The Effect of Scoring and Feedback Mechanisms in an Online Educational Game

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ABSTRACT

A research and development (R&D) team designed and developed the BiblioBouts online information literacy game to give undergraduate students opportunities to learn and practice information literacy skills using online library research tools and scholarly databases while they work on a research-and-writing assignment. To evaluate the alpha version of BiblioBouts, the R&D team analyzed game-play logs from two undergraduate classes and invited students who played the game in class to participate in focus group interviews. The resulting insights into the impact of scoring and game feedback on student game play were used to help instructors plan for game play in their classes and to help the R&D team improve BiblioBouts. These results also spawned game premises to guide the R&D team and other designers of educational games build better games.

Keywords

Educational games, information literacy, case studies.

BACKGROUND

When undergraduate students arrive at the academy, they are operating for the first time in the same rich, deep, diverse information environment that faculty use to teach the knowledge of the disciplines and to extend the frontiers of knowledge. Bereft of expert knowledge of the disciplines, students are totally in the dark about where to start and what expert research and discovery tools to use. As a result, students fall back on their habitual patterns: Google, Wikipedia, and the web (Fast & Campbell 2004; Head 2007; Knapp 2009; Head & Eisenberg 2010; Grathwohl 2011). When they have exhausted this comfort zone, they do not know what to do next. This point of need is precisely when students are most receptive to information literacy instruction.

A research & development (R&D) team explored the potential of games to solve the problem of teaching undergraduate students information literacy concepts and skills. We embraced games because of their popularity with college-aged students (Lenhart, Jones & MacGill, 2008) and because good games are built on principles of learning (Johnson 2006; Gee 2007; Prensky 2007; Schiller & Svensson 2009). Game advocates tout gaming's potential to scale from one student to thousands, and since scaling is an important information-literacy program goal, building a game that reaches large number of students would put gaming to the test in this regard.

To design an information literacy skills game, the R&D team drew on its previous experience designing, developing, and deploying the "Defense of Hidgeon," a web-based board game that introduced undergraduate student game players to the Search Strategy Model for conducting library research (Markey et al. 2008a). This experience included premises for the design of educational games that the team generated as a result of evaluating "Hidgeon" (Markey et al. 2008b). Foremost was the premise that *students will play games that contribute in a useful way to the coursework they are already doing*. Because Hidgeon was found to be inadequate in this regard, the team had to design an entirely new information literacy game. Knowing the new game would have to contribute to students' coursework, the R&D team brainstormed on typical activities in undergraduate courses that would require practice with information literacy skills and concepts that could be delegated to a game. We focused on the bibliography-building activities students perform in the course of writing an instructor-assigned research paper because a bibliography-building game would be discipline-neutral, accommodating instructors across a wide range of fields who assign their students research papers.

Bout	Description	Information literacy skills, concepts, and tools
Donor	Students search the web and scholarly databases for relevant sources (i.e., citations and full texts) on a broad topic and save them to the Zotero citation management tool	Using professional resource and discovery tools: library portal, scholarly databases, and Zotero. Selecting relevant databases, searching databases, assessing relevance of retrieved sources, distinguishing citations from full-texts, downloading full-texts, creating citations.
Closer	Players choose their best sources, make sure full texts are attached, and submit them to BiblioBouts	Assessing relevance, verifying and correcting citation and full-text attachments, using Zotero to manage sources.
Tagging & Rating (T&R)	Players inspect citations, summarize the "big ideas" of each source, tag sources' content, discipline, format, audience, and rate their relevance and credibility	Judging citation completeness, assessing author expertise, assessing relevance and credibility, judging quality, assessing accuracy. Understanding criteria of aboutness, disciplinarity, format, audience.
Best Bibliography	Players define a specific research question for their paper and choose the best sources for that topic	Using relevance and credibility ratings to choose the best sources, compiling an annotated bibliography of sources linked to citations and full texts.
Donor	Students search the web and scholarly databases for relevant sources (i.e., citations and full texts) on a broad topic and save them to the Zotero citation management tool	Using professional resource and discovery tools: library portal, scholarly databases, and Zotero. Selecting relevant databases, searching databases, assessing relevance of retrieved sources, distinguishing citations from full-texts, downloading full-texts, creating citations.

Table 1. The Bouts of BiblioBouts

THE DESIGN OF THE BIBLIOBOUTS ONLINE EDUCATIONAL GAME

With funds from the Institute of Museum and Library Studies (IMLS), the R&D team designed and developed the "BiblioBouts" online social game that teaches students how to find high-quality information for their papers while they go about the business of completing their papers. The game puts professional research tools into students' hands and ushers them through the research process where they could find, evaluate, and select high-quality online information for their papers. The game culminates in an actual bibliography students can use to write an assigned paper. Thus, while playing BiblioBouts, students make major progress on completing an assigned research-and-writing project.

BiblioBouts is an online tournament made up of a series of mini-games or bouts, each of which introduces students to a specific subset of information literacy skills within the overall research process. Because each bout utilizes the game-play accomplishments of the preceding bouts, bouts cannot begin until previous ones finish (except for Closer which runs concurrently with Donor). Thus, students played each bout during its scheduled time instead of one game continuously from beginning to end. Table 1 describes the game's five bouts and enumerates the information literacy skills, concepts, and tools which students encounter during game play.

Students play BiblioBouts on their own but rely on the game's social media features to evaluate the sources they and fellow students put into play and pool their resources to choose the best sources for their assigned paper's bibliography. The R&D team's plans for feedback in the Tagging & Rating (T&R) bout were too ambitious to be implemented in the alpha version of BiblioBouts but feedback was available indirectly through the game's leader board, scoring algorithm, and Best Bibliography sources library. In the evaluation of the game's alpha version, we anticipated students would call for more feedback. The R&D team also encouraged instructors to be proactive about the game, to synchronize game play with course activities and assignments, give students course credit for playing games, incorporate the game into their syllabus, and discuss game play during class. (For more information on the game and its development, please see the project research site at http://bibliobouts.si.umich.edu/. An overview video of gameplay is available at the game site, www.bibliobouts.org.)

THIS PAPER'S PURPOSE

This paper describes how students in two undergraduate courses played BiblioBouts with one class pursuing the traditional goal of completing a research-and-writing assignment and the second playing various types of games to determine their potential learning or educational value. It answers these research questions:

1. What impact does the game's scoring system have on game play?

2. How does in-game feedback affect game play?

3. What game-design premises were discovered as a result of the evaluation?

Because BiblioBouts' design and development was iterative, the R&D team used answers to all three research questions to improve future versions of the game. Answers to research question #3 can also guide other designers of educational games to build better games.

LITERATURE REVIEW

Games continue to be highly popular with college-aged students (Lenhart, Jones & MacGill, 2008), and their educational benefits have been frequently researched. Leach and Sugarman (2005) point out that "studies have shown increased knowledge retention by those using an educational game compared to those receiving conventional instruction with lectures and paper-based materials when specific information or concepts are targeted or the game is used as a reinforcement or practice tool" (p. 192) and note that the lecture format "may not be effective for engaging or maintaining the interest of tech-savvy students" (p. 194). Martin and Ewing (2008) note that "digital games motivate players to learn new skills and tasks because the medium aims to make the activity fun and entertaining" (p. 213). Gee presents a list of 36 learning principles embodied by video games, which include active critical learning, metalevel thinking, probing, and explicit information on-demand and just-in-time (Gee 2003). These studies in the cognitive aspects of gaming have shown that many of the skills developed through gaming can be applied to the learning process in general. In particular, games emphasize learning by doing, problem-solving through trial and error and practicing skills to achieve mastery. Kirriemuir (2008) states that "games that encourage this form of iterative probing can support the development of logical thinking and problem solving, important in learning information literacy skills" (p. 158). Several studies of games point to ways that good games are built on principles of learning (Gee, 2007; Johnson, 2006; Prensky, 2007; Schiller & Svensson, 2009).

Information literacy (IL) is defined by the American Library Association (ALA, 1989) 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." As noted by Robertson and Jones (2009), "The goal of information literacy instruction is to encourage library users to be independent researchers confident in their abilities to locate and use valid information both in physical and digital formats" (p. 261). These fundamental steps of the research process are embodied in the basic structure of many games and can be used as a basis for learning and practicing IL skills. Martin and Ewing state that "incorporating digital gaming techniques into library instruction is one way to motivate and engage students throughout the information-gathering process" (p. 213) and point out that "digital games excel at engaging and motivating players to learn new skills and knowledge without realizing they are in the midst of the learning process" (p. 223). However, most existing IL games are simply animated tutorials (Armstrong & Georgas

2006, McCabe & Wise 2009) which drill students on basic facts (e.g., Bioactive, n.d.; Head Hunt: The Game, 2010; Info Game, n.d.; The Information Literacy Game, n.d.; It's Alive!, n.d.). Some are tied to the resources of one institution (Leach & Sugarman, 2005) or are limited to a single discipline (Smith, 2007) or face technological challenges in attempting to recreate the quality of commercial games (Clyde & Thomas, 2008; Cross 2009). The BiblioBouts game aims to overcome these obstacles through an iterative process of game design, development, deployment, and evaluation, and by our production of game premises that can help others who are designing educational games.

METHODOLOGY

This study utilized two data sources: automated game logs and student focus groups. While students play BiblioBouts, the game automatically records their activity in game logs for subsequent analysis. Logs begin during the Donor bout when the game creates a record for each source donated by players bearing a unique accession number, player identification number, date of donation, title, source, and URL. If players do not close a source, no more data are added to its source record. If players close a source, more data are added to source records in each of the subsequent bouts: T&R, Sorter, and Best Bibliography. For example, when a player rates a source during the T&R bout, the game writes these data to the source record: date and time of the tagging/rating event, the player's identification number, the player's yes/no answer to the game's "full-text" check question, player tags such as keywords, format tags, and discipline tags, player credibility ratings and comments, player relevance ratings and comments. All data in the source records are formatted for download into Excel spreadsheets.

After game play ended, the R&D team hosted focus group interviews with student game players. Students volunteered their participation in focused group interviews and are compensated with $25 cash and a pizza-and-pop lunch. Interview comments were excerpted below to help illuminate the analysis of game log data.

RESULTS

Classes Participating in the Analysis

The 13 classes that played BiblioBouts in the 2009–2010 academic year averaged 24 students. For this paper's analysis, we chose the two largest classes named SI 110, Introduction to Information Studies (IIS) with 90 students, and EDU 222, Video Games and Learning (VGL) with 66 students. IIS students played BiblioBouts while writing a paper about "Worklife quality" in which they were required to cite at least three publications from library databases. VGL students played BiblioBouts while writing a "game play reflection paper" in which they described their experiences playing various games and answered the question, "How do people learn from video games?" More

than IIS students, VGL students were inclined to "game the game," that is, find loopholes in BiblioBouts and other games to quickly and effortlessly earn points, climb atop leader board, and win the game. These students tended to analyze BiblioBouts structure as a game rather than its educational content.

BibilioBouts' setup interface enables instructors to set quotas and caps that represent the minimum level of game play expected of students during particular bouts. Instructors can override defaults and set their own caps and quotas based on their game-play expectations for students. Default quotas for the T&R and Sorter bouts are automatically generated based on the number of closed sources and the number of ratings required per closed source to produce a meaningful average score. For example, if a class of 20 students plays BiblioBouts and 15 students close the bout's default 5 sources and 5 students close 0 sources, to ensure the bout's default 5 ratings per closed source, each student playing T&R would have a quota of [(5 students x 15 closed sources) x 5 ratings)/20 students in the class] or 19 sources required to rate. Points are awarded based on the player meeting, exceeding or failing to meet these quotas.

Table 2 displays the two games' caps and quotas and the points BiblioBouts awards to players for meeting caps and quotas. Table 2 does not detail the many opportunities BiblioBouts gave students to earn "bonus points." These points were awarded based on the extent to which their game-play activity matched the average activity of fellow game players. Because bonus points depended on the activity of class as a whole, the game computed them at the conclusion of each bout and added them to students' scores.

The Donor Bout
To play the Donor bout, IIS and VGL students search the web and library databases for sources on the instructor-set broad-based topics "Worklife Quality" and "Video Games and Learning," respectively. Although both instructors set this bout's quota at 6 sources, scoring encourages students to donate more sources than the quota because it awards them double the number of points (200) for donations above quota.

In the Donor bout, players must save citations to the Zotero citation management tool, downloa the correct full-text and attach it to the citation. The majority of players from both games exceeded the Donor quota. VGL players were fewer in number but they contributed more (140) sources overall to their game than IIS players. The three top-scoring VGL "superplayers" earned 8,700, 9,000, and 24,000 points respectively by each earning 100 points per donation up to quota, 200 points per donation above quota, and at 1.5 times quota. Right from the start, VGL students were "gaming the game" by exploiting the scoring system to rack up points without putting thought into the educational content.

How did players donate so many sources to earn these points? Most likely players used Zotero's "select all" feature to download all citations listed on a database's search results page in one fell swoop. For example, using this Zotero feature in a database that displays 10 sources per page would earn a player 1,900 points for selecting all listed sources. However, few databases accompanied these "select all" citations with full texts, so choosing sources for the upcoming Closer bout would not be as straightforward.

Bout	Cap or Quota	Points Awarded
Donor	6 (IIS and VGL)	100 points for each source up to quota; 200 points for each source thereafter
Closer	5 (IIS and VGL)	100 points for each source up to the cap
T&R	16 (IIS); 14 (VGL)	150 points for each source up to quota; 300 points for each source thereafter
Sorter	20 (IIS); 17 (VGL)	1,000 points for each source up to quota; 1,500 points for each source thereafter
Best Bib	10 (IIS and VGL)	5,000 points for meeting the cap

Table 2. Caps, Quotas, and Points Awarded

The scoring system was intended to reward students who exceeded the Donor's quota because they received valuable practice searching for sources on the web and in databases, selecting relevant ones, and saving them to Zotero; however, students from both classes short-circuited the process, using Zotero's select-all feature to add multiple sources and artificially drive up their scores. Subjects stated:

"It was easy to spam the system with nonsense and get lots of points for it, so I didn't even look at the sources. I submitted the same ones many times and it didn't matter."

"At first I found myself … trying to find only the best sources and adding them but then I realized that the way the points were working and the way the system was set up, that … I was supposed to just be getting any sources that I thought were relevant but not necessarily the best. So then … I just started adding as many sources as I could that I thought I would possibly use or come back to that looked interesting and relevant."

Many students suggested capping donations. The R&D team considered this but decided on progressively reducing the number of points BiblioBouts awarded to students who have exceeded the Donor quota.

The Closer Bout
The Closer bout runs concurrently with Donor plus one day. In the Closer bout, players scrutinize their donated sources, choosing the best ones to submit to the game, and making sure that each source has a complete citation and the correct full-text attachment. These selected sources and their attached full-texts are then imported from Zotero into the game's database. Both instructors set Closer's cap at 5 sources.

About one-quarter of IIS and two-fifths of VGL students failed to meet Closer's cap. The reason why these proportions were so high may be attributed to students' difficulty using Zotero to save downloaded full-texts and transmit them to BiblioBouts. Unlike the Donor bout that accepts sources without full-texts, Closer requires attached full-texts for students' chosen sources. When Closer detects no attachments, it highlights citations in yellow indicating the full-texts are needed for students to close the listed citation. To close such citations, students must backtrack, find the full-texts, and use Zotero to save them. The functionality for saving full-texts in Zotero can work differently between different databases, which made Closer doubly difficult for some students to complete. Students' many comments underlined their difficulties using Zotero:

"The Zotero ... learning curve was kind of steep for me ... I had a lot of like technical problems ... Starting off, it wasn't working very well for me. Once you actually get it going, it's clearly a really useful thing."

"I was a little confused about the whole Zotero thing when I started using it. I for one had to do most of my sources when we were doing the first round by hand because for some reason or another, Zotero wasn't picking up the sources as an actual source. Because it wasn't giving me the little icon to click onto automatically, so I thought the whole Zotero thing was shaky but I other than that, like the instructions were really well written and everything on the games themselves was pretty clear."

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

Summing up the problem of full-texts is the one student who said "The whole full text requirement thing is really annoying."

BiblioBouts players could enlist online support from the R&D team via email to help with technical difficulties, although they rarely did so, preferring instead to rely on their instructors or teaching assistants. If players' difficulties finding full-texts are indicative of the experience of library users generally, then students conducting library research must be finding workarounds to finding full-texts, preferring Google Scholar, the web generally, or full-text databases such as JSTOR and Proquest.

The Tagging & Rating Bout
In the Tagging & Rating (T&R) bout, game play shifts from one's own sources to opponents' sources. BiblioBouts randomly displays an opponent's source to the player and asks him to check for a correct full text and complete citation, tag the source's subject matter, discipline and audience, rate the source's relevance and credibility and give comments explaining their ratings. Players' scores increase 150 points per tagged and rated source up to quota, 300 points per tagged and rated source beyond quota, and 10 points per comment.

About one-third of students failed to play T&R or meet its quota. Of these, 46.4% of IIS and 56.5% of VGL students also failed to play Closer or meet its cap.

With the onset of the T&R bout, most technical problems came to an end. Students' attention focused on the bout itself, meeting quotas and navigating the T&R interface. Because players in previous classes before the IIS and VGL games complained about T&R's high quota, the R&D team reduced this bout's quotas from 19 and 16 sources to 16 and 14 sources; however, students still complained.

"The first few I was more like inclined to do them like to the fullest potential and then after I realized like how long it was taking me and like how almost uninterested I was becoming, I was just like wanted to get through it almost."

"The quota for the Rating & Tagging game. That could be cut down a little bit."

Students were vocal about the absence of feedback in the T&R bout. They wanted to know whether their ratings and comments were comparable to others rating the same sources and how much their T&R activity was contributing to their score. Interview comments about the T&R bout emphasized the inefficiency of the T&R interface. For example, the interface did not allow students to back up and change their ratings, tags, or comments. It asked students to comment after every question about relevance and credibility and opened separate comment windows requiring students to click repeatedly whether they wrote a comment or dismissed comment windows. The interface forced students to click the scroll bar to complete the rating task, which due to the scrolling action sometimes made them inadvertently miss one or more ratings. Players also wanted to be able to see other players' actions..

"It might be helpful to see like how other people rated your articles. Like because you did all the Rating & Tagging and I kept thinking, 'Oh, I wonder what comments people will have about mine?' And then I never saw it. Or if I would be able to see like the ones that I like commented on, I was like, 'I wonder if other people commented similarly to me?' So I kind of wanted to see some of the like ratings or taggings for the articles."

"[I want] to see how other people are tagging the resource. Maybe a graph that plotted your ratings versus the group's ratings. I could see that I was getting points, but I had no

idea if I could have received more points or how my rating compared to others."

The Sorter Bout

Prior to the start of the Sorter bout, the BiblioBouts team elicit a list of conceptual categories related to the topic from instructors and program them into the bout. The Sorter bout randomly chooses 5 sources per page, displays them to the player, and asks them to sort each source under the instructor-supplied category that best summarizes the source's subject content. Sorting 5 sources at a time, players earn 5,000 points up to quota and 7,500 points for 5 sorts thereafter.

Not all instructors played BiblioBouts along with their students so they were unfamiliar with closed sources and unprepared to respond in a timely fashion to the team's call for categories prior to the Sorter bout's start. Instructors' tardiness did not stop the Sorter bout from starting. Unfortunately, it featured one default category named "None of the above." Early-bird players sorted everything into this one category, receiving 1,000 before-quota and 1,500 after-quota points per sort for doing next to nothing. About this, one student remarked:

"I got like a ton of points for doing basically nothing."

Student criticisms of the Sorter bout were few. They felt some categories were not representative of the source collection, they called for category definitions, and they wanted the ability to choose more than one category per source. With respect to the Sorter interface, students complained about sorting being inefficient, requiring them to scroll beneath the fold to drag and drop sources under relevant categories. A student who did not bother scrolling down said:

"I found a way to game the system with the sorting round where me and like four other people just threw 'em all in the top category and ... since we were sorting them in the exact same way, [our score] jumped up a lot."

On the surface, the Sorter bout appeared to be a success because of students reported few problems, exceeded quotas by leaps and bounds, and told us how easy it was to play.

"I did like 108 of the sortings because I was literally just sitting there like on my computer while I was watching the Red Wings [hockey] game just doing 'em and talking to my friend as I was doing them. The Sorter round was really easy to do."

"But the Sorter [bout] to me was very user friendly and it was just easy."

However, students' observations about how little effort they put into earning points and how subsequent bouts made no use of their sorting efforts exposed systemic problems with this bout.

"[Sorter] scoring ... didn't really like have anything to do with like how much effort you put into it ... You could like pretty easily just like click stuff and get a really high score ... [There were] ways that you could like increase your score like by not really doing too much work ... You could ... drag 'em wherever you wanted or just drag 'em ... really quickly and that one was worth a lot of points ... That basically made the first few rounds like not matter at all."

"It is like we sorted the [sources] away into a storage room and will never ... [be able to get them again]."

The Best Bibliography Bout

In the Best Bibliography bout, students choose one of the several instructor-selected research questions and the 10 best sources they would use in a written paper that addresses their chosen question. They earn 5,000 points per selected best source.

Unlike previous bouts, players finished playing the Best Bibliography a few days after it began rather than playing right before the bout's deadline. For example, about two-thirds of IIS and VGL players finished this bout in the first half of the game-play period. Although players offered no reasons why, we might speculate that they finished early to achieve closure and/or to use their best bibliography and the bout's source library to find sources for their papers that were due shortly after the bout's completion.

The percentage of IIS non-players is comparable to previous bouts. In contrast, the percentage of VGL non-players is much higher at 37.9%. Focus group interviews revealed the reason for the high percentage of non-players.

"The point system needs to be reworked. There were some rounds where some player scored 200,000 points while other players that did the required amount got 5,000 points. With point differences like this, there were many players [who] gave up."

"For people who are really far behind ... I know one of my friends said that they were about 20,000 points behind the person ahead of them and they figured, 'What's the point? I'm not going to catch up.'"

The unfortunate consequence of the ill-conceived Sorter bout was immediately felt in the Best Bibliography bout where almost half of VGL players quit playing BiblioBouts, perhaps assuming that they would never catch up to the high-scoring players.

In terms of design, the main problem with the Best Bibliography bout was its instructor-supplied research questions. Not all instructors played BiblioBouts along with their students so they were unfamiliar with closed sources and unprepared to respond in a timely fashion to the team's

call for research questions. In focus groups, players told us they wanted to choose sources for their *own* papers, not for hypothetical papers that addressed the research questions that interested their instructors. Some players ignored the research questions and chose the best sources for the paper they expected to write. Others said that knowing these questions during the Donor bout would have helped them collect relevant sources.

DISCUSSION

Using focus group interviews to explain the analysis of player data revealed needed improvements to the game. The team's initial assumptions about a scoring system that rewarded unlimited game-play activity proved to be flawed because Donor superplayers spammed BiblioBouts with non-relevant sources and Sorter superplayers earned so many points that other players gave up and dropped out, thinking they would never be able to catch up. To discourage Donor spamming, the R&D team eliminated bonus points to players who exceeded Donor's quota by 1.5 times.

On the surface, it might appear that reducing bonus points for Sorter bout activity beyond the quota might be a solution to the dropout problem; however, the bout had other problems such eliciting categories from instructors on schedule and giving undue attention to source categorization. Realizing the efficiencies that could be had by consolidating Sorter's tasks into other bouts resulted in the R&D team's decision to completely eliminate Sorter. The bout's categorization aspect was transformed into keyword-matching tasks in the T&R and Best Bibliography bouts. Keyword matching is now integrated into these two bouts, rather than being the centerpiece of a single bout.

To avoid mistakes made in the scoring of the alpha version of BiblioBouts, the R&D team created an Excel spreadsheet to model new scoring algorithms. Team members enter values in the spreadsheet that reflect game-play styles of quota, above-average, and superplayers, and when they detect runaway scores that are not faithful to BiblioBouts scoring priorities, they change scoring formulas accordingly. Team members analyzed data from the IIS and VGL games, especially the averages pertaining to the T&R bouts tags, ratings, and answers to questions about sources to predict the future performance of quota, above-quota, and superplayers. The team's goal is to develop a more balanced scoring system which rewards students for the effort they put into the game and gives them hope that their continued participation could win them the game or place them high atop the leader board.

The R&D team used the spreadsheet formulas to ensure that future BiblioBouts players will earn a spot high atop the leader board when their game play is in keeping with these five scoring priorities: (1) meeting the game's caps, (2) exceeding its quotas, (3) choosing the same high-rated sources for their Best Bibliography as their opponents chose for theirs, (4) agreeing with their opponents' credibility and relevance ratings and content tags, and (5) being the first to close the sources that their opponents choose for their Best Bibliography. Monitoring BiblioBouts' scoring will be an on-going concern of the R&D team especially when adding new functionality to the game.

The R&D team's experience with scoring revealed this new design and development premise: *Scoring must reflect the effort players put into the task and the importance of task relative to the game's objectives.* If scoring is gratuitous, some students take advantage of the situation, earning as many points as they can with a minimum of effort, and others lose interest, playing with less intensity or dropping out altogether. Before students play the game, we recommend implementing scoring models to predict average, above-average, and superplayer behavior. Getting scoring right also entails studying game logs to determine how players perform various tasks and using the results to refine scoring, awarding fewer points for easy tasks and more points for difficult tasks.

The R&D team's game development and evaluation experience underlined another new premise, *the importance of feedback*. Although the alpha version of BiblioBouts provided feedback indirectly through the game's leader board, scoring algorithm, and Best Bibliography sources library, the team's plans for T&R feedback were too ambitious and could not be completed in time for the alpha version's debut. We expected students to want T&R feedback, and they certainly did not disappoint. The T&R results section above cites students' interview comments in this regard. Students identified many several additional feedback opportunities. For example, they wanted to know how many points they scored and why and, in the game's scoring report, they wanted encouragement for their accomplishments. The R&D team developed several feedback features for both players and instructors that are featured in the beta version of BiblioBouts:

- A "recent actions" update atop all bout pages describes the player's most recent actions and how many points the player earned

- A T&R report showing other players' relevance and credibility ratings for a source alongside one's own

- Average ratings for one's closed sources and the number of times fellow players have chosen one's closed sources for their best bibliographies are shown on the player's home page. Links open the T&R feedback report for the source.

- A list of all the player's rated sources is shown on the player's home page. Links open the T&R feedback report for the source

- An Evaluation Report for instructors to grade their students which summarizes players' game-play performance

- Still in development is a detailed scoring log that describes all player actions and points earned from the start of the game to the present moment

- Another possible avenue for exploration is the automatic generation of messages, algorithmically triggered by low scoring thresholds, which could encourage low-performing players to keep participating, perhaps by giving tips or suggestions on game play. This mechanism might be useful in reducing dropouts.

Pondering Sorter's fate, the R&D team sought to salvage the categorization aspect of the bout and concluded that categories should come from players, not instructors. The R&D team divided the categorization aspect of the Sorter bout between the T&R and Best Bibliography bouts. When players examine sources in the T&R bout, the game elicits keywords from them and awards them points when they match an opponent's keywords for the same source. Matching keywords are also included on T&R feedback reports.

Since many players criticized the Best Bibliography bout's top-down research question feature, the R&D team eliminated it in favor of students entering a topic of their choice into a dialog box. In addition to their paper topic, the Best Bibliography bout also asks students what three keywords their paper addresses and gives them bonus points when the keywords they enter match the keywords players assigned to sources in the redesigned T&R bout.

The beta version of BiblioBouts is a streamlined game without the excesses of the Sorter bout and reliance on instructors for input to Sorter and Best Bibliography bouts. The elimination of the Sorter bout reduces total game play by about 20 minutes. In view of our experience with Sorter superplayers, a challenge will be to score the T&R bout so that it rewards players who exceed quota but does not allow them to open up a lead that other players feel is insurmountable. Here is another premise: *Scoring dictates game play so get it right.* We will model player behavior using the Excel spreadsheet and adjust scoring accordingly, and we recommend other game designers do the same.

The R&D team no longer has scheduled contact with instructors during game play. This is a boon to the R&D team because it streamlines the administration of multiple games, limiting the team's contact with instructors to authorizing them as game owners and responding to their questions, concerns, and requests for assistance. The R&D team's experience with instructors revealed another new design and development premise: *Game design that depends on in-game instructor input that is critical to game play may be risky.* This premise is directed especially at game designers. They cannot expect instructors to play the game along with students or respond in a timely manner to their requests. We do, however, continue to strongly encourage instructor intervention in the form of in-class discussions about the information literacy skills and concepts students encounter during the game. Such discussion range from giving student definitions for simple concepts, e.g., bibliography, abstract, source, to advising students on how to determine whether authors are experts in the field and includes how to distinguish research publication in their field from less rigorous forms of written communication. BiblioBouts features an Instructor FAQ that describes topics that instructors could discuss in class to increase student understanding of the game and the process of conducting library research (Instructor FAQ, n.d.).

SUMMARY

This paper describes how students in two undergraduate courses played BiblioBouts with one class pursuing the traditional goal of completing a research-and-writing assignment and the second playing various games to determine their potential learning or educational value.

Using focus group interviews to illuminate game-play logs, the R&D team made major changes to all of the bouts of BiblioBouts including eliminating one bout and distributing its functionality into the bouts immediately preceding and following it. As expected, focus group participants called for more feedback, and in response, much more feedback was added to the beta version of BiblioBouts. Based on research results, the R&D team generated three additional premises to guide the design and development of information literacy games and educational games: (1) scoring must reflect the effort players put into the task and the importance of task relative to the game's objectives, (2) scoring dictates game play so get it right, and (3) game design that depends on in-game instructor input that is critical to game play may be risky. Remaining faithful to design and development premises continues to be an important project goal of the BiblioBouts R&D team, as well as recommending these premises to other investigators who are dedicated to educational games design and development.

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