Through a game darkly: student experiences with the technology of the library research process

Karen Markey, Chris Leeder and Soo Young Rieh

School of Information, University of Michigan, Ann Arbor, Michigan, USA

Abstract

Purpose – The purpose of this paper is to examine the nature of students' library-research difficulties, especially difficulties rooted in technology, to describe how the BiblioBouts information literacy game helps students overcome these difficulties, and to discuss how BiblioBouts has evolved in order to reduce students' difficulties with the technology of the library-research process.

Design/methodology/approach – Data collection was multi-modal involving quantitative instruments such as questionnaires and logs of students' game-play activity and qualitative involving game diaries that students voluntarily completed after time they played the game, focus group interviews with students who played and did not play the game, and personal interviews with instructors before and after their students played the game.

Findings – The technology underlying the library research process is difficult to use. BiblioBouts helps students overcome their difficulties. BiblioBouts continues to evolve to enable students to reduce their difficulties with this technology.

Research limitations/implications – Playing BiblioBouts gives students exposure to searching library databases but game play *per se* does not focus on searching.

Practical implications – Students benefit from playing BiblioBouts. They gain first-hand experience and practice with library-research technologies such as the library portal for database selection, library databases for quality information, and Zotero for citation management. They are exposed to more sources than they would have found on their own and a logical, methodical process for evaluating the sources they find.

Social implications – Online social gaming has been enlisted to transform library research from a solitary activity into a collaborative activity where students document their research activities and share in the research trail that individual game players leave behind.

Originality/value – The research underlines gaming's effectiveness for teaching incoming undergraduate students information literacy skills and concepts.

Keywords Libraries, Information, Information searches, Computer games, Information research

Paper type Research paper

1. Introduction

Technology has automated many of the individual tasks of the overall library research process such as searching online indexes, downloading digital full-texts from online

publishers, taking notes, citing sources, and drafting outlines. Unfortunately, these tasks are not yet seamlessly integrated.

To seal the seams in the library research process, a research and development (R&D) team designed and developed BiblioBouts, an online information literacy game, that is made up of a series of mini-game or bouts. The game ushers students through the research process of finding, evaluating, selecting, and citing high-quality online information for their papers. It culminates in an actual bibliography students can use to write a class research paper.

BiblioBouts' alpha version was deployed at four partner institutions in the 2009-2010 academic year. At these institutions were librarians who served as liaisons to the BiblioBouts R&D team, recruited interested instructors, assisted them with game setup and syllabus synchronization, troubleshooted technical problems, and visited instructors' classes to introduce students to their institution's library portal, relevant databases, the Zotero citation management tool, and the BiblioBouts game. Since early 2011, BiblioBouts beta versions (1.0 in winter 2011 and 2.0 in fall 2011) have been available to both partner institutions and instructors and librarians anywhere.

A multi-modal evaluation of the game exposed students' successes and challenges with both the technologies of the library research process and the BiblioBouts game itself. The purpose of this paper is to examine the nature of students' library-research difficulties especially difficulties rooted in technology, to describe how BiblioBouts helps students overcome these difficulties, and to discuss how BiblioBouts has evolved in order to reduce students' difficulties with the technology of the library-research process.

2. Literature review

This literature review explores four themes. First, it challenges the myth that today's students are technologically-savvy. Second, because students need to be informed consumers of information to be successful in the academy and beyond, it suggests that information literacy should take precedence over technology literacy. Third, it probes the difficulty of instituting information literacy instruction in the academy due to faculty indifference. Fourth, it proposes that information literacy instruction that is both experiential and contributes to students' coursework is instruction that students and faculty will welcome and introduces the online BiblioBouts information literacy game that students play to learn information literacy skills and concepts while they complete their course assignments.

2.1 The myth of today's technologically-savvy college student

Unlike their elders, today's college students grew up with technology, and thus are presumed to readily adopt new technologies that help them achieve their goals and cast aside ones that do not (Lorenzo and Dzuiban, 2006, p. 2). A variety of names has been applied to students in college today – next gens (Abram and Luther, 2004), net generation or net geners (Windham, 2006; Oblinger and Oblinger, 2006), millenials (Abram and Luther, 2004), Google generation (UCL, 2008), and digital natives (Prensky, 2001). As self-discoverers who are intuitive, connected, immediate, social, and experiential, they draw on these traits to figure out how new technologies work and figure into their lifestyle (Smith and Caruso, 2010; Windham, 2006; Oblinger and Oblinger, 2006).

Research on college students' technological prowess reveals an almost universal predilection toward technologies that entertain them, facilitate communication with

their peers, increase their efficiency, and save time (Lorenzo and Dzuiban, 2006, pp. 9-10; UCL, 2008, p. 12; Kvavik, 2005, pp. 7-13). However, "the impression of broad competence slips" when researchers probe their facility with mainstream educational technologies such as presentation development, spreadsheets, graphics, web page creation, and video production (Oblinger and Hawkins, 2006, p. 12). A report prepared for the British Library warns that "their apparent facility with computers disguises some worrying problems" (UCL, 2008, p. 12).

The headline "exploding the myth of the digital native" capped news reports of the ERIAL studies, ethnographic research that was conducted for a two-year period on five college campuses and examined students' use of and attitudes toward their campus libraries (Kolowich, 2011). "When it comes to finding and evaluating sources in the internet age, students are downright lousy" according to ERIAL researchers (Kolowich, 2011). Others support the findings of ERIAL regarding students' heavy reliance on simplistic Google searches, Wikipedia, and the web (Griffiths and Brophy, 2005; Van Scoyoc and Cason, 2006; Head and Eisenberg, 2009).

The published literature paints a mixed picture of college students' technology skills. This paper shows first-hand whether students sink or swim in the face of the many technologies that characterize the library research process.

2.2 The need for information literate college students
According to Pew-sponsored research, 73 percent of college students use the internet more than the library and only 9 percent use the library more than the internet. College students associate the college library with "books," and rarely if ever with the words "quality," "trust," or "authoritative" (De Rosa *et al.*, 2005, pp. 3-24). Asked how they judge the trustworthiness of the information they find, 83 percent of college students surveyed said they drew on their personal knowledge or common sense (De Rosa *et al.*, 2005, pp. 3-4).

When seeking information, college students want to find information "quickly and conveniently" (Hilligoss and Rieh, 2008, p. 1475). When faced with the dilemma of deciding between two kinds of resources, that is, one resource that is quickly accessible and a second that is more credible but also more time-consuming to access, students give less priority to credibility – they champion speed and convenience. This does not mean, however, college students are ignorant of the importance of credibility. Rather, Rieh and Hilligoss (2008) find that students' credibility concerns are incorporated into their information seeking strategies in such a way that they would start their search process where they trust the information. Research findings suggest the importance of teaching students information literacy, instead of honing technology skills, so that students have the ability to recognize when information is needed and to locate, evaluate, and use that information effectively (Oblinger and Hawkins, 2006, p. 12). Students can draw on the information literacy skills they learn now to keep pace with the changes new technologies will impose on their livelihood, family life, and intellectual pursuits long after they have left the academy.

2.3 Faculty indifference toward information literacy instruction
Because the academy views information literacy skills as practical instead of theoretical knowledge, such skills are devalued and rendered invisible to college students (Walton and Archer, 2004). Information literacy training is not mandatory in college and usually left to the discretion of individual faculty.

Despite librarians' eagerness and readiness to teach students information literacy skills and concepts, faculty are reluctant to invite them to class (McCarthy, 1985; Hardesty, 1995; McGuinness, 2006; Hrycaj and Russo, 2007). Faculty believe that information literacy "is developed in a largely inconsistent, *ad-hoc* manner or through a process of 'trial and error,' as students apply various strategies to problems before arriving at the optimal solution" (McGuinness, 2006). Faculty seem to have forgotten how they relied on brute-force subject searches before they developed their personal network of domain experts whom they contact when they need information (Ellis, 1989; Bates and Drabenstott, 2003). Instead, faculty assume students can learn how to do library research on their own or attend a one-shot instruction session to develop requisite information literacy skills and concepts (Smith and Caruso, 2010).

Bereft of disciplinary knowledge, students have difficulties knowing where to start library research, what research questions to ask, and how to express their information needs in ways that yield useful retrievals from search engines. The results of a nationwide study of how college students research and find information reports that "for over three-fourths (84 percent) of the students surveyed, the most difficult step of the course-related research process was getting started," [followed by] "defining a topic (66 percent), narrowing it down (62 percent), and filtering through irrelevant results (61 percent) (Head and Eisenberg, 2010, p. 3). Also confusing to students is "where in the constellation of library databases they should turn to locate sources for their particular research topic" (Kolowich, 2011). BiblioBouts gives students repeated practice with information literacy tasks including the ones they find especially vexing – getting started, selecting databases, narrowing their topics, and assessing relevance.

Research that investigates the effectiveness of information literacy training reports positive outcomes on student performance such as an increased use of books, more types of sources, and more overall sources (Cooke and Rosenthal, 2011); citations to more scholarly resources, fewer incomplete citations, and higher grades on research papers (Wang, 2006); and positive impact on final GPA (Wong and Cmor, 2011). In addition, students have been shown to continue to use the materials and skills taught in the information literacy instruction throughout their college careers (Daugherty and Russo, 2011). The benefits students cite as a result of playing the BiblioBouts game are an important component of this paper.

2.4 Capitalizing on the experiential nature of games for information literacy instruction
Information literacy instruction draws on a wide array of information-seeking models. Because no one model combines affect (Kuhlthau, 1993), activity (Eisenberg, 2003), and process (Kirk, 1974; Beaubien *et al.*, 1982), students receive an incomplete picture of the information-seeking process. Transitioning information literacy instruction from conceptual models to experiential approaches is needed to make information literacy instruction more salient and give students much needed hands-on experience and practice performing information literacy tasks.

Because games foster experiential learning and they are a favorite pastime amongst today's college students (Abram and Luther, 2004, p. 36; Lenhart *et al.*, 2008), they hold great promise as a medium for information literacy instruction. Unlike traditional approaches to learning that champion conceptual thought, games are more versatile, engaging learners' senses and feelings and giving them opportunities to interact with their peers. Games are effective because what game players must immediately apply

what they learn to become competent, achieve mastery, and win the game. "Learning is not only relevant but applied and practiced within that context" (Van Eck, 2006). Of the 36 learning principles Gee (2003, pp. 207-212) ascribes to video games, several are embodied in the BiblioBouts information literacy game – practice, critical learning, metacognition, probing, discovery, and just-in-time learning.

Our previous games research revealed that students did not want game play that was apart from or unrelated to their coursework (Markey *et al.*, 2008). Thus, a key goal in the design of the BiblioBouts information literacy game is a game that ushers students through information-seeking activities, puts professional search and source management tools in their hands, and produces results that students can incorporate into their writing assignments. Instructors who supplement game play with class discussions on the information literacy concepts students encounter during game play and the feelings students experience during the information-seeking process round out their instruction in information literacy. The next section describes how the BiblioBouts information literacy game works.

3. The library research process and the bibliobouts game

The Association of College and Research Libraries (ACRL) describes information literacy as "a set of abilities requiring individuals to recognize when information is needed and have the ability to locate, evaluate, and use effectively the needed information." The ACRL model of locate, evaluate, and use has been the impetus for BiblioBouts' essential framework that consists of these four bouts: donor, closer, tagging and rating (T&R), and best bibliography bouts.

Instructors choose a broad-based topic for their students to research and use the game's setup interface to schedule the game's starting and ending dates for its four bouts, set caps and quotas, and invite their students to the game. During the donor bout, students search the web and scholarly databases for relevant sources (i.e. both citations and full texts) and save them to the Zotero citation management tool. Playing this bout, students locate information searching the web, library portal, and scholarly databases. They perform a preliminary evaluation of sources, differentiating relevant sources from lesser-relevant sources, and saving the former to Zotero.

While playing donor, students use technology-based tools in the service of locating-evaluating tasks. Some locating tools are familiar to them such as searching Google and retrieving web sites. Other such tools are less familiar such as the library portal for finding and searching scholarly and technical databases. Locating tasks connected with full-texts are totally new to many students. In full-text databases, locating tasks may be as simple as clicking on a PDF button to download the source to the computer desktop. In bibliographic databases, locating tasks may be exceedingly complex requiring students to search the library catalog for a particular journal title, drill down to the desired volume and issue, and pinpoint the desired article in a particular issue.

Because locating-evaluating tasks now take place almost entirely online, students engaged in the library research process must manage their downloaded sources, storing sources that interest them on their desktop machines, adding notes to sources, and formulating bibliographic citations to the cited sources in their papers. BiblioBouts delegates source management tasks to the Zotero citation management software tool. Totally new to most students, citation management software such as Zotero

automatically creates citations for most database retrievals, stores full-texts, and displays the notes students add to full-texts.

Figure 1 shows the Zotero plug-in tool in the Firefox browser for managing retrieved sources. On the top is the ERIC search engine displaying a retrieved citation for a source entitled "Designing a digital partnership with children." When the Zotero user clicks on the "page" icon in the far right of the URL dialogue box, Zotero downloads the full-text to the user's hard disk and creates a citation. On the bottom is Zotero's three-paned plug-in tool. Listed on the left are the user's Zotero libraries. In the center are her saved sources including the one on screen. On the right is the bibliographic citation Zotero created automatically for the highlighted title. Clicking on the green arrow above this panes synchronizes the user's Zotero libraries at the centralized Zotero server. BiblioBouts checks this server at periodic intervals and copies the user's sources to BiblioBouts where all subsequent bouts are played. BiblioBouts' Donor bout displays to players their instructor's suggestions for relevant databases and keywords (Figure 2), but most of this bout's activity takes place in search engines and in Zotero.

When instructors create a BiblioBouts game for their students, they set individual bouts' caps and quotas which govern how much students play. Players earn base points per donated source and a small bonus upon reaching quota. Students who meet the donor bout's quota transition to the closer bout.

Closer puts the spotlight on the evaluation task of the ACRL information literacy model. This bout displays the player's donated sources and invites them to choose their best sources to be entered into competition for a follow-up evaluation by their opponents. In Figure 3, the player has chosen two sources so far including the one saved to Zotero in Figure 2 and must choose three more sources to reach this bout's cap of five closed sources. Players earn base points per closed source and a modest bonus upon meeting Closer's cap.

In the tagging and rating (T&R) bout, evaluation tasks shift from one's own sources to opponents' sources. BiblioBouts randomly chooses an opponent's source, displays it to the player, and asks him to check for a correct full text and citation, tag the source's subject matter, format, and source of publication, and rate the source's relevance and credibility. In Figure 4, the player rates the source's relevance, giving it lower ratings for quality and relevance than for accuracy due to its failure to address the player's specific interest. Credibility ratings work the same with players using slider bars to answer three questions about the source's trustworthiness, scholarliness, and the expertise of its author. Players earn base points per evaluated source up to quota, a generous bonus for reaching quota, generous bonus points for up to 20 additional sources, and more bonus points for matching the ratings and tags of the fellow opponents.

The best bibliography bout addresses both evaluation and use tasks of the ACRL model. Players describe the specific topic, three big ideas, and arguments their papers will address. Once again, they practice evaluation tasks, choosing the best sources for their paper's best bibliography from a list of all closed and rated sources. Thus, the BiblioBouts game culminates in a bibliography of citations to the best sources in BiblioBouts for their chosen topic. The bibliography is the first step toward using sources to write their paper. Figure 5 shows a player choosing sources for her paper's best bibliography from the Source Library bearing all players' sources. Players earn

Figure 1.
Zotero desktop for
managing sources

base points per evaluated source up to a cap, a generous bonus for meeting the cap, and a whopping-big bonus for every source they close that their opponents cite in their best bibliographies.

4. User support for recruiting and orienting instructors

To streamline the task of recruiting instructors, library liaisons encouraged the BiblioBouts R&D team to make BiblioBouts available as a demonstration game. The R&D team responded accordingly with a demo game. Ever since, the demo game has been an invaluable tool for orienting instructors as well as librarians, players, and anyone interested in the game. The BiblioBouts home page begins with a video demonstrating the game in its entirety and advises interested instructors to read the instructor FAQ to determine whether their class activities would be a good match with BiblioBouts. Also available are videos demonstrating individual bouts as well as written instructions. The BiblioBouts R&D team encourages players, instructors, librarians, and anyone interested in the game to message us at info@bibliobouts.org

On the R&D team are two full-time instructors who are available on demand to give individualized support to the instructors to assist in integrating BiblioBouts into their courses. They especially advise instructors about selecting a broad topic and synchronizing their course activities and assignments with individual bouts. This includes reviewing both syllabus and the assignment that students complete while they play BiblioBouts.

Initially, liaisons and R&D team members set up games for instructors, scheduling beginning and end dates of each of the game's bouts and setting caps and quotas. Subsequently, the R&D team added more instructions to the form and an instructor FAQ to give instructors sufficient detail to set up a game on their own. Timelines have also been added to instructional materials to give instructors a visual representation of the game's principal events in sequence.

In response to instructors who grade BiblioBouts game play, the R&D team added an evaluation report to BiblioBouts' beta 1.0 version that details the extent to which students met or exceeded each bout's caps and quotas, their scores per bout, and their current rank on the leader board. To the beta 2.0 version, we have added a report detailing how each player's closed sources fare during the game such as the number of times players cite them in their best bibliography bout, average relevance and credibility ratings, and a suggested final grade based on game play data.

5. Methodology

Data collection is multi-modal, occurring before, during, and after students play the game. R&D team members interview instructors before and after their classes play the game, asking them about the assignments students complete while they play the game, student attitudes, what students learn, and improvements to pre-game preparation and overall experience with the game. While students play BiblioBouts, the game records their activity on game logs for subsequent analysis. For the beta version, game players volunteered to complete in-game diary forms that document their experiences playing

Figure 4.
Rating relevance in the
tagging and rating bout

a particular bout. They also voluntarily complete pre- and post-game questionnaires in which they rate how well they think they can perform the library-research tasks they encounter during game play.

The analysis enlists students' comments in post-game focus group interviews to clarify their closed-ended responses to questionnaires especially details about their difficulties playing BiblioBouts and using related library-research technologies, their understanding of the library-research process, and their suggestions for improvements to the game. Additionally, inquiries from instructors, librarians, and players that the R&D team receives through its e-mail address (info@bibliobouts.org) result in new insights that lead to additional functionality and user-support services. Evaluation data reveals:

- the nature of students' library-research difficulties especially difficulties rooted in technology;
- how BiblioBouts helps students overcome these difficulties; and
- how BiblioBouts has evolved to reduce students' difficulties with the technology of the library-research process.

6. Findings
The R&D team's analysis of evaluation data is presented below according to the sequence of game deployment events. The analysis starts with preparing students for playing the game. Students' in-game experiences with library-research technologies are featured followed by the benefits of playing BiblioBouts.

Figure 5.
Selecting the best sources
in the best bibliography
bout

6.1 Pre-game preparation

The R&D team encourages instructors to invite a librarian to visit their classes prior to the start of a BiblioBouts game to introduce students to their institution's library portal, relevant databases, Zotero, and BiblioBouts. Some instructors delegate game setup and troubleshooting to librarians. Librarians also assist instructors with broad-topic selection, confirming that the library has sufficient online sources for their chosen topic. In focus groups, students praised library liaisons' involvement:

I think the biggest help was when the librarian came in and showed us how to use the different databases because I think that there is just so many that I wasn't really sure where to go. I mean ProQuest was the main one that I used at first because it was just so general but she showed us this specific like business type websites that we could go to. And I liked that. I think that was the most help and it helped me with my other research (student).

I didn't realize we had those databases (student).

Instructors also recognized the usefulness of the librarian's in-class demonstrations:

One of the things that I have noticed is that [students] really [...] need the refresher on what [databases are] out there and what's available and to start thinking about it. Everybody's really good at using the web but when it gets time to go into databases and start thinking about things in other ways, it gets more complicated (instructor).

Librarians also show students how to use Zotero to save relevant citations and full-texts. Some players questioned why Zotero was part of the BiblioBouts game and described how they struggled with Zotero's functionality for saving sources, organizing sources into folders, and correcting its erroneous citations. Winter 2011 players especially criticized Zotero's synchronization feature that was unresponsive for long periods of time due to competing resources. Players' focus group comments are too numerous to list here but their summary statements below underline their frustrations using Zotero.

I was lost when I first [used Zotero] (student).

It was really hard to kind of figure out that Zotero. I didn't know what Zotero was in the beginning and so after I kind of tried to figure it out and just kind of played around on the Zotero website and then I came across the videos. But I still didn't – it – it took me a while to get to it and that it wasn't just kind of like in plain view (student).

[Zotero] would make you want to drop your English class [many students laughing in the background] (student).

6.2 Game registration

BiblioBouts' initial registration procedure required new players to apply for and confirm four different accounts or authentication mechanisms. Account creation was onerous for players and led to numerous challenges getting classes signed up to play. Here is what instructors, library liaisons, and students had to say:

The overly complicated nature of the registering process [...] when that proved difficult to unworkable for the students and me, then the whole process largely came unraveled (instructor).

Trying to register. It took forever. It spoiled most of it for me because I was like, "This is so much work and what exactly am I doing for it?" (student).

A simplified registration procedure debuted in BiblioBouts' beta 1.0 version, featuring tutorial videos and a troubleshooting FAQ developed in consultation with instructors, library liaisons, and students. Since the new registration procedure was implemented, registration has not been troublesome for players.

6.3 It's in the game or is it?

After registering in BiblioBouts, students play the donor bout. This bout may be confusing to players because it gets them started, suggesting relevant databases and keywords, but passes them to their library's database portal where they search databases for relevant sources and save sources in Zotero in the form of full-texts and citations. Beta version game users especially put us onto donor's confusing nature because, in the absence of a database orientation from librarians, they were clueless about how to start playing BiblioBouts. This student's comment addresses the problem:

I guess it would have helped if I would have had a better understanding of the connection between Zotero and BiblioBouts more [...] because I felt like at the [beginning] that we were using BiblioBouts but for the first couple of weeks it was all devoted to like Zotero and saving sources (student).

To eliminate the confusion, the beta 2.0 version of BiblioBouts eliminates the donor bout by transferring its functions to Zotero. BiblioBouts still communicates with players in advance of the closer bout, suggesting relevant databases and keywords and linking to their library's database portal, but it contacts players with this information via email. Players now sign onto the game with their sources already saved in Zotero. BiblioBouts redirects players who have no or too few saved sources to their library's database portal and Zotero.

6.4 The technology of the library research process is hard

The first [bout] just kind of threw off a lot of people as well. Not just because of the software they had to use and stuff but also because it didn't ease up on them and then it got difficult. It was like so difficult and then it just kind of like slowed down and died down. So I think that people kind of got confused in a way because it was just like, "Well, it's already hard now so like if it's already this difficult, then I'm just not going to care about it" (student).

This student is unable to articulate specific difficulties, but she recognizes software is involved, the unrelenting nature of the difficulties, their effect on her interest, and the difficulties finally lightening up. Her comment is vague and inarticulate, mostly likely because she does not have enough understanding of how, when, and what tasks she needs to accomplish to be able to be conversant about specifics.

Instructors also observed students' difficulties with technology. Seemingly simple things such as spelling and pronunciation of software applications were roadblocks for some students:

Those who were willing to give it a chance and kind of climb over the challenge then I think really enjoyed playing but I lost some students at that point who just weren't willing or didn't have at all the technical proficiency to play on any level (instructor).

I think in the course of the game I had expected [students] to learn more about the actual research process but I think we had a couple of pretty sticky points and that they became so bogged down in the technical challenges that I think that they weren't really able to focus on the search [process] skills as much (instructor).

So even things like, "Okay, go to zotero.org," if we didn't have that in front of us, other students were going to the website while they were trying to figure out how to spell Z-o-t-e-r-o. I think at some point I wrote it on the board but they were like, "Zo-te-ro?" Even the word "BiblioBouts" was a little bit difficult to say [. . .] I really think that the students if fluent in English but not conversationally fluent were at a disadvantage, especially when we had a lot of oral directions (instructor).

Instructors comment on students' ease using familiar technologies and their reluctance to learn new ones:

We're really starting from the ground up [with] quite a few [students]. [My] students understand how you use a computer and they can hop on and get in their email or their chat or their Facebook or whatever they usually do. But knowing how to do what [. . .] they like to do on the computer doesn't mean they actually understand what they're doing. They have no idea what a browser is or how that's different from Google or Facebook. [These are] just computer words, and students know how to get to them if they like to get there. So it's almost kind of a little bit of a computer literacy education as far as kind of terminology and understanding that Firefox is a browser and Internet Explorer is a browser and they do the

same thing in different ways and, "Here is why you can only use Firefox" and that kind of thing. So it was a little bit of a tech education, which I think is really useful (instructor).

I think Facebook for them is a comfort zone. When we link with students especially in Korea, a lot of them don't use Facebook. They use different social networking sites and then there's every semester we've done this, there's been this, "Well, why don't you join Facebook?" And they're like, "Well, why don't you join my site?" And they're like, "No. Why don't you join Facebook?" They don't want to go to the other site because it's unknown or something about that. And it's a whole 'nother thing but I see [Facebook] as their comfort zone and they don't want to leave it (instructor).

This instructor's observations are counter to the common assumption that today's undergraduate students are comfortable with technology because they are "digital natives."

I actually had an assumption going into this class, which one of the learning objectives is to integrate technology into communicating, was that my students would be more comfortable than I am with it and they're not for the most part (instructor).

Perhaps the explanation lies in the uses to which they put these technologies. Digital natives are keen on technologies that entertain them and expand their social network. They eschew technologies connected with academic pursuits. These students' comments support this claim:

BiblioBouts [...] is a part of our grade so that's why I saw it as an assignment. And like the game itself like finding sources, it was – it was helpful definitely but it was another assignment (student).

The donor game, you did more than donate a source. You still had to go through and read the article. It still was a step-by-step process and that kind of gets boring like – not boring but it's still something – like I saw [BiblioBouts] as an assignment, an assignment rather than a game (student).

While some players consider playing BiblioBouts academic drudgery, others described how playing BiblioBouts stirred their competitive nature and for some, that also meant increasing their interest in library research process:

I mean it's the motivation of trying to beat somebody else that's really fun about it (student).

Yeah, I had a friend that I was like competing with. I'd be like, "Oh, I'm one up on you now." Like she ended up above me though (student).

If there wasn't a game, [...] had we talked about [doing library research], it wouldn't be so fun or interesting. And so I probably wouldn't have gone out with any enthusiasm where at least with BiblioBouts we had incentives including the points. So if you're a competitive person, you have an incentive to beat a friend or to be in the top five or whatever your desire was. So it was something we had to do regardless because it was a research paper that we were assigned. So I think BiblioBouts made it at least more interesting than if we had just gone about it by ourselves (student).

The competitive aspect of the game was an incentive for some students to play at a high level. As a result, they acknowledged that they put more effort into their research for their course assignment and benefited from the game's end result, a bibliography to get them started writing the paper:

You did all of this and then you actually got it done and you actually got something accomplished [. . .] that is pretty valuable because it's a bibliography and those are pretty difficult to do anyway and so then you did it and you kind of got points for it. It was cool (student).

Making [library research] into a game made it more of a challenge. I was looking for more sources and something that [would] raise my score [. . .] I can say it's just that challenge alone was just made it to where I wanted to look for more stuff (student).

But also I think the point system makes people do more. Like I know for [this bout] some people did all 105 [sources] so I did 105 to get more. And I did read, I did get more information (student).

I think my incentive actually was just to find a good bibliography for myself for my paper just using the collective resources of the class I felt like would be better than just me trying to go out on my own. And I did find a couple of really good sources that I'll be using. To me, that was really the biggest benefit (student).

6.5 Students' perceptions of their technology skills
On pre-game and post-game questionnaires, students' answers to several questions provided insight into their perceptions of their library-research technology skills before and after they played BiblioBouts. Because too few students completed both pre- and post-game questionnaires, a statistical comparison of their pre- and post-game responses was not possible; however, their responses across the three classes show a definite pattern with regard to game play having a positive impact on their perceptions.

Students completing questionnaires were enrolled in education, English, and information studies courses. Questionnaires listed six library-research tasks that students performed when playing BiblioBouts. Pre-game questionnaires asked how challenging they would find each task, how well they could perform it, and how confident they would be performing it, and post-game questionnaires asked students to consider the same questions again, after having played BiblioBouts.

Figures 6 and 7 show the differences between students' pre-game and post-game ratings for six tasks requiring their use of library-research technologies. These tasks are:

(1) Using the databases that experts use to conduct library research (databases).
(2) Finding full-text articles online for the citations I find (finding full-texts).
(3) Downloading and saving full-text articles online for the citations I find (saving full-texts).
(4) Keeping track of the citations, full-text articles, websites, etc., that I find online (keeping track).
(5) Where to find good information after I exhaust Google, Wikipedia, and the web (after Google).
(6) Using BiblioBouts' structured library-research process to conduct library research for my coursework (process).

In parentheses are the shortened task explanations used in the figures. Ratings were on this five-point scale: $2 =$ very (challenging, well, confident), $1 =$ somewhat
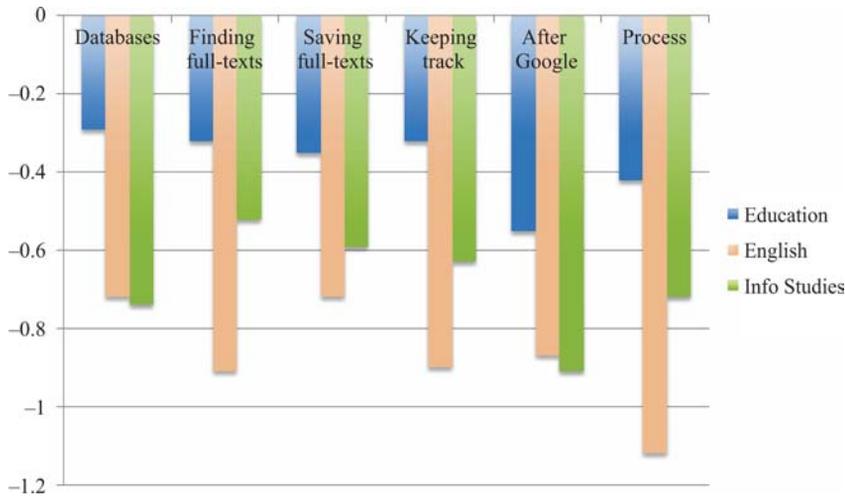
Figure 6.
Technology-based
research tasks are less
challenging
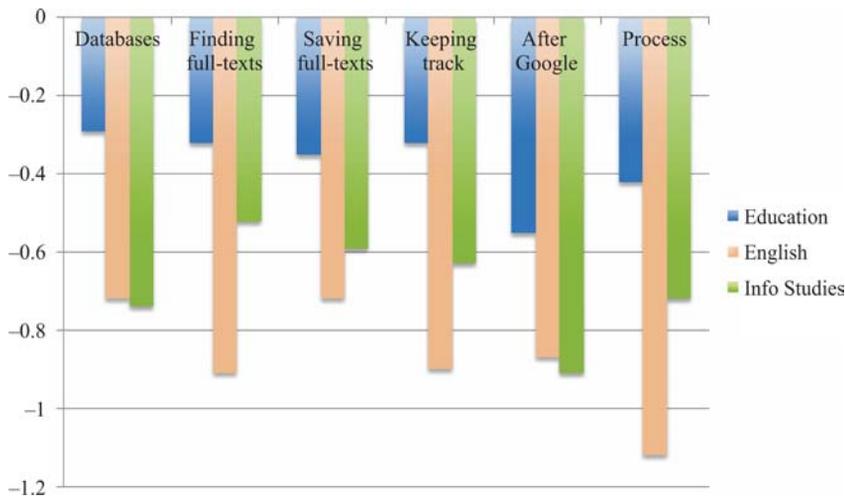
Figure 7.
Players have more
confidence with
technology-based research
tasks

(challenging, well, confident), 0 = neutral, −1 somewhat (unchallenging, poorly, unconfident), −2 very (unchallenging, poorly, unconfident). Figure 6 shows results for the "challenging" question in terms of the difference between pre-game and post-game ratings.

Across all three classes, students felt that conducting these tasks would be less challenging after playing BiblioBouts. Differences between pre-game and post-game ratings were most pronounced for English and information studies students who used sources to write their papers. English and information studies students benefited especially from BiblioBouts' step-by-step library research process and knowing where to find quality information after exhausting Google, Wikipedia, and the web. The education students played BiblioBouts in a course on video games and learning where

their principal focus was not on finding quality sources to write a paper but on learning how to play educational games. They were inclined to "game the game," that is, find loopholes in BiblioBouts to earn as many points as effortlessly as possible instead of playing the game earnestly to make progress on a research-and-writing assignment.

Figure 7 shows results for the "confidence" question in terms of the difference between pre-game and post-game ratings.

This time students' ratings were positive, revealing more confidence conducting these tasks as a result of playing BiblioBouts. Differences between pre-game and post-game ratings were most pronounced for English and information studies and less for education students for the same reasons explained above. Students from all three courses were more confident about knowing quality sources of information after exhausting Google, Wikipedia, and the web. Results for the "well" question are a mirror-image of "confidence," that is, all students felt they would perform these technology-based tasks as well or better than they did as a result of playing BiblioBouts. English and Information Science students were especially positive about using BiblioBouts' structured research process and knowing where to find quality information, respectively.

6.6 Technology benefits of playing BiblioBouts

Despite students' complaints about unfamiliar technologies, the majority rise to the occasion, overcome technology challenges, and play BiblioBouts from start to finish. Asked about the benefits of playing the game, students cite the technologies to which they are exposed including how they will use them in their future coursework.

Students' complaints about Zotero's difficulty are many; however, asked how they benefit from BiblioBouts, students cite Zotero first and foremost. Here are comments from students about Zotero that include their intent to use it in the future:

> I'll definitely try to use Zotero more. Because [...] it's really easy to keep a source. You just click a little button and all of the information is already saved and you don't have to worry about writing it down or keeping some window open while you're writing your paper or anything like that. So that was definitely helpful (student).

> After doing BiblioBouts, I had a psych paper due yesterday. We did the same thing, you have to cite scholarly sources and everything. And so I actually used Zotero like made another folder for my psych class. Before Zotero, I tried keeping a list of my sources that I found in databases just to like, you know, copy and pasting in a Word document. And that gets really messy. Like you don't really know what's what (student).

Playing BiblioBouts introduces some students to the scholarly databases available through their library's portal and gives others greater familiarity with more such databases:

> For academic research, [BiblioBouts] really opened me up to how to use the databases and how to search [...] So having to go into the databases and submit them, now I know (student).

> How to use the Academic One Source. I ain't never used nothing – well, I ain't really been in school long [...] I didn't know how to use the Academic One Source web until I started using that game. So I go on all the time and for papers like this essay coming up, [my instructor] wants us to have two outside sources. And if I go on Academic One Source or to Ebscohost – I know how to use that now. And I'm glad I know how to use that so I won't be like, "Hey [librarian], come here. I need help with this." I can kind of come in here whenever and get in. So that's what I took from it (student).

Playing BiblioBouts gives students first-hand experience comparing sources from Google and scholarly databases. When they choose sources for their papers in the best bibliography bout, the ratings and comments added to these sources are evidence convincing them that scholarly databases yield sources higher in quality than Google and the web generally:

> I mean I think it was helpful. I know how to like find reliable sources now. Which is just really helpful. In the future, I'll just have a much easier time finding sources and knowing that they're credible and just like I won't waste my time using Google and all of that stuff (student).

> Usually I just use Google [. . .] Comparing the results I would get from Google to these databases is a huge difference and I really realize that now, that the material that I was getting was not that reliable and not that scholarly and to be writing research papers and stuff I need to be using like databases and stuff like that (student).

> Now I know more about like scholarly journals and that kind of thing. I feel like those are more reliable than other sources so I'll use those as opposed to other search engines (student).

BiblioBouts exposes players to many more sources than they would have found on their own. Some students pair this with the availability of ratings and evaluation data that they add during the tagging and rating bout that makes their selection process easier:

> [Playing BiblioBouts] made the process a lot easier on me [. . .] If you have like a large paper coming up, like a term paper or something like that and the teacher sets up [. . .] BiblioBouts where everyone can input their sources on the same topic and everyone can look at each other's sources, it makes it a lot easier in finding quality sources (student).

> I haven't used so many databases in my lifetime. But because the assignment required us to use four library databases, I was able to go on and then put that on BiblioBouts, save that as a source online and later on basically just mind share with other individuals to see where they got their information from, what information like they were able to obtain. [So it was] the sharing [that helped me] (student).

Although not a technology benefit *per se*, BiblioBouts teaches students a logical, methodical process for conducting library research that includes evaluating one's sources. Students get repeated practice using different tools to play the bouts and come to associate these tools with the various steps of the library-research process:

> [BiblioBouts] reinforced how I would go through my research and make it more methodical [. . .] It solidified the approach of doing research and it also would give me a platform tailored to those methods. Why shouldn't you have a system to teach you those methods and to go through? There's no reason not to. It only makes sense (student).

> I definitely think it helped, to be more organized when it comes to having a bibliography 'cuz a lot of people put random sources in their bibliography when [. . .] they do their own research, they just do whatever and find sources and, "Oh, this sounds good" and all that [. . .] But the whole step by step thing, it definitely helped the individual just be more organized in their bibliography and have better sources and that was the whole point of the game so I think it really did help out (student).

> It reinforced my ability to determine what a good source was and it had me looking more in depth at what would be considered a proper source in terms of who is writing it. I still would use news sources and that sort of thing but in the future I'd be more wary and try to mainly use primary sources [. . .] for my paper or [. . .] better rated sites (student).

7. Discussion

For today's undergraduate students, the technology underlying the library research process is difficult to use. Although BiblioBouts gives students practice using this technology, most are ill-prepared for BiblioBouts game play until they receive an orientation about the technologies they will use during game play. At the very least, pre-game preparation involves introducing students to the library portal, library databases, and the Zotero citation management software.

Having deployed BiblioBouts in undergraduate courses for the past two years, the R&D team has responded to calls for more instructional elements in its user-support services. This is not limited to students but extends to instructors and to librarians who assist instructors or deploy BiblioBouts in their information literacy courses. Initially, we provided written instructions, FAQs, and videos of game play overall and for individual bouts. Future plans include forums for troubleshooting, reporting bugs, sharing amongst instructors, suggesting new features, etc.

Fielding questions about BiblioBouts from interested instructors, we sense that some have difficulty understanding the game as a whole as well as the tasks that characterize individual bouts. As mentioned in the literature review, instructors are domain experts and use strategies for locating and evaluating information that draw on their personal contact and following citation trails. Students, however, conduct brute-force subject searches because they do not know the important issues or people in the discipline.

Observing some players' exasperation with the game's initial registration process was a difficult pill for the R&D team to swallow because students' interest, goodwill, and patience were sometimes lost before they even started playing the game. Instructors also suffered because they were on the receiving end of student complaints, some delivered in person or in e-mail messages, and others delivered on teaching evaluations. Students expect software products to be free of technical problems. Understanding the experimental nature of BiblioBouts, they were tolerant but felt their concerns were justified when their grades were at stake. BiblioBouts' registration problems were corrected in time for the beta 2.0 version of the game. Online games and comparable software that debuts in classrooms must be problem-free right from the start and have satisfactory user support.

Attuned to the need for game play to start on the right foot, the R&D team observed players of the beta 1.0 version of the game. Their confusion stemmed from a donor bout in which game play took place in search engines and Zotero. Although the donor bout's interface was helpful in terms of suggesting relevant databases and keywords, it was not essential to game play. To eliminate the confusion, the beta 2.0 version of BiblioBouts eliminates the donor bout. Minus donor, players conduct their searches in conventional online research tools. BiblioBouts does not allow students to start playing the game until they meet its quota of saved sources. This major structural change should help players draw distinctions between locating tools such as Google and library databases and source management tools such as Zotero. Additionally, technical problems should be easier for librarians and instructors diagnose when BiblioBouts is no longer "a player" during the source-location phase of the game.

Recognizing the complexity of the library research process and the technology-based tools that support it, information industry vendors are producing software solutions that give library users a Google-like search and retrieval experience. For example, ProQuest's

Summon service consolidates visits to the library portal, database selection, and query-entry tasks into a single search box followed by button clicks for full-text delivery. Missing from Summon is source management and access to the full range of the library's collection. For the time being, Summon may satisfy the vast majority of undergraduate student uses of library collections because comprehensiveness is rarely a search goal. The moment they seek sources that lie outside the user-friendly confines of the Summon environment, they will have to blaze a trail through information environments that are neither intuitive nor seamless to locate what they are looking for. Playing BiblioBouts will give them experience and repeated practice blazing such a trail.

Library research technologies are difficult for students especially in regard to knowing how, why, and when to use them in the course of their research. Because BiblioBouts gives students hands-on practice using these technologies, students realize how, why, and when to use them in the course of their research. Game players especially develop an appreciation for Zotero, embracing it after realizing its efficiency gains. After playing BiblioBouts, students feel that technology-based research tasks will be less challenging, they will have more confidence performing these tasks in the future, and they will perform these tasks as well or better than they did before exposure to the game. They also cite the game's helpfulness for exposing them to many more sources than they would have found on their own and introducing them to a logical, methodical process for conducting library research that includes how to evaluating one's sources.

To increase students' interest in BiblioBouts and make it more fun, the R&D team has added more game-like features to BiblioBouts. Initially limited to aliases, scoring, and a leader board, BiblioBouts' beta 2.0 version has these game-like features:

- *Tagging and rating feedback*. Players compare their ratings, tags, and evaluation comments with their opponents.

- *Best bibliography feedback*. Players display the ratings, tags, and evaluation comments their opponents give their closed sources including the number of times their opponents choose their closed sources in their best bibliographies.

- *Scoring feedback*. BiblioBouts details why the game awards them points for their actions.

- *Trophies*. BiblioBouts awards players trophies for meritorious and non-meritorious game play. Feedback reports include trophy displays so players can assess the game-play quality of the player rating sources.

- *Levels*. Players reaching certain scoring milestones can reach up to six levels. Feedback reports include the level badges so players can assess the game-play quality of the player rating sources.

Future game-like features include feedback-rating so that players can judge the quality and usefulness of fellow players' feedback on their own and others' sources. Trophy cases that display a player's care and fanfare for crowning the game winner – the BiblioBoss – are planned.

8. Conclusion
This paper examines the nature of students' library-research difficulties especially difficulties rooted in technology, describes how the BiblioBouts information literacy

game helps students overcome these difficulties, and discusses how BiblioBouts has evolved in order to reduce students' difficulties with the technology of the library-research process. Evaluation results reveal that the technology underlying the library research process is especially for students to use. The BiblioBouts R&D team responded, supplementing written instructions with videos of game play, and streamlined BiblioBouts, eliminating two bouts and incorporating their salient features into the game's remaining bouts and required pre-game activity. Students benefit in several ways as a result of playing BiblioBouts. The game exposes them to many more sources than they would have found on their own. Their confidence increases. The game introduces them to a wide array of professional search and source management tools in their hand and as a result of hands-on practice using these tools during game play, they come to realize how, why, and when to use them in the course of their research. In fact, some students adopt Zotero before the game ends, using it for assignments in other courses. The R&D team continues to make improvements to BiblioBouts based on evaluation results and invites instructors to incorporate the game into their academic and information literacy courses.

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Corresponding author
Karen Markey can be contacted at: ylime@umich.edu