alone product. If the free app is used in conjunction with the website, a basic MLA bibliography including books, journal articles and websites can be assembled very easily.

Desirable Features

After working with a variety of apps, a number of features were identified that should be present in an ideal citation app:

1. Discoverable
   No matter how good an app might be, it won’t be helpful if it can’t be found. Users should be able to readily locate the app in the iOS and Android marketplaces. Difficulty in finding apps may be a result of limitations inherent in the iTunes App Store or Google Play. Developers may wish to consider submitting their app for review in venues like AppShopper.com, a third party app directory dedicated to making apps more discoverable (AppShopper, 2015).

2. Multiple Styles
   Having to download a separate app for each popular citation style is a waste of time and device memory. Students often do not address citation style early on in their research, so it is desirable to have an app that can easily convert citations from one style to another with a minimum of effort, rather than have to re-enter the citation with a different app. For undergraduate use, it would be desirable to have at least APA, MLA and Chicago styles integrated into one app.

3. Intuitive Interface
   The learning curve for citation apps must be low, since there is little or no documentation associated with the products. Some of the apps tested began scanning with no warning as soon as the app was opened, and it was unclear what was happening. For other apps, it wasn’t obvious how to get the generated citations off the device. Several apps that were investigated in the preliminary stages of the project were sufficiently counter-intuitive as to be deemed not worthy of further testing.

4. Multiple Entry Mechanisms
   Barcode scanning is by far the easiest and fastest way to enter book citations and should be considered essential. ISBN lookup should also be present. However, not all books have accessible bar codes or ISBNs. That is particularly true of library materials, where books are often missing dust jackets, have been rebound or had library labelling applied that may obscure these features. Voice-to-text entry input allows for easy input if scanning or ISBN entry is not possible, but can introduce capitalization errors. Apps should also allow for manual entry and should provide some user guidance as to how information should be input, such as spelling out author first names or appropriate title capitalization. Whatever mechanism is employed, users should be able to edit entries as necessary.

5. Citation Transfer
   Transfer of citations from the device must be easy and intuitive, and preferably allow for sending them via email or text or by synching with a web service.
6. Authority
The app’s creator and credentials should be apparent. Several of the apps examined in the study gave little or no information about the entity behind them. Since librarians are engaged in teaching students about issues of authority, they should feel confident that the creators of the tools are knowledgeable about proper citation practices. Similarly, apps should make the source of scanned or searched citations transparent to the user. If the app performs a barcode look-up in WorldCat, for example, that should be clearly indicated.

7. Multiple Formats
Books are not the only materials used for research. At a minimum, apps should be able to scan a journal article’s digital object identifier to generate a citation. Since many articles do not have digital object identifiers, being able to look up journal citations is extremely helpful. Websites are also commonly used in student research and an app that could generate a website citation from a URL would be welcome. Obviously, apps are not at a stage of development that can handle the large variety of formats that traditional citation managers like EndNote can, but adding these two additional material types along with books would make the apps much more useful for student needs.

8. Bibliographies
The ideal app should allow the user to generate both single citations and bibliographies. When multiple citations are created, the app should be able to add, delete or alphabetize them to create a bibliography if desired.

9. Accuracy
The whole point of using citation tools is to automate the mundane process of creating accurate citations. If the citations are not correct, the tool is not doing its job. For minor mistakes that cannot be automated, like capitalization errors of proper nouns occurring in titles, the app should allow the user to easily make minor edits.

10. Cost
To be attractive to students, the app needs to be moderately priced. It is likely that students would be willing to pay a small fee for a well-executed app.

Conclusion
While mobile technology has many benefits for users, librarians should keep in mind that apps may not always perform as expected. Before widespread adoption on library-owned equipment or endorsing an app for student use, the library should evaluate the product. The mobile environment is complex. There is often insufficient vetting before an app reaches the market to be able to assume it will perform as promised.

Citation apps should be appealing to both students and librarians. Students must understand when and why to cite to avoid plagiarism, but is it important for them to be intimately familiar with the minutia involved in formatting bibliographic citations? Formatting citations by hand is time-consuming, tedious, and not intellectually engaging for most people. From the results of the study, it is clear that students must still be taught that style guidelines exist, and that a style manual or guide must be consulted for verifying the accuracy of citations produced from an app or other citation management tool. At present, citation tools can be handy for getting started, but they don’t produce a finished bibliography. Librarians have a role to play in helping students manage the advantages of citation tools with the accuracy required by discipline-specific styles.
While there are many apps currently available that work on different devices and platforms, overall, the quality is lacking. Of the apps tested, EasyBib was easy to use, available for both tested platforms, offered MLA and APA styles and had reasonable accuracy. The option to use it in conjunction with the website offers students an excellent, free tool for generating MLA bibliographies. It would be more useful, however, if journal articles and websites could be formatted using the app directly on the mobile device. For students who need to create book citations in APA format on an Android device, Citations2go had the lowest error rate of the apps tested.

In general, it is striking how little attention developers have paid to the accuracy of the finished product. One would presume that people who are developing apps would consult the style guides to ensure accuracy, but that does not appear to be the case from examining the citations generated.

Students seem to accept apps at face value and possibly with good reason. One of the least accurate apps tested was RefMe, which was recommended by Apple to their 15 million social media followers as one of their “Best New Apps” for 2015. Librarians have an opportunity to contribute to a discussion of the quality of these apps by submitting reviews, both in the library literature and in app marketplaces such as iTunes and the GooglePlay store.

Another possible solution to the problem of inaccurate apps might be for organizations who create style guides, such as the American Psychological Association, to develop and market their own app. The authors believe there would be a sizeable market for an accurate, reasonably priced, “official” app and would be glad to have such an app to recommend to students.

Mobile apps for citations have great potential given the increase in portable device usage. The popularity of more sophisticated tools like Zotero, Qiqqa, Papers and Mendeley is evidence that researchers find value in products that help them manage references and personal document collections. Many of these products have at least one corresponding mobile app. The challenge for librarians will be in assessing which systems will work well for researchers.

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