Capstone Project: Bringing Zotero to iOS

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Abstract

Zotero is a popular, open source research-collection and citation-generation tool that works with web browsers to automatically detect and extract citation metadata. It is designed largely as a desktop-based product, offering a standalone client, a number of browser extensions, and "bookmarklet" options. The Firefox extension offers a unique unified experience, bringing the full function of the standalone client directly into the browser. The experience of using Zotero in iOS is insufficient and needs to be addressed to better enable student research success. This project will endeavor to bring a native experience to iOS comparable to the best available Zotero experience—its desktop Firefox plugin—allowing browsing of Web pages and library resources and direct, immediate access to Zotero's organization, synchronization, and citation management tools.

Capstone Project: Bringing Zotero to iOS

Problem Statement

Zotero is a popular, open source research-collection and citation-generation tool with more than 175 patron institutions ("Institutions Recommending Zotero", n.d.) and thousands of registered individual users ("Zotero:People", n.d.). Zotero works with web browsers to automatically detect and extract citation metadata with a click of a button; the company's site claims Zotero is "the only research tool that automatically senses content in your web browser, allowing you to add it to your personal library with a single click" ("Zotero Home", n.d.). Librarians at many colleges and universities recommend this tool, and some are heavily invested in this tool as a key component of their bibliographic instruction (BI) curricula.

At present, the Zotero experience is designed primarily for the desktop. Zotero offers a standalone client for Windows and macOS (formerly OS X), a number of browser extensions and JavaScript-based "bookmarklet" options for desktop browsers, and access to a person's Zotero library via a website. The Mozilla Firefox extension offers a unique, unified experience, providing the full function of the standalone client directly in the browser. Today, access to Zotero features from a mobile device is limited and the experience is subpar. While it is possible to utilize some Zotero features on a tablet, there is no full-functioning standalone client nor an extension for mobile browsers. Effective use requires moving between a minimum of three apps to achieve what is possible within Firefox on the Mac, Windows, and Linux desktop using the Zotero plugin.

Bringing a true, integrated experience to iOS will better enable student research success. This project endeavors to bring a native experience to iOS comparable to the best available Zotero experience—its desktop Firefox plugin—allowing browsing of web pages and library

resources and direct, immediate access to Zotero's organization, synchronization, and citation management tools.

Project Scope

Bryn Mawr College is a small, non-profit liberal arts college for women outside Philadelphia, PA and is part of both the historical Seven Sisters and an active Tri-College (Tri-Co) consortium with Swarthmore and Haverford Colleges. Bryn Mawr College research librarians use Zotero both in general research assistance and in library instruction. Bryn Mawr and Tri-Co staff have anecdotally observed growth in the student and faculty use of both tablets and larger format phones when doing research. Zotero does not have an equivalent experience to either the desktop functionality, or competing products in iOS, the most common mobile platform. Bryn Mawr College has an opportunity in terms of available resources and applicable current initiatives in digital humanities and blended learning, an investment in Zotero as a citation tool, and a longstanding dedication to bringing greater good to our students and our peer institutions. As a merged library and IT organization, Bryn Mawr College Library & Information Technology Services (LITS) has the opportunity to share resources and knowledge toward such a goal.

This project is presented in terms of Bryn Mawr's perspective of need, ability to resource and implement the project, and desire to offer a new tool both to students and to the learning community.

Background and Research

Project Context

Library Instruction.

Library Instruction (also called Bibliographic Instruction, or BI) is a critical and growing part of modern library research support. In a 2013 research library trends report for the Association of Research Libraries, Janice Jaguszewski and Karen Williams discuss the changing role of library instruction:

> "Librarians at many institutions are now focusing on collaborating with faculty to develop thoughtful assignments and provide online instructional materials that are built into key courses within a curriculum and provide scaffolding to help students develop library research skills over the course of their academic careers" (2013, p. 6).

They went on to describe additional trends, and ways in which library liaisons are offering new perspectives.

> "Librarians at the University of Minnesota provide education and consultation services for personal information management. Tools, workshops, websites, and individual consults are offered in areas such as citation management, productivity tools, managing alerts and feeds, personal archiving, and using social networking for teaching and professional development" (2013, p. 9).

Citation tools are a common item in library instruction curricula, with librarians taking various approaches. At the Copenhagen University Library (a division of Denmark's Royal Library), Zotero instruction became so popular, the library staff now offer an open session twice a week called "Doctor Zotero." Librarian Christian Lauerson (2015) says that though the Copenhagen University Library offers instruction on multiple tools, Zotero is easily the most

popular. Rebecca Kuglitsch at University of Colorado Boulder goes so far as to claim that a

creative use of Zotero group functionality to work with students can reduce the burden of in-

person embedded library instruction by allowing librarians to use (with student agreement)

Zotero's group functionality to oversee student research (2014).

The case for an iOS app.

It is easy to see the rise of mobile devices in the modern world. According to technology

analyst and futurist Mary Meeker in the 2016 edition of her annual "Internet Report", the growth

of the Internet is slowing year-over-year (2016). However, mobile browser use recently exceeded

use from desktops for the first time.

> "More users are accessing the internet from smartphones and tablets than from desktops
>
> for the first time ever worldwide, according to new findings from StatCounter Global
>
> Stats. According to the research, 51.3% of internet usage in October 2016 came from
>
> mobile devices, while 48.7% came from desktop access" (Forrest, 2016).

This follows signals from Google in early 2015 that searching from mobile devices was

outpacing desktop searching (Google, 2015), and a comScore report in 2015 observing the

significant acceleration of mobile use for purchasing. It is clear that information consumers

expect to be able to access information of all kinds from any platform.

The EDUCAUSE Center for Analysis and Research (ECAR), a highly respected research

organization in higher education, recently published their "2016 Students and Technology

Research Study" (Brooks, 2016). ECAR conducted an online survey of college and university

students, asking questions about importance of technology, its use, its effects, and their

experiences. Over 71,000 students from 183 institutions responded (p.3). ECAR analyzed 10,000

randomly selected U.S. responses to produce these findings. Results indicate that while laptops

are still of primary importance to students, and 93% own one, tablets and smartphones are both

considered important and are used by students in courses at a level heretofore unprecedented in

the thirteen years of the survey. Smartphone ownership is higher than laptop ownership, now at

96%, with tablet ownership at about 57% (p. 9). Furthermore, 52% of students also own all three

types of devices (compared to 36% nationally) and less than 1% own no device (p. 10). In this

report, the importance of mobile devices has stayed stable in the 40-50% range, but use of these

devices in courses, particularly phones (up 9% since 2015), has substantially increased over time

(p. 12). ECAR analysts speculate that lack of power or ability to perform all tasks is why laptops

are still the most important by a factor of two. If true, this project has the potential to remove one

such factor. The main findings also indicate that students who are using technology well are

more engaged and that students strongly prefer blended learning (learning with both technology

and human elements).

Meeker's report (2016) also shows a substantial lead of Android device sales over iOS

device sales over the last few years with no sign of a change as the world approaches an apparent

saturation point. In this case, it may seem counterintuitive to choose an iOS app over an Android

one. However, there are two significant reasons that an iOS app is a more appropriate choice for

this project.

First, an Android app is a much more difficult and expensive product to create and

maintain. The conventional wisdom is that unless the audience is in some way (demographically,

by Google platform, actions not possible on iOS, etc.) Android-based, a project with limited

resources should start on iOS (Yarmosh, 2015). Android projects are said by experts to be more

time consuming and more expensive. One development company has documented their projects

requiring 40% more code and approximately 30% more time than the same project in iOS (Car,

2015). There are several reasons cited: greater amount of code, slower emulators within the development environment, a more manual layout process, and most importantly fragmentation. Android, unlike iOS, is considered to be an open platform; while a full distribution of Android software is not completely open source, the underlying operation system is. "'Android' can mean several things. It's an open-source operating system (AOSP), yes. But what most people think of as 'Android' complete with all the Google bits is only a partially open-source operating system" (How-To Geek Staff, n.d.). While Android holds a large market share, Android (like its open source predecessor Linux) is not just one thing but a family of similar distributions with certain core commonalities. Manufacturers vary hardware widely and both manufacturers and carriers can add their own software modifications and affect new version adoption. There are even several "official" stores for Android apps based on manufacturer, carrier, or your favorite retailer. To get operating system updates, new builds must be created for each phone and each carrier must agree to send them out "over-air," no simple task.

> "Getting a new version of Android up and running on any device with different hardware requires a significant amount of additional work, and even more effort is needed to bring across proprietary code from chip-makers…The build process the needs to be tailored to the phone's hardware, and existing customizations need to be worked into the new version of Android without breaking anything" (Dobie, 2012)

The fragmentation of system versions, screen sizes, and other specifications is a challenge for developers.

> "Android's open licensing can be a double-edged sword. Because of the wide variety of different devices and iterations of the operating system, there is a significant amount of fragmentation. When you build an Android app, you need to test it on several different

devices to ensure that there won't be dependency issues between different versions"

(Argwal, 2014).

Version	Codename	API	Distribution
2.2	Froyo	8	0.1%
2.3.3 - 2.3.7	Gingerbread	10	1.2%
4.0.3 - 4.0.4	Ice Cream Sandwich	15	1.2%
4.1.x	Jelly Bean	16	4.5%
4.2.x		17	6.4%
4.3		18	1.9%
4.4	KitKat	19	24.0%
5.0	Lollipop	21	10.8%
5.1		22	23.2%
6.0	Marshmallow	23	26.3%
7.0	Nougat	24	0.4%
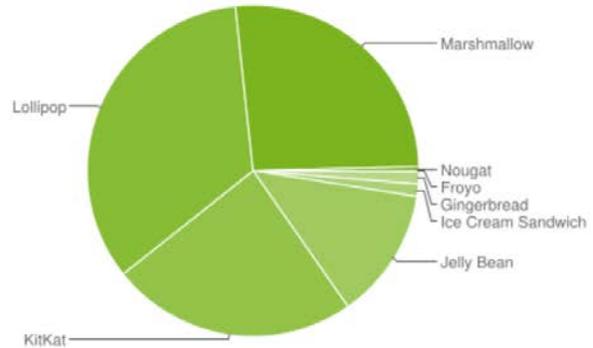
Data collected during a 7-day period ending on December 5, 2016.
Any versions with less than 0.1% distribution are not shown.

*Figure 1. Android OS version distribution as of December 5, 2016 per the Android Developer Portal
(Android Developer, n.d.).*

The degree of operating system fragmentation is a particular challenge, as demonstrated

above. For reference, version 7 (Nougat) with 0.4% adoption was released in late August 2016

(Samat, 2016). In comparison, adoption of iOS 10, released in September 2016, is conservatively

63% as of November 29th per the Apple Developer site (n.d.). Analytics company Mixpanel

estimates approximately 80% iOS 10 adoption with less than 5% of devices still using a version

previous to iOS 9 (below). Typically, mobile developers are asked to build solutions supporting

particular platform versions. For iOS, this is typically limited to the two most recent versions;

for Android it is commonly as many as four or five versions going back several years and

limiting severely the functions developers can use (Pearlman, 2016). This, combined with

Apple's complete end to end control of the product (the consistent and limited product line, their

complete control of the development tools and APIs for application on their own products, and

even the sales and deployment process) minimizes fragmentation issues and significantly

simplifies the development and delivery of apps for the iOS platform.
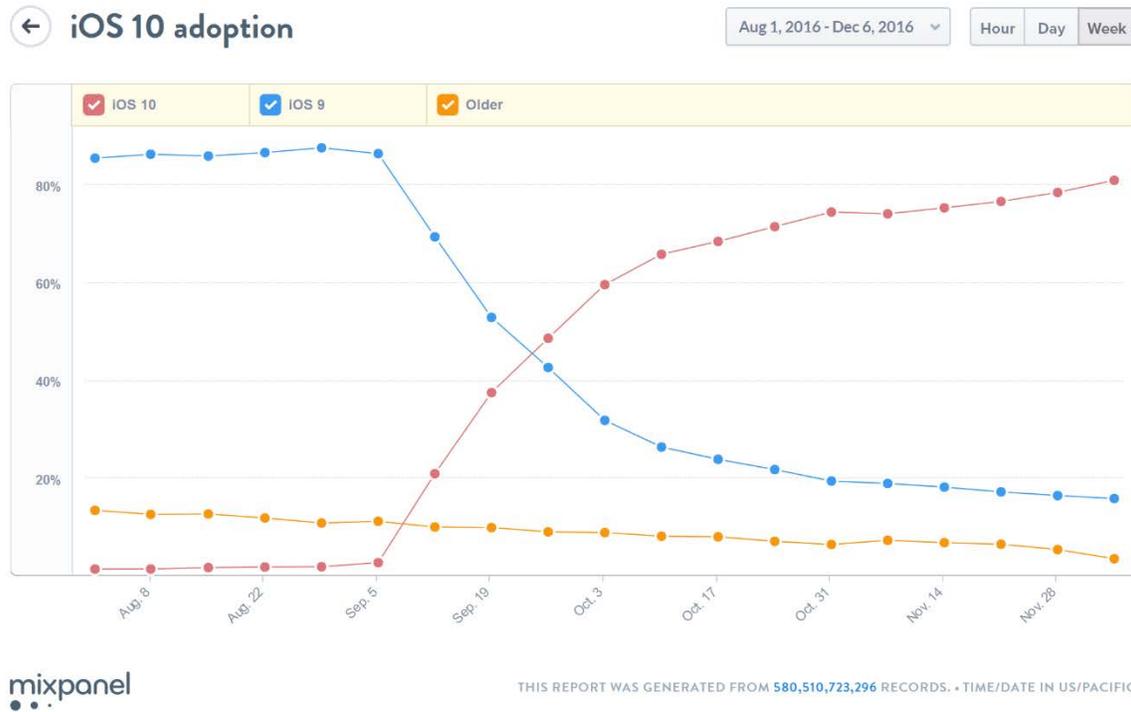

Figure 2. Mixpanel iOS adoption report as of December 6, 2016 (Mixpanel, n.d.)

Second, and more significant, is the dominance of iOS in the small college sphere.

According to developer and technology pundit Ken Yarmosh, "Android currently has the largest

global platform share, with a particular prominence in lower income areas and developing

nations. Comparatively, iOS users typically have higher income, higher education levels, more

engagement, and spend more per app" (2015). Given these demographics, one might expect

students attending smaller, elite institutions to lean toward iOS as either they or their parents

often fall into these groups.

Network data from small colleges provides a very different picture of device usage than the worldwide numbers. In the month of October 2016 at Bryn Mawr College, network data shows 10,218 individual devices attaching to the network; 4,016 of those devices were running iOS (approximately 40% of all devices). Android was represented by only 987 devices (approximately 9.5%). While mobile device counts are surpassing desktop counts on the Bryn Mawr campus as they are globally, iOS is clearly the dominant mobile platform.

In the interest of ensuring that this trend is reflected at other institutions and that an iOS app is the choice that will benefit the most users in the small college community, other colleges were surveyed. Requests for similar data from peer institutions via the Consortium of Liberal Arts Colleges email list and the EDUCAUSE Small Colleges Constituent Group list yielded ten responses drawn from student surveys, and system and network data. Additional institutions answered and indicated either that they did not track these statistics, or that they were not willing or able to share. While the pool of responses was small, each and every result submitted indicates iOS dominance over Android at a ratio varying from 1.5:1 to 15:1 with the most common results clustering between 3 and 5 to 1. As Bryn Mawr's data is consistent with the submissions received and lies near the median, it is likely Bryn Mawr's longer term trends in this area are representative (see Figure 4).

Citation Management Tools in the Market

Citation management is critical to research writing. Students and faculty have consistently adopted citation management software as technology has become more embedded in academic research and everyday use, especially the move of many resources to online databases and journal stores such as JSTOR (JSTOR, n.d.).

EndNote is a longstanding product and the industry leader in this area. Although EndNote

Basic (a limited, web-based product) is free, the full product retails at $249. Student pricing

varies by retailer, between $80 (Citation Manager Team, n.d.) and $120 ("Endnote X8", n.d.).

The full version of EndNote is full-featured to support writing not only papers and articles but

books, presentations, and reports on major studies and as a result more complex.

Mendeley is the major free competitor to Zotero, though it has a purchasable

"Institutional" version with more features. It too has a desktop client, online tools, and some

browser integration. Mendeley had been growing in popularity since its launch in 2008, but was

acquired by for-profit academic publisher Elsevier in 2013 (Lunden, 2013). Elsevier, the

publisher of many top journals, is a contentious corporate entity in the academic world. While

Elsevier journals provide academics with much-needed prestigious publishing opportunities, the

company is often accused of price gouging and unfair practices. One example is a 2012 boycott

by thousands of scientists, refusing to publish work in journals with prices so high that their

work could not be easily accessed (de Vrieze, 2012). In the same year, Harvard University

openly stated that they could not afford Elsevier's prices (Sample, 2012). They and other

libraries ended up cancelling regular subscriptions and going to alternative models. The rise and

growth of various Open Access movements at research institutions is related to this issue.

> "Open Access offers a viable solution to the serials pricing crisis. Widespread open
>
> access will ensure that libraries can provide access to *all* journal publications needed by
>
> their constituents. As well, libraries will be able to cancel the financial support they
>
> provide to journals (through institutional memberships and other methods) without the
>
> risk of losing access to essential publications" (OASIS, n.d.).

Elsevier's reputation of high prices, closed access and paywalls or tolls, makes academics and

librarians interested in keeping access free wary of adopting any Elsevier offering, including

Mendeley. While other web-based tools exist (some free, others available for purchase or

subscription), Zotero is the only open-source non-profit, full-featured (with automatic discovery,

groups, maintaining and managing multiple libraries, exporting in multiple formats, etc.) option,

and (as stated previously) the only tool which automatically discovers citation data.

Mobile options.

Both EndNote and Mendeley offer free mobile options. Mendeley has both a universal

(iPad and iPhone capable) iOS app and an Android version, while EndNote offers only an iPad

app. Both sync library content with free web-based accounts. The EndNote experience on the

iPad is smooth, using an internal browser to facilitate creating web-based references as well as

managing existing citations. The information capture from the browser is lacking compared to

Zotero, and requires substantial manual data entry. The Mendeley apps allow only manipulation

of existing library items, though the tool does allow PDF markup and includes a send-to option

from the browser (which could not be made to function in testing with Safari in iOS 10).

Zotero maintains a mobile-accessible version of the Zotero web tools, and a Zotero

bookmarklet is available. The web tools allow manipulation of the library, but with you the drag

and drop friendliness of a native client. Similarly, the bookmaklet is difficult to set up and not

user-friendly. There are also a few third party tools such as PaperShip, a free app for iOS which

syncs with a Zotero or Mendeley library and allows management of that library. It also has the

ability to search certain pre-defined common research resources such as JSTOR, Google Scholar,

and Science Direct. However, one cannot easily add browser-based content or any resources

outside the pre-defined databases without manual entry, and there is no way to export a

bibliography in a common citation style from this app. ZotPad is another app with limited

functionality; presently it can read and write Zotero citations (originally it was a viewer only),

but it has not been updated in some time. A few other apps also exist which perform one or two

functions. Limited market options place significant limitations on the user experience and the

mobile citation management capability.

<div align="center">**Business Analysis**</div>

Add more of scratch here?

Assumptions and Dependencies

This entire project is dependent on the continued existence of Zotero and its associated

open API and the continuation of its open source status. At this time, there is no reason to believe

that these will change as Zotero has a home and a major university and continuing funding:

> "Zotero is a production of the Roy Rosenzweig Center for History and New Media at
>
> George Mason University and the Corporation for Digital Scholarship. It has been
>
> generously funded by the United States Institute of Museum and Library Services, the
>
> Andrew W. Mellon Foundation, and the Alfred P. Sloan Foundation" ("Zotero: About",
>
> n.d).

The success of the project also depends on the ability to secure funding and sufficiently

skilled resources as discussed below.

While there are many advantage of working within the Apple infrastructure, there are also

risks. The success of this project assumes that Apple will not significantly change development,

review, and testing infrastructure and that this project will remain within Apple's acceptable

scope. Other factors of working with Apple are details in the Risks (below).

Requirements

The concept for this project is to deliver an experience on iOS (both iPhone and iPad) that is substantively equivalent to the best available Zotero experience, the Zotero Firefox extension. In order to do this, the iOS solution must have the following features:

- Support on iOS 9 and newer including all compatible iPhone and iPad models

- Ability to log in to an existing Zotero account, secure and transit credentials securely, and provide a link to account creation and recovery (as allowed by Apple)

- Ability to sync the user's local Zotero library with the Zotero server

- Ability to view, manually create, edit, and delete Zotero citations including changing the citation type per Zotero's pre-defined types

- Ability to add a citation by lookup of ISBN, DOI, or PMID

- Ability to create, modify, and remove collections and sub-collections; ability to copy and move citations from one collection to another

- Ability to view and manipulate Duplicate Items, Unfiled Items, and Trash folders

- Ability to index PDF files

- Ability to select and export Zotero citations to a bibliography based on common citation styles (APA, MLA, Chicago, etc.)

- Ability to attach a file, link, note, or tag to an existing citation

- Ability to add related citations to any citation

- Ability to search citations across all fields and tags

- Ability to view any snapshot; ability to open web-based sources directly in a web browser

- Ability to automatically create a citation from a web-based resource using Zotero's unique data identification methodology

- Automatic creation of a snapshot when creating a web-based citation

- Ability to create a parent citation record to a PDF or other file

- Ability to scan a PDF for metadata and populate that data into a parent citation for the PDF file

- App must support Zotero group functionality

- App must be developed using industry security and app development best practices

- All data must be encrypted in transit and at rest on the device

- Ability to protect access to the app via a PIN or Touch ID on capable devices

- Side by side library and web browser views on capable devices

- Adherence to all Apple App Store Review Guidelines

For the initial release, advanced search, library and cross-ref lookups (a recently added feature) will be considered "nice to have" and not required for acceptance. Future enhancements may include features not included in the Firefox extension such as PDF/attachment markup, ability to scan ISBN barcodes, and ability to store camera images of pages as notes.

This project also has some non-technical requirements. First, the published app must be free of charge and available on the App Store. Second, in keeping with the Zotero project itself and the spirit of community, the code for this app will be maintained as an open source project on a site suited to hosting such projects using industry-approved version control practices and software.

Key personas.

Personas can help the team meet the needs of key user archetypes. These are common usage patterns based on the experience of LITS.

- **Alicia** is a typical Bryn Mawr senior writing her undergraduate thesis. She is primarily writing on her laptop, but would like to be able to make citation notes while in the library stacks with her iPhone. She also sometimes has a thought when she is in a lounge or dining hall and if she performs a search on the spot, she'd like to be able to easily record the resources she finds and be able to get back to them from her computer when she returns to writing.

- **Briana** is a second year student who has come to college with an iPad Pro as her primary computer. She is in a class where the professor is asking her to do a lot of current events related writing. She wants to be able to easily manage citations from online sources like newspapers and magazines and wants the process to be as automatic as possible. She has no interest in lab computers as she prefers working in a quiet space and wants to do it all from her iPad, and she doesn't see any reason the experience should not be smooth and equivalent to what other students have on their computers. She wants to save the resources, note quotes, tag everything for easy searching, and keep each week's work in a separate collection. Exporting the references for use in Word or Pages should be easy and she will need APA formatting.

- **Cassie** is a humanities professor writing her first book. Her colleagues say she should use EndNote, but she is trying to conserve every cent of her limited funds, and she is not sure she needs all those features. She used tools like Zotero during

graduate school and feels it should support her needs. Her research requires heavy travel and she's trying to work off of her iPhone 6s Plus as much as she can, but when she gets back she's going to use both her home and office computers to write. The publisher requires the Elsevier Harvard citation style.

Technical Feasibility

Zotero publishes and documents an extensive open API meant for both their own use and for projects like this one ("Zotero Web API v3", n.d.). The API has framework to support the required features and will enable the connection of the iOS app to Zotero's servers (above). Per the existing App Store Review Guidelines, Apple presently allows the techniques described in the technical approach (below) and tools exist in the iOS development infrastructure to make effective use of the API (Apple, Inc., n.d.). As such the project is technically feasible.

Resources and Funding

The resource estimates in this project are based on previous Bryn Mawr LITS projects and the educated estimates of Senior iOS Developer Craig Pearlman (2016). Pearlman is a software engineer and software architect with over twenty years of development experience, of which the last four years have been exclusively iOS and has a good working understanding of the Zotero product. The required resources for this project are as follows:

- Apple Developer Program membership (Bryn Mawr's existing membership can be used at no additional cost).

- One MacBook Pro for development (can be drawn from existing LITS technical use pool).

- A minimum of two test devices for development, one iPod Touch or iPhone (no service required) supported by iOS 9 at minimum to simulate iPhone form factor,

and one iPad of iPad Air 2 class or newer (can be drawn from existing test and loan pools). Group testing will require more devices and can use the LITS Educational Technology iPad pool which is typically used for bibliographic instruction applications.

- Time from multiple individuals
  - o Approximately 15-20 hours per week for one year from one entry level developer (intern) for design, development, and documentation. If an intermediate to senior developer were to be secured, this time would reduce to approximately 250-350 total hours (Pearlman, 2016).
  - o An average of one to two hours per week from existing Bryn Mawr or Tri-Co research librarians acting as sponsors and product owners. These individuals will be consulted on the development of stories and epics for the development effort and will review features for completion.
  - o Dedication of time during course-embedded library instruction for demonstration and testing (approximately one to two class sessions per course). Students in these courses with iOS devices will be asked to use these devices in their research and provide feedback.
  - o Creation of an online feedback form and an assessment strategy. Data collection can be facilitated through existing tools (Wufoo, Qualtrix, or Office 365 Forms) and can be designed and implemented by the LITS supervisor.

- Approximately 2-3 hours per week on average of existing LITS professional staff time for one year to guide and mentor developer, manage project, and manage feedback and assessment.

- 60 hours of an outside senior iOS professional's time to assist with architecture, design, development, subject matter expertise, and intern mentoring ($15,000, est. based on $250/hr consulting rate). This is required both for successful project completion, and for the greatest possible professional growth and learning experience of the intern in keeping with LITS philosophy on internships.

At present, Bryn Mawr has a unique opportunity. Typically, a liberal arts college does not have the resources to prioritize this kind of project. Bryn Mawr College is currently the recipient of a three year Mellon Liberal Arts in the Digital Age grant which supports two full time educational technology interns (recent graduates) each year ("Mellon Liberal Arts", n.d.). This project is within the mission of this program and intern time can be used toward a project like this one. Although the program is scheduled to end in 2017, at this point the internal expectation is that LITS will be able to keep these interns and extend the Blended Learning program of which they are part. At the time of this writing, there appears to be sufficient skill and availability of prospective interns, but not all project proposals are yet in (see Risks, below). The dollars for the outside research can be funded by this grant, or by LITS directly; the Educational Technology and Client Services budgets both have sufficient discretionary dollars to support this modest cost. Bryn Mawr LITS can afford to dedicate the other time and resources identified above.

There is no cost recovery for this project other than grant and/or internal funding. This app is intended to be offered free of charge. Rather than being revenue-generating, this is a mission-oriented project delivering benefits to student and faculty research.

The initial version of the app should be considered a live pilot. The issue of ongoing funding will be open until after the app is launched and its usability, usefulness, and adoption is assessed. If the app is deemed to be usable, useful, and adoption occurs at a reasonable rate, the associated LITS staff will look for ongoing funding or possibly collaborate with Zotero to allow them to take over maintenance. Ongoing development costs depend on the complexity of the final product and Zotero's rate of change, but will likely be 40-50 hours per year (Pearlman, 2016). Possible sources for ongoing funding are LITS and/or Tri-College budgets, turning the project over to Zotero, or finding a foundation or Bryn Mawr donor willing to fund a project's success over time.

Risks

The overall effect of this project's potential failure is minimal considering that it is exploratory in nature and there are no external pressures to complete it. There is no loss of dollars, function, or ability to continue to function, only a small potential for reputation loss. The following are the significant risk factors to the success of the project:

- The greatest risk of this project is that, despite the worthiness of the goal, funding (or resources from existing funding) will not be approved.
  - While this project fits within the Liberal Arts for the Digital Age grant, this project is competing with others for resources. If too many quality faculty projects are proposed before the proposal deadline, it may not be possible to prioritize this project and a secondary funding source will need

to be secured. If this occurs, the project must be dropped or delayed while

funding is secured via other grant opportunities.

- o Other likely sources are the Andrew W. Mellon Foundation's grants for

  Liberal Arts Colleges ("Liberal Arts Colleges," n.d.) or the Institute of

  Museum and Library Services partnership with the National Endowment

  for the Humanities for funding Digital Humanities Advancement Grant

  projects (IMLS, 2016). If the team does need to secure a new grant,

  timelines will vary. Grant issuing organizations issue funding on different

  schedules and this period will be outside the control of the product team.

  Because there is no hard deadline and the continuation of the project

  depends on the grant, the development phase of the project will be on hold

  until funding is secured.

- o The project plan will have to take into account this flexible timeline when

  it comes to project resources. Other than building in flexibility, there is no

  potential mitigation strategy.

- The proposed development model depends on the ability to attract interns from

  Bryn Mawr or within the Tri-College Consortium who are interested in app

  development and have some pre-existing foundational skills. The time estimates

  laid out above take into account that the intern will not be a professional and will

  not only need to develop skills, but will be slower and need more guidance.

  However, if LITS is unable to attract an applicable intern, the project must be

  dropped, delayed, or rescaled for professional development (a much more

  expensive alternative). All three schools have computer science programs and

Swarthmore also has an engineering school. In the past, interns recruited for the Mellon grant and similar programs have had programming or web development experience, and it is reasonable to expect that such an intern may be found, however there is no guarantee that such a candidate will apply in any given year.

- Assuming an appropriate intern is found, using an inexperienced developer is always a risk. She may be unable to complete the work, or unable to complete it within the time available. She may experience design and performance issues common with inexperienced individuals that require major refactoring to resolve. Interns always require significant support in order enable their learning and success, but this project could prove daunting even with support. The best way to address this is to ensure a structure of regular check-ins and scheduled work time with both the supervisor and the external subject matter expert identified in the project plan, and by setting clear expectations and goals.

- Apple publishes App Store Review Guidelines, but has had a history of surprise changes and sudden variances in enforcement (AppleInsider Staff, 2015). One notable example is the sudden disappearance of the popular app (with millions of users) AppGratis in 2013 despite an approval of a new version just days earlier (Dawlat, 2013). In early 2016, MacStories surveyed 172 developers and found "Inconsistency from App Review was another major recurring theme in the survey responses" (Spencer, 2016). It is possible (although not likely) that Apple will choose to reject the app and require changes that limit functionality, or deny it entirely. This is an abiding concern for developers. The only way to approach

this is to carefully comply with the currently published Review Guidelines, be aware of any changes, and be prepared to do some refactoring and resubmission.

- The MacStories survey (Spencer, 2016) also indicated significant delays in approval, sometimes without explanation or feedback. This is a small risk since this project has no outside pressures, but if the delay goes far into the summer, it will affect plans to use it in fall courses.

- Even if a product is completed and published in the App store, it cannot be successful unless there is adoption and use. Upon request, Zotero will advertise the apps they do other extensions of the service, and LITS staff will encourage adoption and recommendation by peers via professional contacts and organizations. Adoption is critical to both delivering value and potentially securing ongoing maintenance funding.

- An additional risk, though low, is that Zotero will shut down or significantly change back-end services in such a way as to make the app immediately obsolete and render it unusable. There is no evidence that this will occur. Zotero clearly communicates major changes before they occur, has versioned and documented APIs, and its small staff has continuing funding.

Technical Approach

As previously established, this project will be an iOS solution offered via Apple's existing App Store infrastructure and will take advantage of Zotero's existing API and server infrastructure. The solution will consist of a single iOS app and an action extension that can be used in Safari on iOS as well as from other apps (Instapaper, Pocket, etc.) to automatically create references from web-based content (and some non-web content such as PDFs) and will conform

to the requirements outlined above. Both the App and associated extension will be constructed

primarily in Swift (with Objective-C as needed). The App will maintain a design and

organization functionality reminiscent of both the standalone Zotero Client and FireFox plug in.

See Figures 5, 6, and 7 for comparative screenshots of the existing client and early design

snapshots for the App.

Existing iOS APIs and well-maintained and tested open source libraries and frameworks

(including the Zotero API) will be used where appropriate. Using these reduces the amount of

custom code to produce and maintain, utilizes existing solutions, and reduces both delivery time

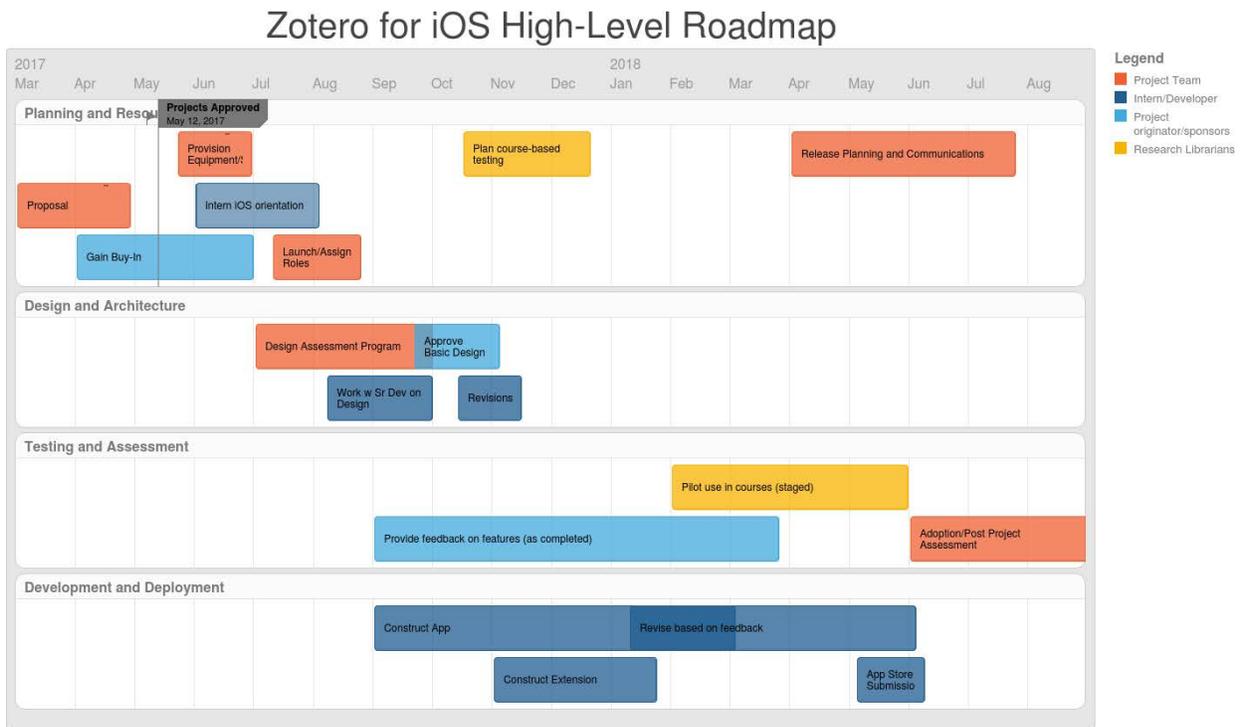and complexity.

Solution Development

Figure 3. Project Roadmap, projected

This project will last just over a year from proposal to post-assessment. Actual

development and documentation will take approximately ten months. This project will use a mix

of Agile and Kanban project management methodologies, using a Kanban board or card wall to

track tasks and assignments, and adopting the Agile practices of regular check-ins and the intern

developer regularly meeting with the project sponsors to demo newly created features and collect

feedback.

Even an entry level developer (intern) with good fundamentals is unlikely to be

experienced with iOS development unless she has undertaken an independent project. An intern

beginning in June would be expected to spend the majority of the summer months going through

iOS hands-on tutorials and creating a small app for the purposes of learning under the guidance

of LITS staff.

Formal project launch including assignment of roles, and in depth project planning would

be expected to commence in July of 2017. The external iOS resource would be brought in in the

latter part of the summer to work with the development intern on the design and technical

architecture of the product. This individual would also be an excellent resource for security best

practices and lightweight, iterative project management.

Librarians will provide feedback throughout the project, and will plan beta testing of a

feature complete app in the spring semester of 2018. The beta tests will be managed by creating a

build signed with a Bryn Mawr College Apple Enterprise Distribution Certificate and making it

available both to Bryn Mawr test devices and student-owned devices. These builds can be

placed on a secured website for download and the certificate revoked when testing is complete so

that users cannot continue to use old (potentially buggy) builds.

<div align="center">**Ethics**</div>

This project on the surface seems inherently ethical. The interest is in providing a citation

tool which extends the functionality of an existing open source platform to students and faculty

free of charge. There is no profit and seemingly little to no potential for harm. However, there are still questions to consider.

The first would be whether the development of this app is permissible and aligned to the Zotero mission. Zotero is Open Source software under the GNU Affero Public License version 3, was developed at George Mason university, and continued to be non-profit and funded by donations and foundation funds. Zotero's statement of intent is as follows:

> "Zotero is an open-source project committed to providing the best research tool available anywhere. Our philosophy is that what you put into Zotero *is yours*, and one of our founding principles is to make it as easy as possible to take the fruits of your research where and when you want it and to share it how you like–or to choose not to share it at all" ("Zotero Privacy Information", 2015)

This project is entirely within this philosophy. In addition, Zotero's most recent release notes advertise several independently developed apps that extend Zotero.

However, the Privacy page goes on to clearly define its use of information given to the system. It is logical that any ethical extension of this system would use the same philosophy of limited information collection and use, and of clear explanation regarding data collection and use.

Limiting data exposure is in keeping with the philosophy of professional librarianship. The library profession has long considered research history to be protected information with the interest of protecting academic freedom and protect both themselves and their patrons from being censored, targeted, prosecuted, or persecuted based on their research interests. In the modern day, we and many other colleges host students and faculty from other nations some of which work to control knowledge and which have a much broader view on what would be

considered seditious, heretical, illegal, or undesired conduct. The American Library Association (ALA) has extensive writings on privacy and confidentiality in library consultations and records. These are based on the ALA Code of Ethics which has included a right to privacy since 1939. In the official interpretation document on privacy, the ALA states:

> "In a library (physical or virtual), the right to privacy is the right to open inquiry without having the subject of one's interest examined or scrutinized by others. Confidentiality exists when a library is in possession of personally identifiable information about users and keeps that information private on their behalf. Confidentiality extends to 'information sought or received and resources consulted, borrowed, acquired or transmitted' (*ALA Code of Ethics*), including, but not limited to: database search records, reference questions and interviews, circulation records, interlibrary loan records, information about materials downloaded or placed on "hold" or "reserve," and other personally identifiable information about uses of library materials, programs, facilities, or services" ("Privacy", 2014)

As libraries and librarians are recommending the use of Zotero and its online sync services to store the types of information considered confidential under this standard, it follows that librarians would want all parts of such services to be aligned with this philosophy.

To provide the service, Zotero and the new iOS app must collect some information. However, minimal reasonable information should be captured, and all such data should be protected. With this in mind, app security is important, and so is security for data transit to Zotero's servers. This would be in keeping also with Zotero's practices. The full Zotero Privacy Policy states:

"The Site has security measures in place intended to protect the loss, misuse and

alteration of the information under our control. We use industry standard encryption when

collecting your Personal Information, and we take reasonable steps to safeguard Personal

Information we collect from unauthorized access or disclosure and accidental loss or

alteration" (n.d.).

A second consideration is whether this project is within the mission of the organization.

Bryn Mawr College recently published internally a short list of strategic directions. One of these

speaks specifically to supporting the affordability of the student experience. Expanding services

while keeping the app free of charge aligns with this goal. A second direction is a focus on

supporting Science, Technology, Engineering and Math (STEM) opportunities for women

Recruiting a Bryn Mawr student as an intern would support this goal as this project would

provide an applied learning experience. Elements of these strategic outcomes also speak to

providing flexible learning and learning across multiple environments, and strengthening the

educational experience of our students. LITS works to support these directions and the overall

mission of the institution. In addition, LITS has specific departmental goals:

"[i]n a rapidly evolving digital environment, we use technological advances to provide

the best possible educational experiences for students…We value contributing to an

academic community that takes diverse approaches to scholarship and education, and

partnering with academic and administrative colleagues to enable goals and prepare for

the future of data and systems use, campus services, and information technology

infrastructure" (LITS, n.d.)

Bryn Mawr is invested in the Digital Humanities, in Blended Learning, and in teaching

and library innovation, as evidenced by its application for and receipt of Mellon Foundation

grants for the Tri-College Digital Humanities Initiative ("About: Tri-Co Digital Humanities, n.d.)

and Bryn Mawr's Blended Learning in the Liberal Arts, part of the Mellon Liberal Arts for the

Digital Age program ("Mellon Liberal Arts for the Digital Age", n.d.). Members of the LITS

team also host an annual Blended Learning conference; in 2016, LITS librarians presented their

research in piloting blended and flipped library instruction (Castello & Pfunt, 2016), and

individuals from Smith College (Martines & Eisenhauer, 2016) and Trinity Washington

University (Easby, 2016) (among others) spoke about mobile learning and digital resources

("2016 Conference Archives", 2016). This project supports all of these goals or interests and is

aligned with the interests of both the College and LITS.

The Markkula Center for Applied Ethics at Santa Clara University lists five sources (or

approaches) of ethical standards: utilitarian, rights, fairness or justice, common good, and virtue

(2009). The idea of producing an app to expand the capability of using Zotero is supported by all

of these ethical approaches. Creating an iOS versus Android app or apps for both platforms

serves utilitarian aims (in doing the most good and least harm) and the rights approach, and

serves as many members of the community as possible within the bounds of available resources.

Certainly it would be ideal to develop for both platforms, and expanding to Android if this is

successful is certainly possible. Given limited resources, some expansion (with no loss of current

function) is certainly beneficial to many and therefore ethical.

One challenge is the ongoing development for this app. Grant-based projects are typically

funded for the development and pilot (or first-run) of a program. It is then up to the team to

assess success, and source ways to provide ongoing resources. If this project is adopted by

individuals and no source can be found for ongoing maintenance, at some point in the future the

app may become unusable and functionality could be lost. While this would be unfortunate, the actual harm is relatively small.

Conclusion

Zotero is a valuable tool in citation management and measures up well against its competitors. One weakness in its portfolio is its mobile functionality, and an iOS app will best serve students at small colleges. Bryn Mawr College and its Tri-Co partners are well-positioned to provide subject matter expertise in research and citation management, assessment, and to bring new dimensions to library instruction as evidenced by the presentation given by Olivia Castello and Alex Pfunt at the 2016 Blended Learning in the Liberal Arts Conference (2016). A current grant provides an opportunity to both create this new community resource and provide a high value STEM-based learning experience for an intern. Creating an iOS app for Zotero is a low risk, inherently valuable project and should be pursued.

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Tables

Table 1

Raw Data: Small College Device Types

| Institution	Source	Total Devices	Number iOS	Number Android	Percentage iOS	Percentage Android	Ratio	Data Type
Haverford	CLAC	1856	984	272	52.40	14.50	3.62	Automatic Network Collection
Augsburg	SMALLCOL	1894	966	280	51.00	14.78	3.45	Automatic Network Collection
Hamilton	CLAC	319			0.83	0.14		First year students only, by survey
Amherst	CLAC	7523	3058	665	40.65	8.84	4.60	Automatic Network Collection
Reed	CLAC				0.68	0.28		First year students only, by survey
Kalamazoo	CLAC	3735	1352	657	36.20	17.59	2.06	Automatic Network Collection
Williams	CLAC	4782	2116	422	44.25	8.82	5.01	Automatic Network Collection
Chowan	SMALLCOL	6182	2416	1586	39.08	25.66	1.52	Automatic Network Collection
Grand View	SMALLCOL		2062	129			15.98	From BB Connect
Muhlenburg	SMALLCOL	4569	2145	579	46.95	12.67	3.70	Automatic Network Collection

Figures
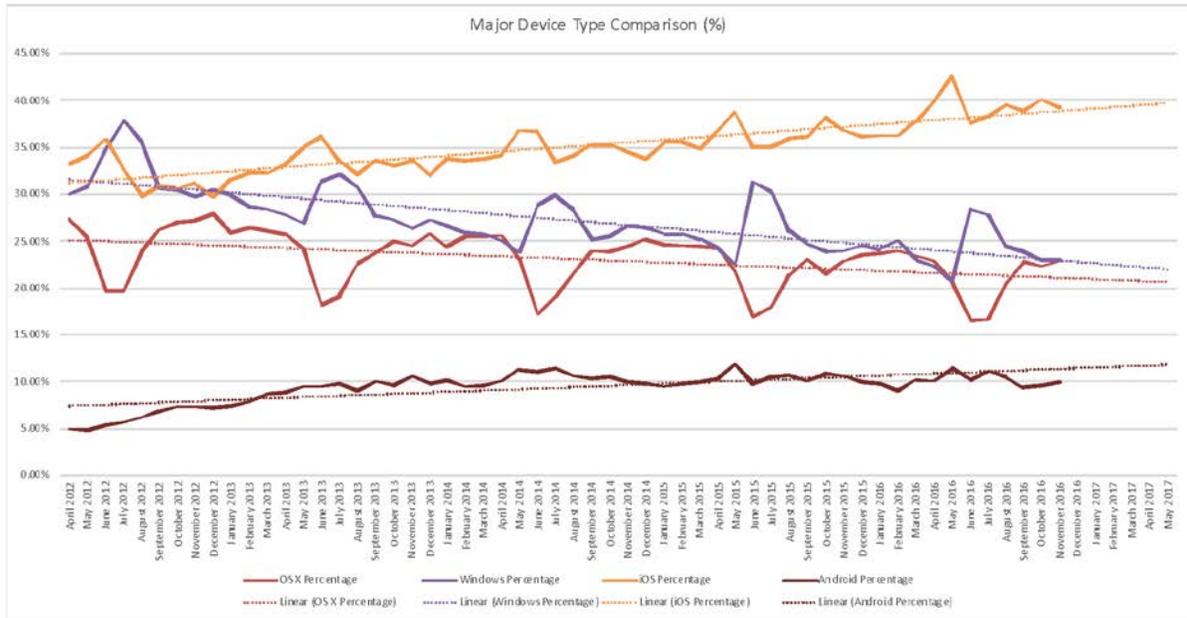
Figure 4. Historical data 2012-2016 for Bryn Mawr College. Indicates total devices of each type contacting Bryn Mawr's network in each month. This data is automatically collected by network infrastructure tools and collected monthly by the Bryn Mawr LITS Networking Staff.
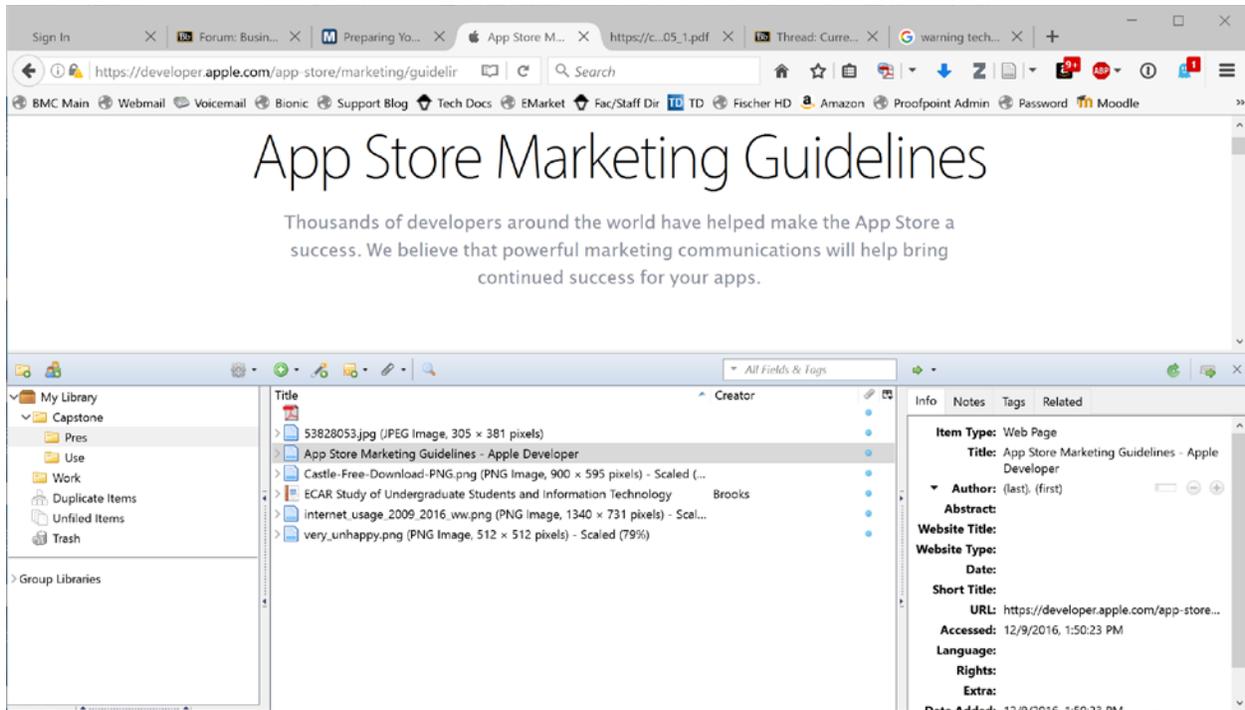
Figure 5. Screentshotof Firefox with the Zotero extension in use, taken December 10, 2016.
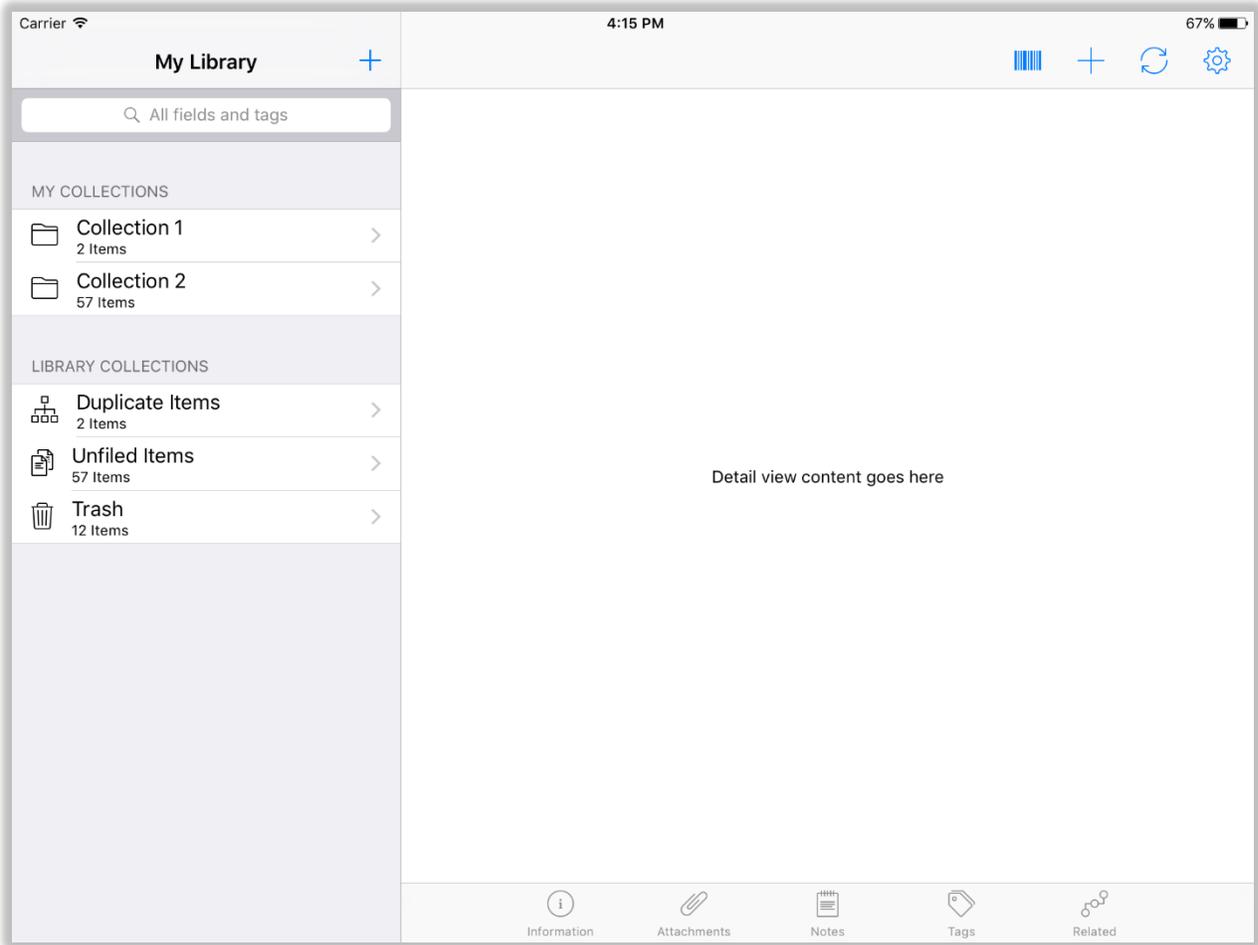
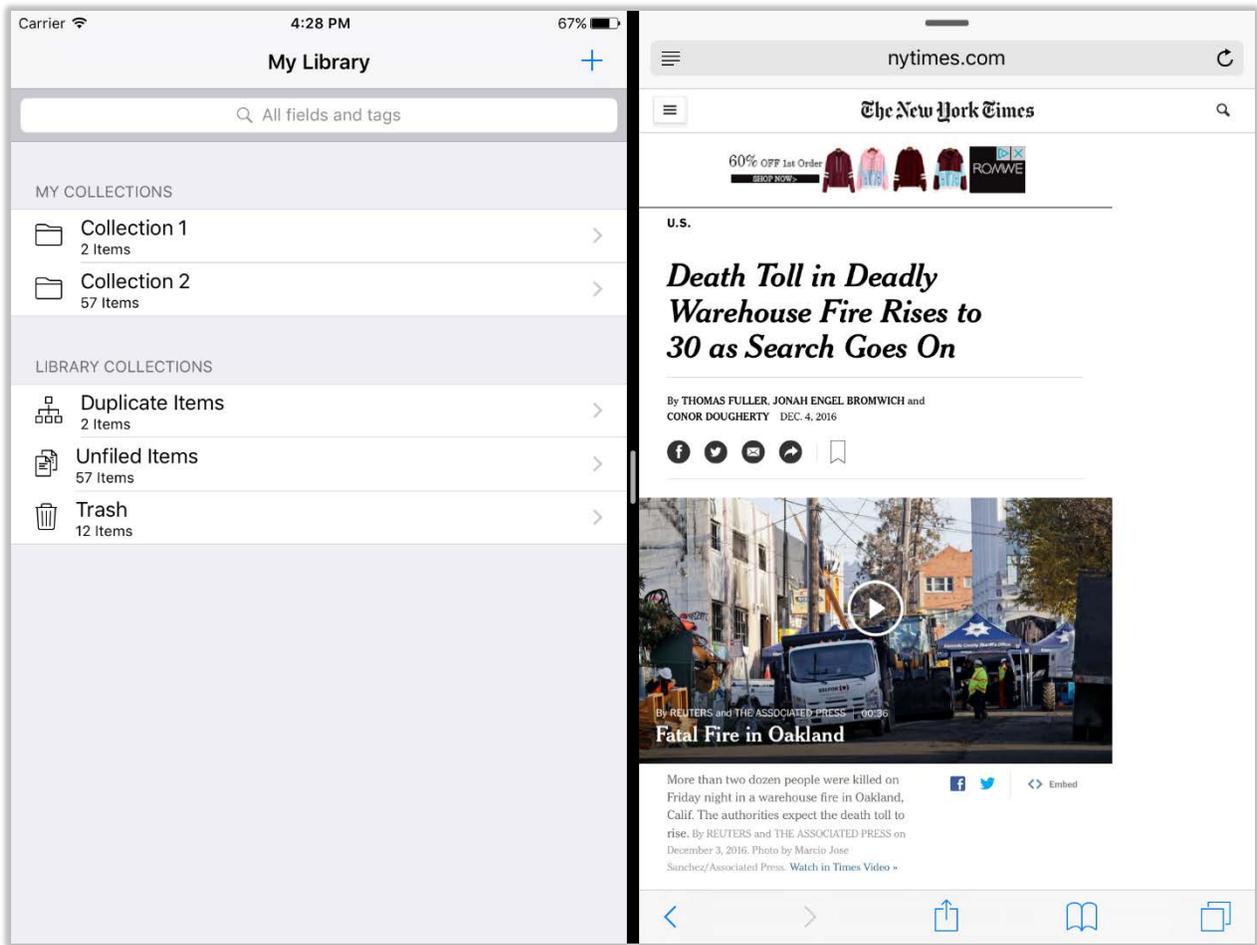*Figure 6. Early image of visual layout for Zotero iOS app.*

Figure 7. Early image of visual layout. Split view of Zotero app and Safari.