A Tablet-Based Interactive e-textbook for Business Statistics: A Case Study



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Executive Summary

- Tablet and mobile devices continue to proliferate on college campuses, creating an opportunity for faculty to guide student learning in new and innovative ways.
- E-textbooks are an excellent resource that students can readily access on tablet and mobile devices, thanks in part to proliferation of wireless networks and the low device cost.
- Early indications of interactive web-based supplements suggest that they can have a positive impact on student learning.
- This report evaluates the tools and technology necessary for faculty to provide tablet-based interactive e-textbooks to students, and is based on the experience in developing an e-textbook for business statistics.
- Based on a requiring a number of interactive features, and exploring various distribution channels available from three major e-textbook publishers, best practices are identified to help faculty interested in developing their own tablet-based interactive e-textbooks.
- Specific findings include a listing of tablet computers, suppliers and differentiating features, such as "read aloud" with Google Play Books, and "study cards" with iTunes books. We found that for authors interested in What-You-See-Is-What-You-Get (WYSIWYG) book editors, Apple's iBooks Author is the best option to embed interactivity directly into the e-textbook. For the broadest range of distribution channels, Google's Sigil editor was recommended, as it could produce a book that could be distributed on iTunes Books, Google Play, and with automated software, distribute a converted version for distribution on Amazon Kindles.

Abstract

This case study investigated the development and distribution of a tablet-based interactive e-textbook for business statistics. A variety of e-book development tools were evaluated, based on deploying the e-textbook across iTunes Books, Google Play Books and Amazon Kindle Books. The study found that while a large number of software solutions were currently available for e-textbook development, they often lacked the ability to add the level of interactivity sought by the investigation. For example, some software tools , could add interactivity, but to only a subset of tablet devices currently on the market. Other software tools could add interactivity, but without a reliable mobile "app" to render the e-textbook on the mobile device. Additionally, testing the quality of the interactive e-textbook was problematic and time consuming, although some recent technology updates have helped in this regard. Overall, the specifications for interactive e-textbooks are making their way into the commercial software necessary for faculty to develop e-textbooks. Also, robust apps that allow the books to be used on a tablet device continue to improve. The coming years for interactive e-textbooks appear to be promising as the technology continues to mature, and are beginning to become an excellent source of asynchronous e-learning for students today and the foreseeable future.

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Project Introduction and Goals

Electronic textbooks are becoming more commonplace, yet the interactive nature possible from an e-textbook has not yet reached the market in a significant way. Mobile technology has helped to accelerate the possibility of interactive electronic textbooks, but significant challenges remain. These challenges are broad, and include mature software for authors to use in creating the e-book, publishing platforms such as iTunes to distribute the e-book, and tablet applications to help students learn from the e-textbook by taking notes, highlighting, and creating an interactive experience. Overall, interactive e-textbooks provide another useful mechanism to help instructors "flip" the classroom and allow for more hands-on time when the class meets face-to-face.

The primary goal of this project was to create, mature and enhance an interactive e-textbook that provides overall support for Graziadio's online and hybrid/blended course offerings in Decision Sciences. It supported e-learning by providing students with a tablet-based textbook that covers the essential elements of business statistics for advanced undergraduate and beginning graduate students, and is planned to be used for the first time as part of the Flex BSM program starting in spring 2014. It also provides an engaging refresher to incoming Fully Employed MBA (FEMBA) and Full Time MBA (FTMBA) students who would benefit from a review of the theory, application, and spreadsheet implementation of foundational statistical concepts found in contemporary business practice.

The contents of this case study cover the positive and negative experiences of developing an interactive e-textbook for business statistics, as well as capturing important lessons learned and best practices. The best practices are believed to be largely generalizable to other disciplines, as many of the features sought for interactivity are discipline independent. The investigator hopes that this case study will help serve as a guide for those academics interested in writing their own e-books with features that were simply not possible in traditional print media.

1. Background

Publishing an electronic document is not new. But, the ability to create an interactive e-textbook that can be easily distributed via an "app" to a tablet computer is a very recent development. The three major distribution channels examined in this study were Apple iTunes Books, Google Play Books, and Amazon Kindle Books. Each of these has been distributing books electronically for some time, but Apple has taken the lead in developing the capability to provide interactivity to its e-books.

1.1 Motivation

The motivation for providing interactivity into a textbook on business statistics was formed based on the empirical evidence shown below in Table 1.1. Here, an online set of interactive web-pages was provided to students to supplement lessons from the classroom in preparation for the final exam, but not the mid-term exam. Students were also given a few bonus points if they provided constructive criticism on this online supplement that can be found at

http://gsbm-app.pepperdine.edu/BSM471new2/index.html

The results are based on students who were enrolled in a 14 week trimester course, and were required to take a mid-term and final exam, that each account for 25% of their grade. The exams were open-book, open-notes, and open-computer, but must be completed individually. The time to complete the exam was four hours, and students typically finished the exam in about three hours. The exams are designed the assess mastery of materials covered in the previous seven weeks of class, so the final exam was not comprehensive.

As shown in the 2nd and 3rd columns in Table 1.1, not every student opted to participate in providing feedback on the online supplement, yielding a participation rate slightly higher than 50%[1]. This rate is preferred, because we were interested in the difference in mid-term to final exam scores, where an additional dummy variable was used to identify participation in reviewing the online supplement as part of final exam preparation. Thus, we had a balanced sample with observations that included those who did and did not use the online supplement for final exam preparation. Also, any significant trend in scores (which were typically downward) or absolute student performance between the mid-term and final was removed by focusing on the net effect of using the online supplement. As the table shows, students who reviewed the online supplement had a positive net effect on the final exam relative to their mid-term score. On a weighted average basis, student scores were 7.5% higher than those students who didn't use the online supplement to review for the final exam, relative to their mid-term exam score. This increase suggests that the interactivity of the online supplement made a positive impact on student learning.

Section, Term	*Sample size*	*Number participating in review of online supplement*	*Net Effect of using the online supplement on final exam, relative to mid-term exam score*
Fall 2011, West LA (WLA)	26	14	+11.02%
Fall 2011, Irvine	20	6	+9.37%
Spring 2012, WLA	24	16	+9.43%
Spring 2012, Irvine	18	12	-2.19%
Totals, Weighted Average	***88***	***48***	***+7.51 %***

Table 1.1: Impact of students reviewing and commenting on an online supplement and their improvement on final exam, versus the mid-term exam. Exams are not cumulative.

1.2 Pros and Cons of Self-Publishing an Interactive e-Textbook

It is important to note that publishing an electronic book, or in our case, an e-textbook, may by-pass the usual route of engaging with a book publisher, such as McGraw Hill or Pearson. This was the route taken in this case study, which offered several benefits, but also created many challenges. The benefits of publishing directly on Apple iTunes, Google Play, and Amazon.com include:

- The ability to update versions more rapidly.

[1] It is possible that some students used the supplement to prepare for the final, without providing feedback and receiving extra credit, but this number is assumed to be negligible.

- Greater share of the sales revenue.
- Greater control over content.

The challenges of this route, which is much like self-publishing in the traditional sense, include:

- Lack of technical support in typesetting content.
- Limited or no marketing support from a large, established player in book publishing.
- Limited technical and/or editorial support, if any.

2. Technology Requirements and Desired Features

As noted previously, one of the downsides of publishing an e-textbook can be limited technical support. This section of the case study is intended to provide a review of many of the technologies involved in the overall process of making an interactive textbook available online. It is not mean to be comprehensive, but does express a variety of aspects worth considering for any academic considering self-publishing an interactive electronic textbook.

2.1. What is a "tablet-based interactive e-textbook"?

To begin, we define more clearly what is meant by "interactive e-textbook". In our case, interactive includes the following characteristics

1. Active table of contents – Allows readers to quickly jump to chapters or sections within the e-textbook.
2. Active glossary – Allows reader to select bold or underlined terms or concepts, and immediately jump to a text description of the meaning.
3. Dynamic paging – Allows reader to change font size, font style/typeface, line spacing and margins.
4. Searching – Allows readers to search for words or phrases throughout the book.

Additionally, tablet-based is suggested to be one in which the book can be read either online or offline using a tablet device. These devices include, but are not limited to those in the following table, which individually have some additional features as indicated with an "X".

Tablet Name	Vendor	Cloud Support	Read Aloud	High-lighting	Note taking	Book-marking	Study Cards
iPad	Apple			X	X	X	X
Nexus 7	Google	X	X	X	X	X	
Nook HD[2]	Barnes & Noble	X	X	X	X	X	
Kindle Fire	Amazon	X		x	x	X	

Table 2.1: Tablet computers, suppliers and differentiating features.

[2] Uses Google Play app installed on Nook HD, which became available in May 2013. For more information see http://www.digitaltrends.com/mobile/nook-hd-google-play-impressions/

Some of the features in Table 2.1 are worth additional discussion, as they can be very relevant to e-learning. The first is cloud support, which suggests some form of synchronization across devices and or platforms. A good example of this is the Kindle Fire, which when synchronized with an Amazon account, allows readers to read the same book on multiple Kindle devices, and keep track of the latest page viewed. Cloud support is also available from Google Play Books and Kindle Cloud Reader, which goes the additional step of also providing web browser support. So, for e-textbooks published on either Google or Amazon, students and faculty can open and read the book on a tablet as well as any traditional desktop or laptop personal computer with a modern web browser[3].

The read aloud feature is unique to e-books published on Google Play, and requires an active internet connection to function. When connected, a non-robotic sounding voice reads the text of the book out loud using the tablet speaker's or connected headphones. During some basic tests of this feature, it was found to work quite well, with few exceptions, such as when it encountered a line representing an equation, calculation, or table. Otherwise, the read aloud feature offers a unique benefit for books published on Google Play. It should be noted that the read aloud feature was tested on both the Nexus 7 and the Nook HD, which both accessed the book through Google Play Books. Presumably, other android-based mobile devices, like the Samsung Galaxy Tab, HTC One smartphone, Droid Incredible smartphone, etc. running a current version of the Android OS, would be equally as capable provided that have access to the Google Play store Books app.

The last notable feature of the e-textbook is the ability on the iPad to make note cards. These cards become dynamic content created by notes entered by students. Once the notes are entered, the note cards, called study cards in iBooks, can be viewed as virtual flashcards on the iPad. Viewing of the notecards can be done in the sequence they were made in the book, or randomly.

In all cases, the features listed in Table 2.1 are automatically available on the devices described, and require no additional work during the development of the book. In the next section, additional features will be discussed that require specific software to implement. In some cases, the additional features that follow are not available from all book development environments, or are available but in very different ways.

2.2 Other desirable features for a tablet-based interactive e-textbook

The features listed in the previous section are native to tablet computers listed, but additional features are also desirable. These features were part of the online supplement discussed in the previous section, and which appear to have helped produce the higher exam scores. These features are:

1. Short audio and/or video clips
2. Matching exercises
3. Multiple choice quizzes

[3] Modern web browsers include, but are not limited to: Apple Safari, Google Chrome, Microsoft Internet Explorer, and Mozilla Firefox.

In the online supplement, these features were available in some cases using Adobe Flash technology. Unfortunately, with Apple leading the way on transitioning from Flash to HTML5, the tablets evaluated in this study no longer support Flash. In addition, while the solutions to multiple choice problems (that involved computation) were provided in the online supplement with immediate feedback on the correct solution, a detailed solution that led the reader to the correct answer were not included. To that end, we also found it desirable to also include the feature

- Linkage between exercises/problems to solutions in the "back of the book".

As will be seen in the sections that follow, the development of the e-textbook follows a different path in order to provide these features, and depends largely on the tablet device targeted for the e-textbook.

3. Development environment for the interactive e-textbook

The first choice that needs to be made by someone considering publishing an e-textbook is the target platform they are interested in publishing on. The table below lists the software used to publish to the devices identified in the previous section, based on an assessment of alternative software tools that follows. The e-book software development options support either ePub 2, which is the currently and widely accepted standard, or ePub 3[4], which is in the early stages of adoption.

Target	Desktop or Laptop OS	eBook development software options	Additional Software and Accounts
iPad	Mac OS X or later	iBooks Author[5], Pages, Sigil[6]	iTunes Producer, iTunes partner account
Nexus 7	Window 7 or Mac OS	Sigil, BlueGriffon ePub Edition	Google Play partner account
Amazon HD	Window 7 or Mac OS	Sigil, BlueGriffon ePub Edition	Mobi converter software, Kindle Direct publishing account

Table 3.1: Software evaluated to develop and upload an interactive e-textbook.

3.1 Developing an interactive e-textbook for the iPad

There are three options available, as listed in Table 3.1, for developing an interactive e-textbook for the iPad. Free from Apple for Mac OS users, iBooks Author is recommended as the best option for books targeting the iPad. Based on Apple's interpretation of the ePub 3 specifications, it can provide all the interactivity features previously discussed, except for read aloud and cloud support. iBooks Author has the additional benefit of being very easy to use (relative to other software listed in the 3rd column of Table 3.1), and receives "free" marketing support by being categorized as a "textbook" when published in iTunes. Please see the screenshots in the later sections of this case study for an example, which we believe creates much greater visibility and marketing of the book than other books published on iTunes. Evidence of this greater visibility appears in the download history of an early prototype of our online

[4] http://en.wikipedia.org/wiki/EPUB
[5] Recommended for ease of use and best integration of interactive e-textbook features.
[6] Recommended for greatest compatibility with different tablet computers.

supplement converted into an interactive textbook using iBooks Author. Figure 3.1 shows a significant amount of traffic with no additional advertising or marketing of the book was performed.

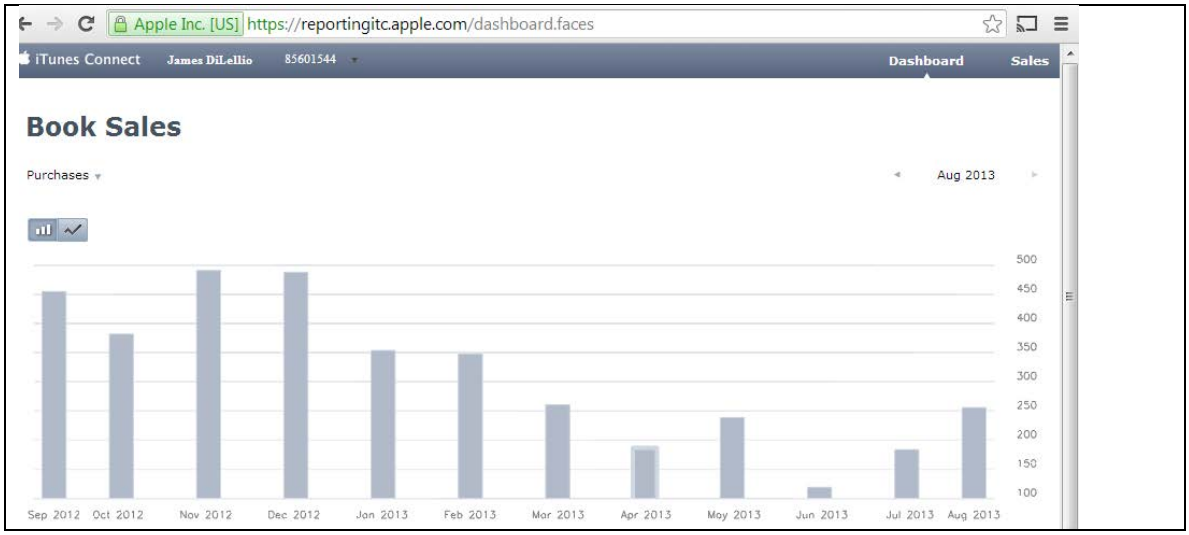

Figure 3.1: Monthly download history of "StatiCity, Volume 1" from iTunes.

Another benefit of using iBooks Author is that it also supports the option of either embedding audio/video directly in the book, or supporting streaming the video into the e-book from an external source such as YouTube. This option is important, because adding audio and videos to a book can quickly grow the file size that stores the book, and can be potentially frustrating for students trying to download the book. In our own e-textbook evaluation, the file size for a volume containing four 5-7 minute videos grew by a factor of 10^3, from ~400 kb to 400 Mbytes. Given the significant benefits of including short video clips in an e-textbook, and the "always connected" nature of many tablets, the streaming of video clips appears to be the preferred option. For more information on streaming video into iPad book created by iBooks Author, please refer to http://ibooksgenerator.com/

While we believe iBooks Author is the best option for publishing an interactive e-textbook for the iPad, it is not without its own limitations. First, the free software is only available for up-to-date versions of laptops and desktops running Apple's Macintosh operating system (Mac OS). In addition, the program works in a version of the book with the extension ".iba", requiring authors to manually create ".ibook" files for upload. Lastly, the ".ibook" files have legal restrictions on their use. Per the end user license agreement (EULA) from Apple, these files may only be distributed on iTunes[7]. Also, the ".ibook" file can't be automatically converted to other formats, thus restricting its use to iPads only[8].

Two options that were investigated for this case study for developing an e-textbook for the iPad are Pages and Sigil. Pages is a program that is part of the productivity suite of tools from Apple, and runs solely on Mac OS. It has many similar characteristics to Microsoft Word, but has the additional feature of saving a document that has been formatted using certain "rules" that allow for it to meet the

[7] http://support.apple.com/kb/HT5071

[8] The next planned upgrade of the Mac OS X is expected to offer viewing iBooks. For more information, please see http://www.apple.com/osx/preview/.

aforementioned ePub 2 standard. The primary limitation of Pages is that it is produces e-books based on the ePub 2 standard, which wasn't designed for the interactive features identified in section 2. It also has some limitations as a WYSIWYG (What You See Is What You Get) editor, since Pages is designed for documents with a fixed layout, not the variable layout created by the ePub format. In summary, Pages appears to have been a solid choice for simpler e-books prior to Apple's release of iBooks Author in 2012.

The third option considered to produce the e-textbook for the iPad was Sigil, which is free software provided by Google[9]. It also follows the ePub 2 standard, but has begun to integrate select ePub 3 features, called "enhanced ePub" by the developer. Sigil is also an improved WYSIWYG editor when used in "book view", and allows for greater control of the e-book's layout than Pages. This aspect has proven very useful, as special characters for equations and tables appear to be supported features by Sigil. Unfortunately, Sigil is not designed, nor is it planned for upgrade to support the interactive quizzes and/or matching exercises suggested by the ePub 3 specification, which are currently available from iBooks Author.

3.2 Developing an interactive e-textbook for the Android tablets

There were two different e-book development tools evaluated in this category of tablets. The first was Sigil, which was discussed in the previous section. The second is BlueGriffon ePub edition, which claims to support ePub 2.0 and some ePub 3 specifications[10]. Our experience with BlueGriffon ePub edition initially showed promise, as it provided better support for tables and mathematical equations than Sigil. Unfortunately, the mathematical equation support requires the Nexus 7 to run an app that meets the ePub 3 specifications. A variety of apps were found, such as the Sony Reader Android app[11] and Gitden ePub3 Book Reader[12], and tested on a Nexus 7. Sadly, none were found to be sufficiently reliable. Additionally, the BlueGriffon tool carries a cost of 195 euros per user, the user interface appears to require some specialized skill to use, and little training materials are provided with the license. With these issues, we decided that the BlueGriffon tool would not be used to produce the ePub file. But, we may revisit this decision in the future as the tool matures and additional help files/training become available for it.

Thus, we selected Sigil to develop the interactive e-textbook. It carried the additional advantage of being a Google product, which provided more extensive help manuals, as well as (presumably) better compatibility with its distribution over Google Play Books. This latter point will be discussed in the next section on e-book distribution. Unfortunately, as cited in the discussion on using Sigil for the iPad e-textbook, it has limitations in the following way.

- No support for embedded short quizzes.
- No support or embedded matching exercises.

[9] https://code.google.com/p/sigil/
[10] http://www.bluegriffon-epubedition.com/BGEE.html
[11] http://goodereader.com/blog/electronic-readers/sony-reader-for-android-updated-to-support-epub-3
[12] https://play.google.com/store/apps/details?id=com.gitden.epub.reader.app

To address these limitations, we explored and ultimately chose to implement these functions by embedding a link in the e-textbook to an external website running HTML5 code[13]. While functionally equivalent, requiring the student to switch between the Google Play Books app and a web browser is not as elegant of a solution as the embedded option from iBooks Author. Nevertheless, to reach the vast number of Android devices, like the Nexus 7, this was found to be the only viable alternative.

3.3 Developing an interactive e-textbook for Amazon Kindle devices

To distribute an e-textbook for Amazon Kindle users, the file must be formatted in either the KF8 or Mobi formats. Fortunately, there is a tool available from Amazon that automatically converts ePub files, with the ".epub" extension, to this format[14]. Our tests of this conversion found the process to be straightforward and easy to do. We also manually transferred the ".mobi" file to a Kindle Fire, convincing us that the file could be rendered successfully on Amazon Kindle devices.

4. Distribution of the interactive e-textbook

Depending on the target platform chosen, distribution of the interactive e-textbook is fairly easy. Nevertheless, Figure 4.1 may provide the additional guidance needed in order to understand the necessary steps involved.

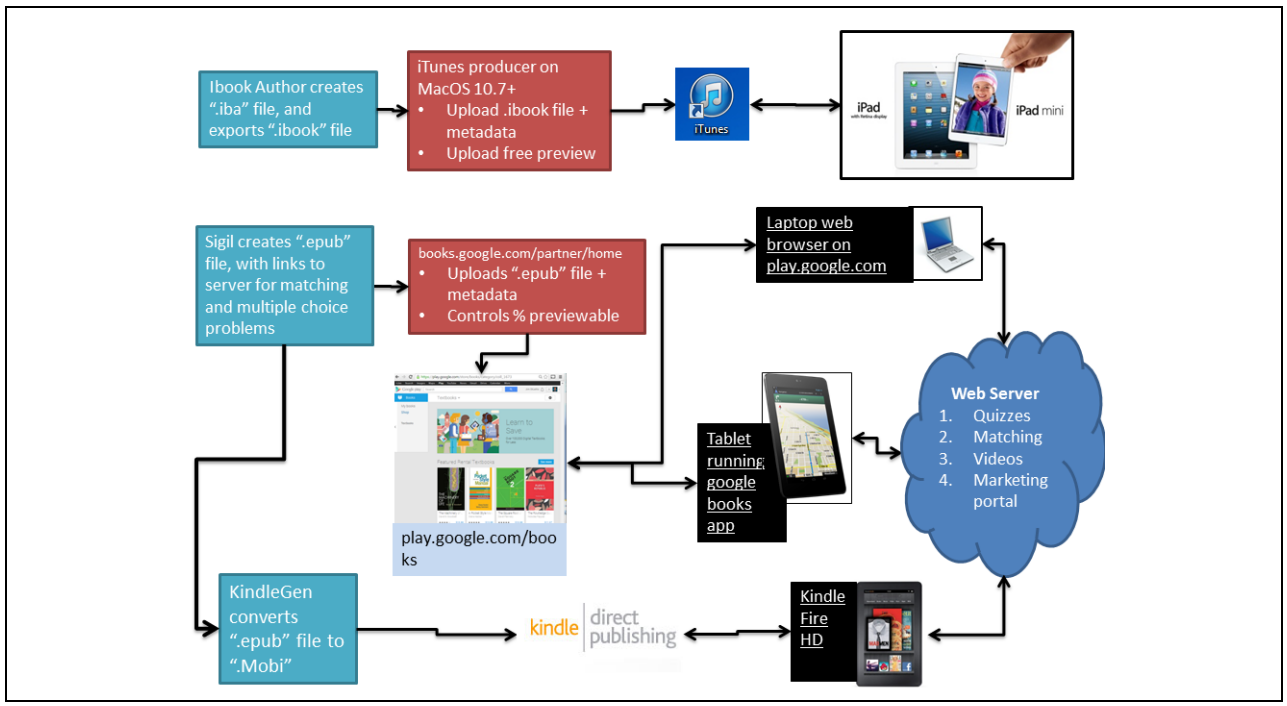

Figure 4.1: Tablet-based Interactive e-textbook workflow.

[13] Some interactive games of the original online supplement were flash based, so needed to be replaced with HTML5 versions. We accomplished this by using templates obtained from a $300 subscription to http://elearningbrothers.com.

[14] http://www.amazon.com/gp/feature.html?ie=UTF8&docId=1000765211

4.1 Publishing on iTunes

Before publishing on iTunes, an iTunes Connect account will need to be established. Within the account, which is set up at https://itunesconnect.apple.com, authors can monitor sales on a per-day, week, month or yearly basis. An example start screen appears below in Figure 4.2 for two volumes of the interactive e-textbook developed as part of this case study. In addition to sales information, the iTunes connect website provides a wide variety of software resources, such as iTunes Producer, to provide guidance and upload the ".ibook" file to iTunes. Additional users, bank account information, and trouble tickets associated with e-books are also all managed through this site. Overall, the site does an excellent job of supporting self-publishing an e-book on iTunes.

In the event there is an issue with the ".ibook" file uploaded to Apple, email and trouble tickets will lead the author through the correction process. It was our experience that issues that prevented books made by iBooks Author from appearing in iTunes were typically quality issues when low resolution images were not deemed acceptable. The issues were quickly resolved, and the time between upload and availability on iTunes was typically less than 1-2 weeks.

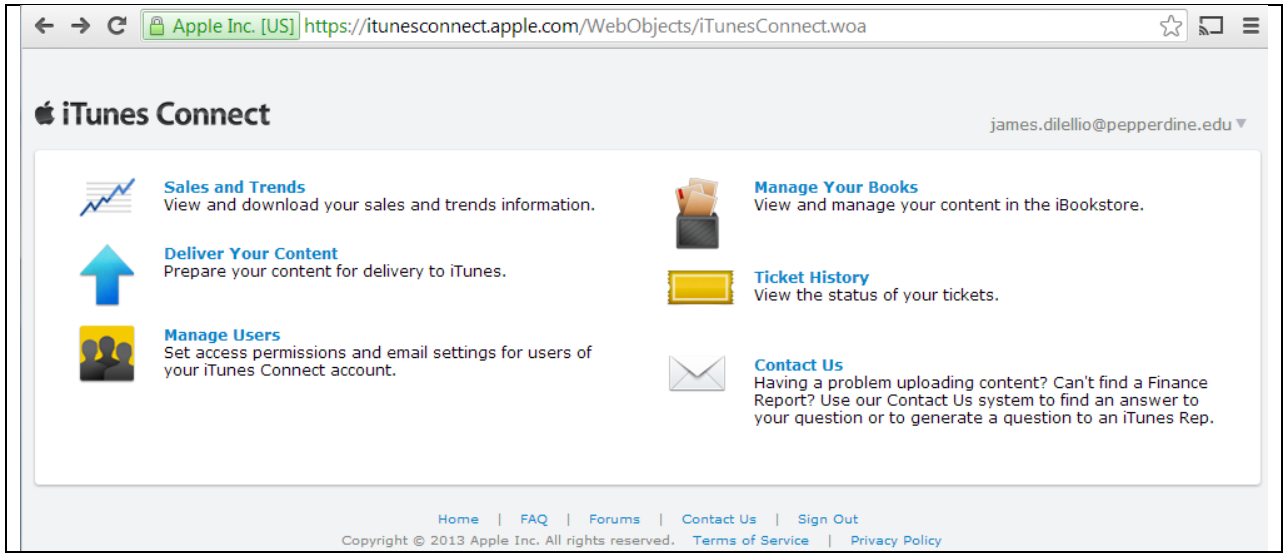

Figure 4.2: The start screen from iTunes Connect.

The Apple Store Apple has also designed their online store to highlight interactive books made with its software. Below are screen shots from the iTunes store as of September 2013, indicating where the current two volume interactive e-textbook can be found.

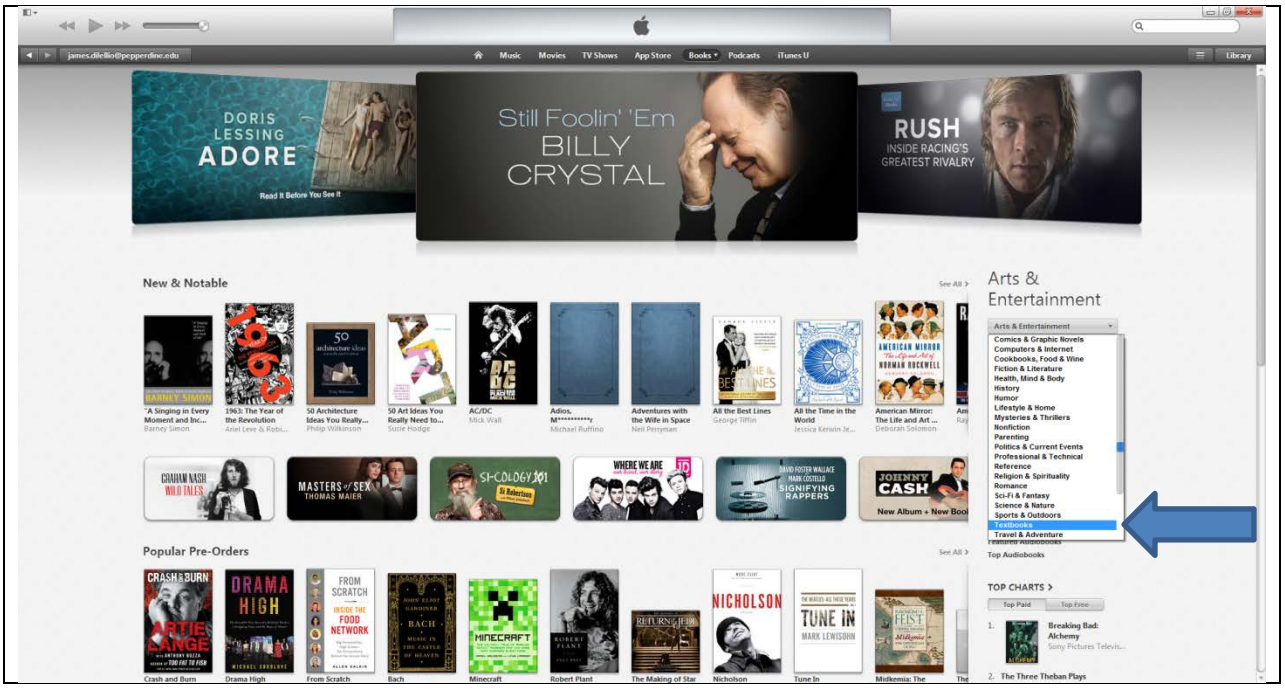

Figure 4.3: Screenshots from iTunes, 1 of 4.

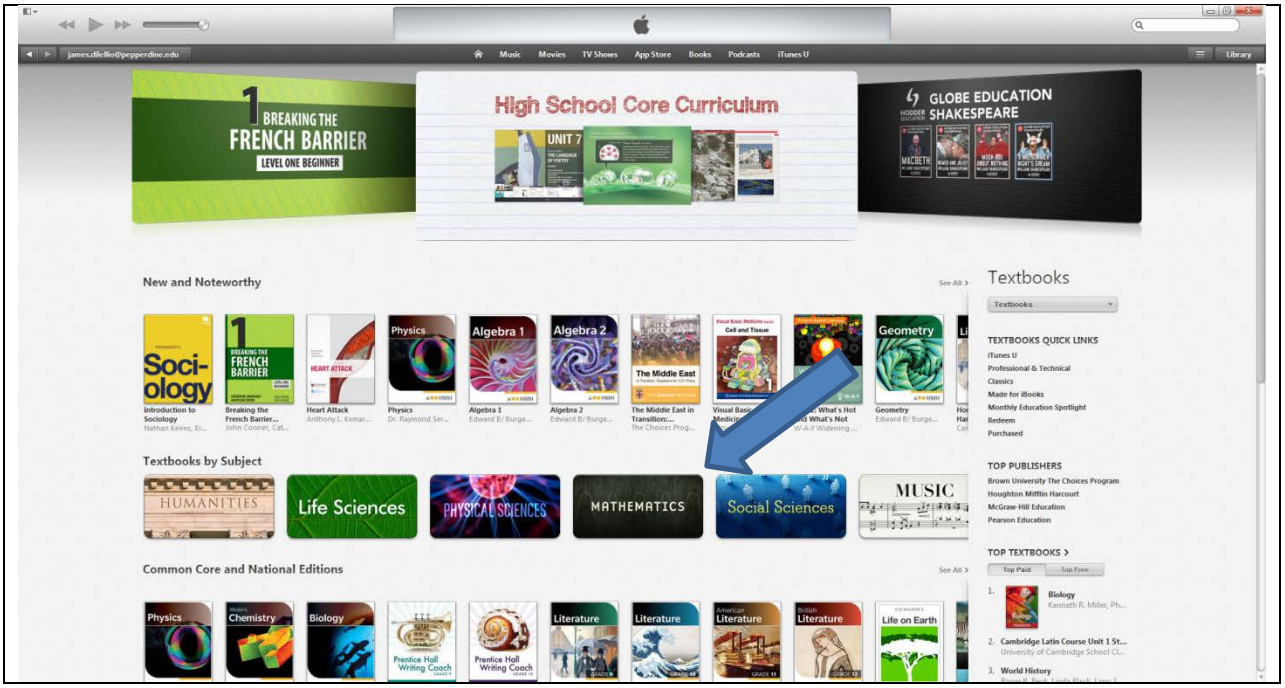

Figure 4.4: Screenshots from iTunes, 2 of 4.



Figure 4.5: Screenshots from iTunes, step 3 of 4.

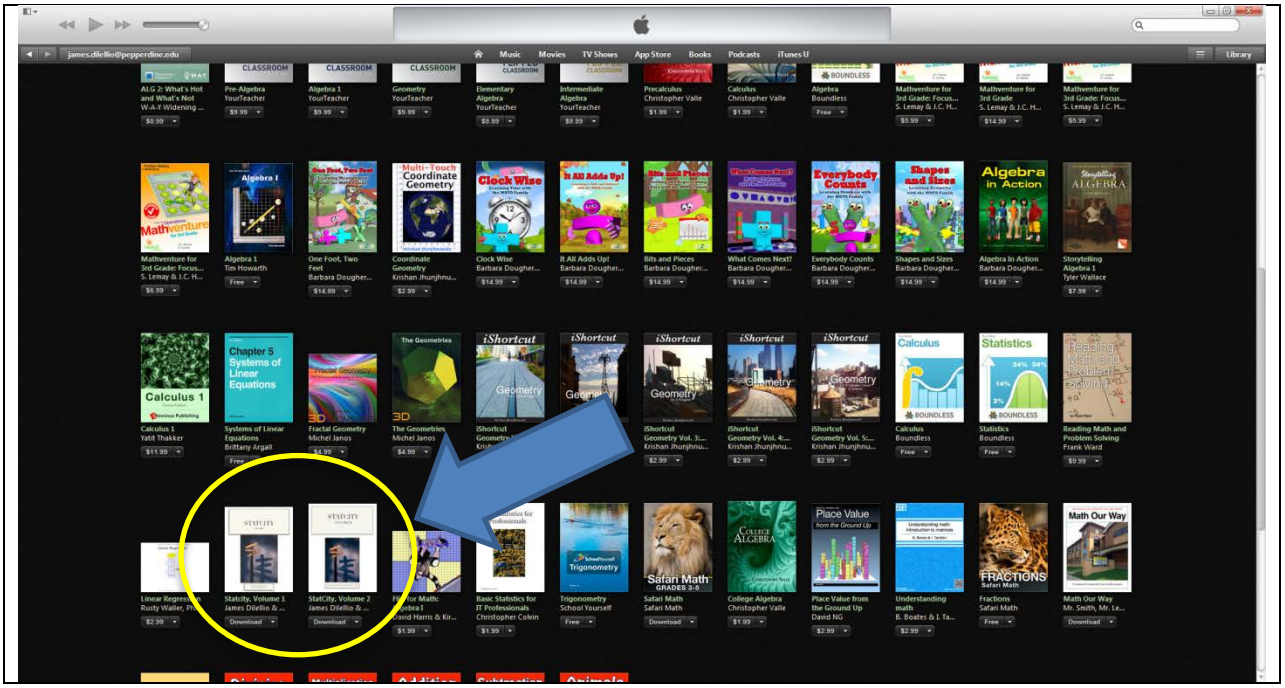

Figure 4.6: Screenshots from iTunes, step 4 of 4.

4.2 Publishing on Google Play Books

Like iTunes, publishing a book on Google Play also requires a Google account to be set up at https://books.google.com/partner/home. Once setup, authors simply upload their ".epub" files via their

web browser. The web interface has recently improved as of July 2013, with an example appearing in Figure 4.7 below.



Figure 4.7: The start screen after logging into the Google Play Books account.

Also like iTunes, authors can view sales reports, check on the status of recently uploaded books, and enter bank account information. It also provides information on any issues encountered with the e-book. Our experience with these issues were primarily caused by not exercising the "check ePub" button in Sigil, and then making the corrections necessary to remove the warnings[15]. We also were happy to see that, as of May 2013, these issues could be seen much faster by manually uploading the files to a personal Google Play books folder[16]. Otherwise, many weeks would go by and the Google book support team provided little relevant direction on the root cause of the problem and how to correct it.

The Google Play store also has a dedicated textbook section, but it does not highlight interactive books as iTunes does. The simplest way to find a book on Google Play is to simply type the name of the book or author's name in the search box at http://play.google.com/books. Searching for the book developed as part of this case study then appears as shown in Figure 4.8.

[15] In some cases, removing the warnings required switching Sigil to "code view" and removing HTML code within the ePub file. In other cases, simply re-generating the Table of Contents corrected the issues.
[16] http://www.theverge.com/2013/5/15/4334444/google-play-books-ios-android-sideloaded-ebooks

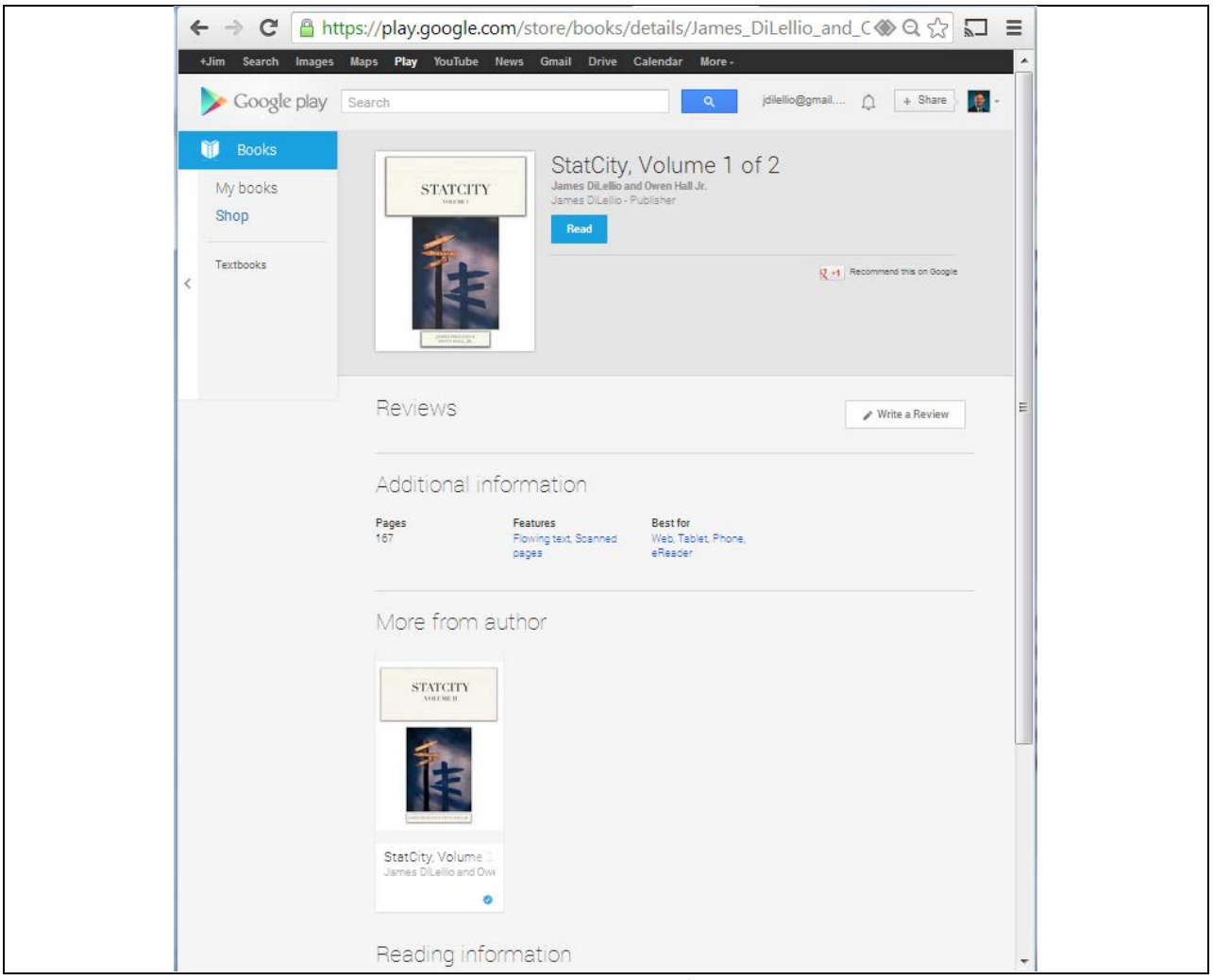

Figure 4.8: Finding a book using search at play.google.com/books.

Conclusions

This case study identified the benefits of interactive content on student learning in an undergraduate business statistics course. It then evaluated the technology necessary to bring this content to tablet and mobile devices. While not ubiquitous, there is currently sufficient support for developing an interactive tablet-based e-textbook. The best support available comes for free from Apple, which provide iBooks Author on the Mac OS, and which can provide 100% of the features and interactivity needed. In addition, e-textbooks created with iBooks Author are featured on iTunes, increasing visibility for students and faculty browsing the iTunes online sales portal. Unfortunately, these interactivity features can only be accessed on an iPad, which significantly limits their access to the tablet and mobile device market.

For this reason, Google's Sigil tool was also recommended so that, with support from HTML 5 web pages, could provide equivalent features as provided by Apple's iBooks Author. When published on Google Play, e-textbooks carry the additional "read-aloud" feature, as well as book access from any modern PC web browser. Google's Sigil offers the additional benefit that, by following the open ePub 2 standard, Amazon provides an automated tool to convert to a format that can be distributed to Amazon Kindle devices. Thus, the file produced by Sigil can be viewed by both Android devices with access to the Google Play Store, as well as the Kindle devices accessing the Amazon online book store.

Future work in this project could be in several areas. First, because the tools are continuing to mature to embed interactive content into e-textbooks, an updated assessment on the use of the tools commercially available could be performed. Also, a more detailed discussion on the use of Amazon Kindle devices may be helpful, as neither a sales account nor distribution point were setup as part of this case study for Kindle devices. Lastly, developing, collecting and analyzing data based on the initial rollout of the interactive e-textbook developed as part of this case are warranted. With this information, a better understanding of the overall effectiveness of an interactive tablet-based e-textbook could be obtained.

Additional Readings

Online group learning:

Davis, J. and Chao, F. (2004), "Effective Collaborative Group Activities for Online Statistics Courses,", Paper presented at the annual meeting of the Hawaii International Conference on Statistics and Related Fields, Honolulu, HI.

Everson, M. (2006), "Group Discussions in Online Statistics Courses," eLearn Magazine [online]. Available at http://www.elearnmag.org/.

Online teaching:

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