



The Digital Companion Project

**KQED**



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## **Abstract**

The KQED Digital Companion explores the design of a computer-mediated information- and knowledge-sharing space for an adult, out-of-school population. This space is embedded in a prototype for an interactive, digital iPad application serving as a companion to a general-population book entitled "The Science of Big Waves", written by Kerry Tremain. This will be the first in a series published by the University of California Press; each book will dovetail with the content of one televised Quest science program from KQED, the nation's largest public radio and television station.

Though there are many excellent mobile and web-based textbook and collaborative learning applications for in-school students, currently none address the unique concerns of our target population of adult, out-of-school readers. We believe we have started to fill that gap for this general readership.

What is new about this project is our research on what barriers hindered participation by this population, what reduced these barriers and increased motivation, and what features increased users' trust in others. We believe that should our work prove effective and easy to implement, it could provide a useful template for extending learning opportunities in a wide range of interactive mobile applications.

This work draws on computer-mediated communication (CMC) studies, user experience and interaction design, qualitative sociology, participatory media for education, and visual design, as investigated at the University of California School of Information and College of Environmental Design's Cal Design Lab.

## Origins

Our partners -- the University of California Press and KQED Quest -- asked for a "Digital Companion" to go along with the first book in a series they are co-producing. Each book will be on a single science topic, tied to an individual episode of the Quest public television series. This first book is on the science of big waves and includes chapters on tsunamis, standing waves, the effects of climate change, and related subjects.

The Digital Companion will be distributed through the iTunes store, though details such as whether it will be a separate purchase from the book, require purchase of the book, or be free to all, has not been decided upon. For purposes described below, we assumed that each Digital Companion purchaser would get one login/registration tied to a persistent ID (though not necessarily the user's real name).

Our design brief was for an application that also created a "dynamic relationship between the user and the text" (from Tremain's original book proposal), not just an ebook version of the original text. The idea of the collaborative information-sharing environment was original to this project.

Other constraints for the design came from both the UC Press and Quest. These were:

1. Both UC Press and KQED Quest were clear that the book was for a general readership. As the book proposal put it, readers would be "commuters, lifelong learners, the curious". This meant we could not assume a classroom setting, an instructor, a closed social system, or any of the assumptions about confidence, trust, and motivations implicit in those environments.
2. UC Press wanted the Digital Companion to present a good experience of reading over a hundred pages of text, to allow the user to mark up or note the text, place bookmarks, and read the text in either a linear or non-linear way.
3. Since KQED Quest had television, radio, and online components, they wanted to include multimedia from the shows and access to web content from within the application.

We decided that when dealing with the content of a book, even when the goal is to extend the text with interactivity and collaboration, keeping a mental model close to that of a book would more likely allow the user to be familiar with and engaged earlier in his or her exposure to our application.

Similarly, we saw value that the Digital Companion's collaboration features would work mobile-to-mobile, rather than the mobile app being an extension of or base for a web- or desktop-based space. Tieglund & Wasko (2004) saw that in

a computer-mediated environment, adding "extra physical effort" such as requiring a user to open another web browser -- let alone move from a mobile device to a computer -- reduced user participation. Gray (2004) found that people declined to share knowledge in part because they found going to a specific web site (a different affordance) was a high barrier. We feel that keeping user sharing within the mobile application reduces such barriers.

With these goals in place, we surveyed the mobile learning application space and found nothing that meets all these requirements. Though there are excellent efforts in the textbook/in-school category, we did not see any projects that directly addressed this problem for our target population.

## Missions and Objectives

Our main goal was to research and design features and affordances would motivate the target population to share their notes and observations with other users, as well as to identify and lower barriers to participation. Following some social network paradigms that connect strangers, we designed the system to allow users to "subscribe" to notes on the text and web links created and collected by other users, as well as choose to make their own notes and links available for others to subscribe to. Though e-textbook applications such as Inkling and Cafe Scribe have explored this space within an educational context, none to our knowledge have addressed a general readership.

On the way, we had the contextual goal of creating a prototype for an easy-to-use, navigable ebook for the iPad that integrated interactive and multimedia elements. There are many examples of finished and very polished products that do this, and we took inspiration from some. Features such as pop-up definitions for words, creating notes, and highlighting in the text are all fairly standard (and we saw in testing that most users were able to complete these tasks easily). Proposing to integrate in-application web browsing required some research but seems to be possible to implement with iOS's UIWebView class; we had posited that this would be a useful feature for self-directed learners, and user testing supported this.

We chose to structure the information-sharing features of the Digital Companion around the note-taking and link-saving features of individual users. Each user can write and place the equivalent of sticky notes within the text of the book, and store links to web content. Each user can then choose whether to make these public or not -- if so, other users of the app could choose to "follow" a user's notes or links or both. That user's contributions would then appear in the following user's app (though visually distinguished). We chose not to include any direct communication features between users to preclude issues of flaming and perhaps trolling<sup>1</sup>.

This ties the information sharing to users; the evaluation of whether to take in shared information is tied to each potentially following user evaluating the producing user. Our goal was to explore the issues of trust that arise from this unidirectional, dyadic interaction in the out-of-school population, and try to design affordances and features to increase trust and encourage participation.

Though many products and projects are and have been working on similar environments, they have (as far as we, and researchers at the University of

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<sup>1</sup> Turner. D. D. (2010). Comments Gone Wild: Trolls, Flames, and the Crisis at Online Newspapers. (Unpublished paper). University of California Berkeley School of Information, Berkeley, CA.

Southern California Annenberg Innovation Lab<sup>2</sup>, can tell ), been designed for an existing educational context. However, the mandate for this project was an adult, out-of-school population – as a result, they did not have many of the defining characteristics of that studied population, including proscribed/preexisting social connections, community, instructors.

As a result of our population constraints, we had to face the following issues.

- Learning must be self-directed: We will address the implications of this in the Theoretical Foundations section.
- Community: We cannot rely on known motivators (Hew & Hara, 2007) such as "commitment to group".
- Trust: This is perhaps our prime concern. In our field studies, prospective users voiced many worries around this. Comments included "stranger danger", "how do I know they won't spam me" (where "spam" was explained as excessive or irrelevant notes and/or links), "people are not courteous online", "I wouldn't usually talk about a book with a random person on the street", "what will they know about me?".

A similar set of concerns has been voiced over the "Popular Highlights" feature<sup>3</sup> recently introduced for the Amazon Kindle. One day, Kindle users turned to their favorite ebook and saw passages highlighted that they could not remember highlighting; this was the Popular Highlights feature pushing out to users what at least three other uses did to their copies of the same book. The feature also harvested information about what passages you highlighted and sent that back to Amazon servers. All this was on by default.

Many Kindle-fan web sites approvingly quoted Andre Codrescu's commentary on NPR's "All Things Considered":

I'm reading a new book I downloaded on my Kindle and I noticed an underlined passage. It is surely a mistake, I think. This is a new book. I don't know about you, but I always hated underlined passages in used books. They derail my private enjoyment.

When somebody offers perception of what's important, something moronic, usually, which is why I always prefer buying books new so I could make my own moronic marks. But moronic or not, it was all between me and my new book.

And this thing on my Kindle is supposed to be new. And then I discovered that the horror doesn't stop with the unwelcomed presence of another reader who's defaced my new book. But it deepens with something called view popular highlights, which will tell you how many morons have underlined before so that not only you do not own the new book you paid for, the entire

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<sup>2</sup> (E. Reilly, personal communication, March 15, 2011).

<sup>3</sup> [https://kindle.amazon.com/most\\_popular](https://kindle.amazon.com/most_popular)

experience of reading is shattered by the presence of a mob that agitates inside your text like strangers in a train station.

So now you can add to the ease of downloading an e-book the end of the illusion that it is your book. The end of the privileged relation between yourself and your book. And a certainty that you've been had. Not only is the e-book not yours to be with alone, it is shared at Amazon which shares with you what it knows about you reading and the readings of others.<sup>4</sup>

This made us all the more aware of the barrier of trust. However, we took this as confirmation that our decisions to set the sharing options off by default, and not to push but to require users to seek shared information, was the right tack.

We measured our success in terms of users' ability to find and access information the Digital Companion's information-sharing features and these users' subsequent actions. We found as we iterated that users displayed less hesitation in completing tasks, lower task completion failure rates, fewer questions, and -- most important -- more exploration of the information-sharing features and more positive reactions to them. Though we would have liked to have held more test sessions with more users, we feel we have made progress in an area that is little studied.

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<sup>4</sup> Codrescu, A. (March 7, 2011). E-Book Tarnishes The Reader-Book Relationship [radio commentary]. in *All Things Considered*. National Public Radio. Retrieved from <http://www.npr.org/2011/03/07/134342235/E-Book-Tarnishes-The-Reader-Book-Relationship>.

## Theoretical Foundations and Related Work

Conducting research on an adult, out-of-school population presents challenges more daunting than with an in-school group. And we were not the only ones to find this, apparently: "narrow variation among participants (e.g. socio-demographically similar in education, age, etc.)" is a key limitation of controlled experiments (Cheshire & Antin, 2010), and a recent research paper noted that there are "scant studies concerning adult students" (Chu & Tsai, 2009).

Given this, we stepped back and took two major tacks. The first is situating this project within participatory education studies, using previous works on andragogy (the practice of working with adult learners) and constructivism (learning theory based in the idea that people produce knowledge through the friction between ideas and experience, and a focus in the growing field of remote and student-centered learning). Through these, we hope to identify factors affecting motivation and participation. The second is the extensive sociological research on trust and confidence in computer-mediated communication (CMC). Even though users never technically act in exchange, the choice to participate represents "a situation of risk" (Luhmann, 2000) to users, as seen above, and the Digital Companion's follow features representing a unidirectional trust relationship in a dyadic situation [qualify?] that previous research on trust can be applied here.

### **PARTICIPATORY EDUCATION:**

#### ***Andragogy***

Andragogy, the "art and science of helping adults learn" (Henschke, 2011), was developed in the modern sense by Malcom Knowles from the late 1960s on<sup>5</sup>. He stated that adults require self-directedness, abundant experience in the learning process, readiness to learn, and problem-centered learning opportunities (Knowles et al., 2005), for a successful learning environment. (These and other features of/tools developed for androgogy have subsequently been considered as keys to student-centered learning initiatives for children.)

As Sabry and Baldwin (2003) recounted, "[l]earning interactions can be categorized into four types (Moore, 1989; Hillman *et al*, 1994; Moore & Kearsley, 1996): Learner-content, learner-instructor, learner-learner, and learner-interface." Though their qualitative study was conducted on an in-school population of undergraduate and postgraduate learners, we assert that these categories and the findings related to the first and third (Sabry and Baldwin do

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<sup>5</sup> For a more detailed history of andragogy, see Henschke (2011).

not address the last) are generalizable to an out-of-school group of self-directed and ready-to-learn users.

- Learner-Information (L-I): "Information" here is taken to be synonymous with "content", and the latter is defined as both course and non-course material, including multimedia, web, and other outside sources.
- Learner-Learner (L-L): Sabry and Baldwin made clear that this is not limited to synchronous, but can include asynchronous, interactions between students (or, in our case, Digital Companion users). Users can collaborate to create understandings of information through social activity.

The Digital Companion, with a mix of text, interactions, media, and the ability to draw from the web, certainly provides the L-I type. The L-L type of learning is what we hope to encourage; this framework was not unexpected, but gave us context within the literature.

Using Felder & Soloman's (1999) Index of Learning Styles, Chu & Tsai (2009) explored what elements of content, interactive or plain, worked best with "sequential" and "global" learning styles. The former showed better learning when logical progression of ideas were shown, with activities, and with interactions. The latter preferred keeping the "big picture" always available. This gave us a sense of what elements in our Digital Companion design should remain easily accessible at all times, and what features (such as interactions) should be more highly stressed.

Another very interesting finding from that study was that "providing a variety of asynchronous interactions... can help Sequential learners to get involved... while also giving opportunities for Global learners to obtain a holistic view of the discussions" (Chu & Tsai, 2009, p. 451). This gave us strong support for our asynchronous information-sharing model.

### ***Constructivism***

Constructivism (not to be confused, unlikely as it may be, with constructionism) is an epistemology based on the idea that people build knowledge through active participation, through the tussle between abstract ideas and their own experiences in the physical world. "Learning by doing", the importance of collaboration and of discussions between learners (Duffy and Jonassen, 1992, Vygotsky), and the notion of the learner as an active processor are constructivist precepts. Much of the work being done in the field of student-centered learning<sup>6</sup> builds upon this epistemology.

This is a natural tie with the self-directed adult learner of an androgogic situation, and the nature of the interactive simulations and note- and link-taking

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<sup>6</sup> Such as being done at the Center for Next Generation Teaching and Learning (<http://ngtl.ischool.berkeley.edu/>)

by users, so we feel that conclusions from the framework of constructivism will be applicable and illuminating.

Zualkernan (2006) and Chu & Tsai (2009) used the term constructivist internet-based learning environments (CILE) to describe such a space. We agree with Chu & Tsai when they wrote "[f]or adults, exchanging ideas with peers may not be a major focus in learning, unless the peer possesses a role as supporter associated with the learning task; social and emotional interaction may be reflected as a secondary gain when they participate in a learning activity (Kim & Merriam, 2004; Knowles *et al.* 2005)" and find that it supports our decision to limit information sharing to be presented through the text, rather than allowing direct communication exchanges between users. This secondary (at best) placement of social interaction was borne out by our own data.

That the knowledge about CMC learning and information sharing among out-of-school adults is sparse was supported not just by our own literature search: "there is a need to develop better understanding of constructivist Internet-based learning environments (Zualkernan, 2006)" (Chu & Tsai, 2009).

One potential problem in leveraging this approach is that the research around constructivist learning has taken place within guided learning environments. We hope to counter these concerns by providing some structures -- chapters, topics -- within the Digital Companion that offer a degree of focus and implicit guidance.

## **SOCIOLOGY**

### ***Trust***

As outlined above, users voiced that trust is a critical factor in whether they would choose to participate, either by making their information public or by following another user's information.

Cook, Cheshire, *et al.* (2009) offered a definition of dyadic "relational trust":

"In a two-party relationship, actor A is said to trust actor B when A views B to be trustworthy with respect to the matters at hand... . To trust B, however, actor A must be able to make an assessment of B's likely trustworthiness with respect to her in particular situations and with respect to specific matters."

Their definition also required an aspect of risk. This placed it well within the framework of Luhmann (2000), who even called trust "a solution for specific problems of risk" and that a situation involving trust must "has to have possibility of being "disappointed by the actions of others". We feel that our research showed that potential Digital Companion users felt they were engaging in a risk activity. People didn't like the ideas of having all their notes ("thoughts") be public ("what would everyone know about me?"); allowing

unknown people to put items in their own text (as in the case of Amazon's Popular Highlights); the risk of being spammed or other bad behavior. As a result, we can say that "trust" is relevant.

Though much, if not most, sociological research looks at trust as involving reciprocal interactions, trust can be unidirectional within a pair. I may trust you to loan me your car, but you may not trust me. This keeps our system's form of interaction within the realm of trust -- User A can decide whether or not to trust User B's behavior and quality of notes, but User B does not require any trust of User A.

Our system falls somewhere between the two types of interactions -- repeated exchanges and "one-shot interactions" -- outlined by Cheshire & Cook (2004). Our users cannot interact directly (exchange messages or goods) but they can view at any time the history of information provided by another user who chooses to make that public; the choice of following or not is a one-time choice, but based on the other user's actions over time (in a way, this could be a kind of reputation system). A user will see all notes or links going forward of the other user he or she follows, but the "followed" user will not necessarily have any interaction after allowing the user to follow. Though this places our system outside of research findings tied specifically to repeated trades, or "one-shots", we believe the decision-making process for sharing, either way, is still relevant to the trust discussion. And we feel that the persistent past record of User B is a strong feature for User A to evaluate the risk of following: "One of the most convincing forms of evidence that others merit trust is their past behavior" (Nissenbaum, 2004).

Though it is not usually seen as such, we think a visible record of who a user is following, and who is following that user, can serve not only as a type of reputation system but also as a signal of trustworthiness. Citing Olson, Grudin, and Horvitz's (2005) "people's willingness to share depends on who they are sharing the information with", Joinson *et al.* (2010) pointed out that this "highlights the importance of the *relationship* between the discloser and the recipient in determining disclosure behavior, including the trust we have in the other party to our information". This could possibly be a kind of transitive property.

This idea was reinforced by research into friend-of-a-friend (FOAF) networks, such as done by Hexmoor (2010). Though his study was in the context of data security, with automated harvesting of machine-readable descriptions of people within a scale-free network, we feel that the basic idea that users will find a FOAF more likely to be trustworthy than a user without such a connection.

As a result of the work of Joinson (2010) and Hexmoor (2010), we added in the second design iteration "following" and "followed by" indicators. By looking at User B's own page, User A could see who was following User B, and whom User B was following. We would hope that not only would various properties of this (perhaps User A would recognize a trusted name somewhere, or User A would explore the pages of some of the other users) would encourage more information sharing.

Implicit in the descriptions of risk by potential users (concern about being spammed and other bad behavior, worry about who was seeing their notes) is the problem of anonymity. Other users are "others", strangers, and "anonymity creates uncertainty and risk" (Chesire & Cook, 2004).

Purchasers of the Digital Companion will receive one registration number and will be encouraged, though not required, to log in with their real name.<sup>7</sup> There is a wealth of literature on how highly disposable user identities enable bad behavior such as flaming and trolling; we hope that allowing only one identity per user -- and letting all users know that this is the case -- will reduce this risk, and user concerns about this risk.

An interesting result from our study sits in contrast to the findings of Joinson *et al.* (2010). Building on the work of Tidwell & Walther (2002), they found that "privacy and trust were found to operate in a symbiotic relationship, such that the lack of one was compensated for by a surfeit of another." In the context of the Digital Companion information design, this would be expected to result in a higher rate of actions from User A that signified trust in User B when more of User B's personal information was exposed.

That is, we would expect to see User A choose to follow another User B more frequently when User B's "About Me" information was visible by default. But we consistently saw the majority of users rate the "About Me" as neutral or negative a factor in their decision. This would be one area for future study and testing.

### **Confidence**

Like trust, confidence is, in Luhmann's words, a "way of asserting expectations". However, while trust is between actors in a system, confidence is in respect to the system itself. You may not trust scamseller1989 on eBay, but you can have confidence that the system that manages your transaction is stable and predictable.

KQED, as both a television and public radio station, and Quest, as an educational science series, have excellent reputations in education and public service. Keeping the KQED brand on all the Digital Companion screens is, we feel, a way to signal confidence in the Digital Companion application to users. As Hargittai *et al.* (2010) wrote about web sites, "the importance of [presenting the brand] in assessing a site's credibility cannot be ignored".

"Confidence in the system and trust in the partners are different attitudes with respect to alternatives, but they may influence each other" (Luhmann, 2000) and "trust in the online world begins with confidence in systems, but does not end there" (Nissenbaum, 2004) give us reason to keep the KQED brand name present and visible, even if the (non-control) logo and name use up valuable screen real estate.

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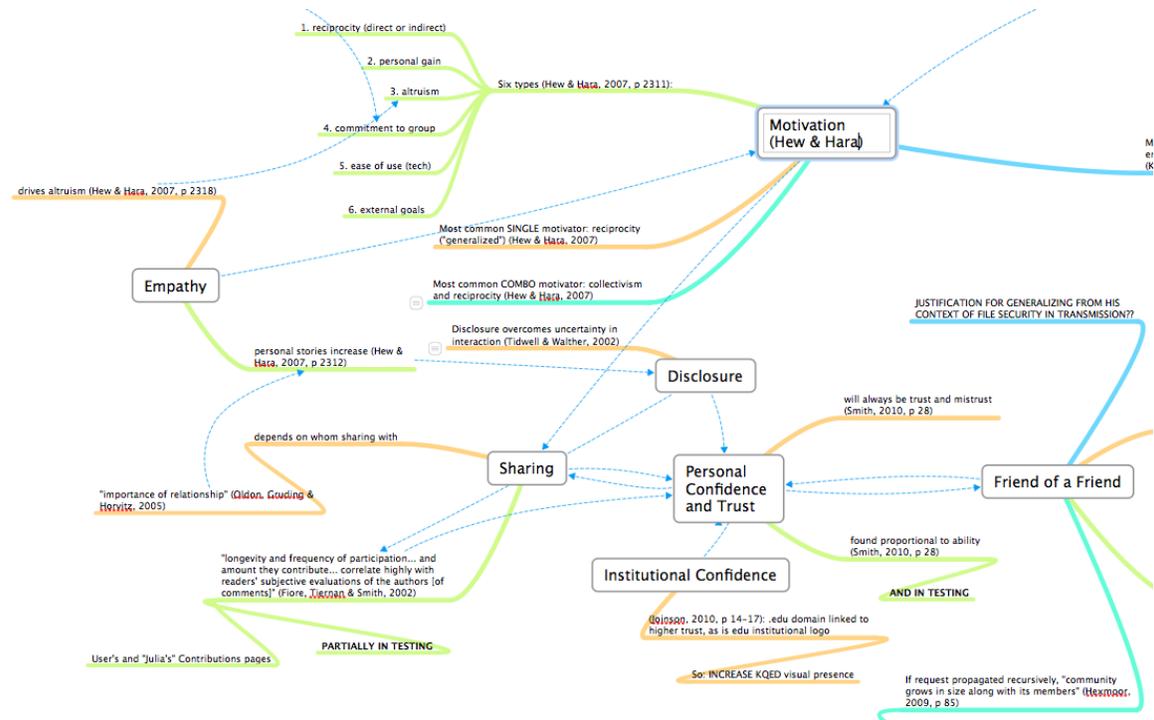
<sup>7</sup> This is very similar to the way The New York Times handles registration for commenters on its web edition.

### Empathy and Altruism

Hew & Hara (2007) defined motivation as a way to "energize and direct people's behavior to share knowledge" and found six types of motivations in a CMC context: reciprocity (direct or indirect), personal gain, altruism, commitment to group, ease of technological use, and external goals.

Their study showed that the most common single motivational factor was indirect (also called generalized) reciprocity -- "when help given to one person is reciprocated by someone else and not by the original recipient of the help". (In a blow to the UX community, they also found that "ease of use" was a low motivator.)

An interesting connection appears when we look at empathy. Hew & Hara (2007) support the suggestion by Batson, Ahmad, & Tsang (2002) that the "most commonly proposed source of altruism is empathetic emotion". Empathy is increased when there is a high level of disclosure of personal information/stories (Hew & Hara, 2007). Disclosure overcomes uncertainty in interpersonal interactions (Tidwell & Walther, 2002), increasing trust. Trust increases sharing, as we saw above. Sharing can lead to more empathy and altruism, which completes the virtuous circle (see Fig. 1).



(Fig. 1)

### ***Motivation***

But still, users have to choose to be participants. What are some of the tentpole findings in the above research on specific motivational factors for this population?

In a qualitative study of over 400 adult learners (Chu & Tsai, 2009), the elements most highly valued by the students in their educational content were relevance to life (authentic feel, represent real-life situations) and reflective thinking (self-analysis). The least valued were criticism, student negotiation, and ease of use. (Due to the nature of this project, we will place our own value on the last.) Chu & Tsai also quoted a past study that showed "meaningful contexts that associate with their past and present experiences are important for adults to reflect on their own learning (Ermer & Newby 1993)".

Kollock (1999) stated that there must be four conditions in place to encourage reciprocity in CMC situations: ongoing interaction, identity persistence, knowledge of previous interactions, and strong group boundaries. This can obviate the need for users to be altruistic, he stated; with these conditions, users who help others also help themselves. We can see our system meets only the second and third of these conditions, and in a qualified manner. Whether Kollock was wholly right and our system depends on the pure kindness of strangers to become a viable information-sharing space, is a question for future study.

There was a hopeful note that participation itself could be a motivator; as Sabry & Baldwin also stated that "[a]ccording to some studies, learners who interact on a regular basis with other learners were found to be more motivated and had better learning experiences (Garrison, 1990)."

## Concept

Our original contribution and focus of this project was to discover the elements of design that would enable a collaborative information-sharing space for an adult, out-of-school, self-directed population.

Normally, a design project would begin with exploring who the users would be. For this project, however, we were given a defined population. This moved us directly to a needs assessment of that population.

We solicited interviews with family and friends, and went to locations such as bookstores, cafés, and public transit sites to survey likely readers. Questions included what they read, how they read, whether were more aware of subjects once they had read about them, and their discussion habits centered around their reading.

Though patterns of usage and sharing (discussion) varied in our dozen field interviews, the base concerns of users seemed to emerge. This gave us an idea of what potential Digital Companion users would see as barriers to information sharing and possible tactics to lower these barriers.

Combining our partner's design requirements, our user research, and our literature review, we created a compact statement for our Digital Companion's scope and goals: "An interactive information-sharing system that can be integrated into ebooks for a general, out-of-school readership."

## Use Cases

The choice of making the Digital Companion a mobile rather than a web- or desktop-based application arose from design and research into use cases.

Our initial field research, which included small contextual studies and in situ observations, showed that many people read while commuting on buses or other public transportation, as well as in public settings such as cafés, outdoors, or in other places where they might have to wait, such as lines at the bank.

Use case sketches and initial queries of someone trying to read and possibly interact with a laptop in a public space revealed issues such as:

- "I had to find a table at the coffeehouse -- and not just any table, one with enough room for my laptop and my bag."
- "If I can't find a seat on BART, I can't pull out my laptop to read."
- "My laptop gets heavy in my lap."
- "I can't connect to web sites to read online when I'm not near a hotspot."

When we asked them about reading a book or interacting with a phone or e-reader:

- "I can hold it mostly with one hand."
- "It's lighter, so I can carry it more places than a laptop."
- "I can pull out my Kindle or iPad like I can a book -- it's too obvious in public to set up a laptop."
- "I can access stuff through 3G."

In addition, mobile devices mimic the physical affordances of books much more than web or desktop applications do, and are built for use in many of the places and situations good, old-fashioned books are used.

In his post-mortem analysis of the phenomenal success of the iPhone and iPad game Angry Birds, Charles L. Mauro wrote about the importance of users quickly forming a mental model of use.

"[F]ew realize that a simple interaction model need not be, and rarely is, procedurally simple. Simplification means once users have a relatively brief period of experience with the software, their mental model of how the interface behaves is well formed and fully embedded. This is known technically as schema formation. In truly great user interfaces, this critical bit of skill acquisition takes place during a specific use cycle known as the First User Experience or FUE. When users are able to construct a robust schema quickly, they routinely rate the user interface as 'simple'."

Designing a simple interaction model, especially when multiple sources of information and interaction are vying for priority, is not itself simple, so we tried to reuse elements and controls we thought would already be familiar to users.

One example: early on we abandoned the idea of presenting the text as virtual book pages (as Apple's iBooks does), as this would cause cognitive clashes with the controls that had to be on-screen, and moved to a more web-like, scrolling presentation of the text, and found this tested better with users.

## Prototypes and User Testing

Because our team skills did not include coding, we limited ourselves to paper prototyping initially. We began with structured testing of two low-fidelity iterations and then were able to do some "mini-tests" in the higher-fidelity prototype (presented on a laptop screen). User tests on the first two iterations were mostly conducted in controlled circumstances; user mini-tests on the high-fidelity iteration were relatively quick and in outside environments such as cafés.

The medium of paper enabled us to move quickly in creating and altering even large user task sets (some user testing sessions took over an hour). In addition, it allowed us to go into public places for shorter, more limited ad hoc sessions with strangers.

Including interactive prototype testing might have enabled us to capture more user responses and feedback with complex tasks, such as using texture brushes on a coast, or allowed us to test different types of alerts.

### Low-Fidelity Prototypes

Our concerns were twofold. First, we had to provide a useable reading experience with added features such as multimedia and interactive elements, as well as now-standard ebook functionalities such as highlighting. Second, we had to research and design elements that would encourage information sharing by our user population (while allaying their concerns around this).

When we began sketching out possible user interfaces for the Digital Companion, we tried to use many of the suggestions and common elements in Apple's iOS Human Interface Guidelines (HIG).

#### ***First Iteration***

Since this was a Digital Companion to a book, we began by structuring a reading experience around a Table of Contents, from which users could move to chapters by tapping on a chapter "button". However, in addition to the obvious error of not including chapter numbers, this "button" interface did not offer progressive information disclosure, punished user errors such as tapping the wrong button with mode changes (requiring backsteps), and took users out of an immersive experience.

#### *The reading experience:*

It was surprisingly challenging to create good navigation within and between chapters. Though this stage of the prototyping was "intentionally ugly", it was still difficult to lay out user flow between the table of contents, chapters,

chapter sections, and back again, especially in a non-interactive, paper prototype. Also, we discovered that buttons within the text window we usually ignored by users.



(Fig. 2)

### *The information sharing experience:*

We were greatly concerned with letting users know about "contributions" from other readers. To bring this feature to the user's attention we included a "feed" of Recent Contributions as one of three major screen elements, in conjunction with the chapter navigation and the text itself. The goals were to provide low-frustration reading and navigation, but also to foreground the collaborative element.

This tested poorly. Though users noticed it without prompting, they found the color and placement between the text and the navigation distracting. The chapter navigation and system-wide controls (buttons) were also hard to understand.

When users were led to a home/"Collection" page of a hypothetical other user, their reactions were surprising. As described in the "Trust" section, users tended to associate personal information about and from that user as suggestive of a social network, which they did not want the Digital Companion to be, and

eroded confidence in our system while not increasing the perception of trustworthiness in that hypothetical user.

However, users pored over past entries of the hypothetical user, and tried to find ways to scroll back through their history. That appeared in testing to be, and was explicitly mentioned in debriefing as, the primary source for users to evaluate trustworthiness. The choice to feature separate follow controls for links, posts, and notes appeared to be useful; users would tap selectively, evaluating each column's contents.

*The interactive simulations:*

There were kept fairly simple in concept, as this was not the focus of our work. However, we still did learn interesting things at this stage of feedback, such as when and where to include a few words of instructions and/or labels (when faced with a coastline in profile, users did not know to tap on the ocean floor and raise or lower it). Too much confusion about any part of these features led to boredom in the users.

## **Second Iteration**

*The reading experience:*

By moving the Recent Contributions to a small space and relying on iOS notifications, we were able to enlarge the reading area. Users were more clear on how to move within the text.

Though removing colored items from the table of contents and chapter navigation elements reduced user distraction, there were still navigation issues. Users seemed not to know where within the chapter section they were; in our printed prototypes the "Chapter 2.1" was very dim, and users were not looking there to locate themselves. The chapter and subchapter column was also problematic. The iOS standard for this kind of information hierarchy would be a split-pane view, but that takes twice the screen width and requires the user to tap multiple times to go down the information hierarchy, then again to go back up, then again to go back down -- poor heuristics for a user who may be browsing as one would in a book.

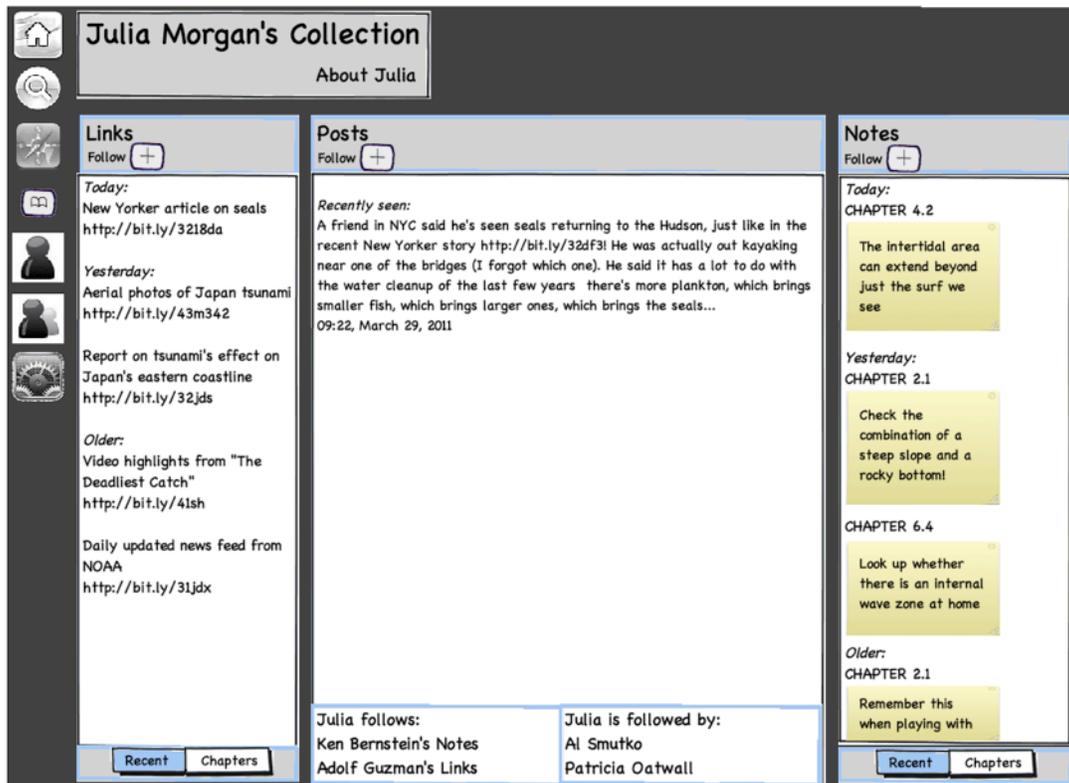
We experimented with a navigation element that used the "turn arrow" model such as in the Mac OS X Finder (Microsoft Windows uses "+" and "-" for the same functionality). This is not a standard iOS element, but it tested better for the user interaction flow and information hierarchy, though it was still not perfectly transparent.

The system controls (on the left side in Fig. 3) were confusing to most users, though much of that seemed to be due to poor print quality -- the Safari icon in particular was very difficult to make out.

*The information sharing experience:*

As a result of the work of Joinson (2010) and Hexmoor (2010), we added indicators of User B's own page showing any visiting user who was following User B, and whom User B was following. We would hope that not only would various properties of this (perhaps User A would recognize a trusted name somewhere, or User A would explore the pages of some of the other users) would encourage more information sharing.

We also added indicators for scrolling up and down (in this iteration, users attempted to without prompting), buttons for organizing notes or links by date or by context, and the "follows" and "followed by" information.



(Fig. 3)

*The interactive simulations:*

Though in general we found that reducing the number of buttons on screen, adding tool buttons reduced user confusion greatly; all users, even those who did not have smartphones or tablets and rarely used their computer were able to understand. In addition, this allowed us to add "terrain brushes", extending

the simulation. Users all reacted well to both simulations (the other involved how changing the average ocean temperature affected wave heights around the world) emotionally and intellectually.



(Fig. 4)

## High-Fidelity Prototype

Moving to a high-fidelity mockup proved to be more challenging than anticipated. We couldn't just replace UI elements with higher-resolution versions; the latter sometimes simply not fit, or disappear visually, or add confusion. We also combined the "up-rezzing" with trying to incorporate what we learned from the previous round of user testing.

At this point, we also took some tips from iOS developer Matt Legend Gemmel<sup>8</sup>:

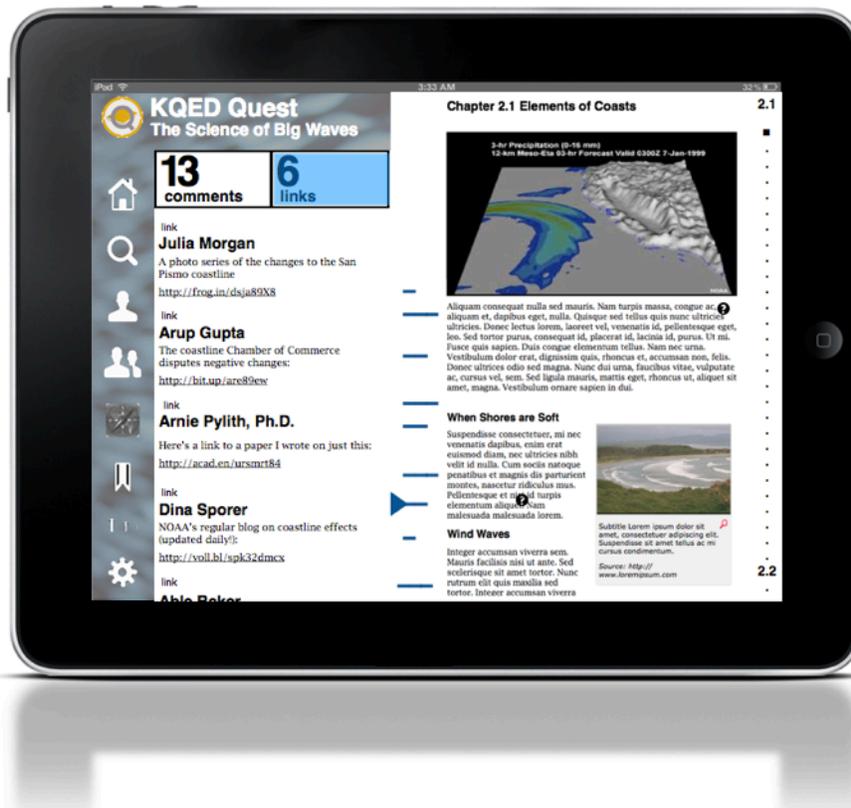
- Hide configuration UI until needed.
- Look like a viewer, and behave like an editor.
- Edit object properties in place.

<sup>8</sup> <http://mattgemmell.com/>

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- Attach the editing UI to the object. Show/hide/move as necessary.
- Inspectors should present context-relevant UI.
- Hide controls which don't apply to the selection or focus.

*The reading experience:*



(Fig. 5)

The user interaction with the text remained largely unchanged, and mini-tests showed that users were able to create notes, highlight text, and scroll just as easily as in previous iterations.

Navigation was quite changed. The table of contents function was relegated to an iOS popover called up by a system control. Mini-tests showed that this enabled users to move between chapters by tapping and dragging their finger, rather than multiple taps with cognitive activity in between.

We also added an indicator along the right side of the text to show users where they were in the chapter. This provided positive feedback to the users, as well as error correction if they scrolled too much or too little<sup>9</sup>. Whether in the final product users would be able to tap on it to jump in the text would have to be tested with an interactive prototype.

*The information sharing experience:*

Our goal was to return this feature to the foreground, but in a less intrusive yet more integrated form.

We should be clear that the content on the left side is from users not currently followed by the app user; these are links and notes unknown users have chosen to make public. Notes from followed users will appear in the app user's text, as in earlier prototypes.

Bars along the left side of the text show where users who have created public notes; these would scale programmatically to show relative volume of notes. An arrowhead signals to the readers to what in the text the content on the left side of the screen is related. The best way for these elements to move as users scroll in the text would have to be tested in an interactive prototype.

The reduction of color helped reduce the visual distraction, as confirmed in mini-tests. This design also obviated the need to explain what public notes and links were and signaled to the app user that other users were actively sharing information.

Though we were not able to conduct A/B tests, mini-tests showed that users were likely to read and express more interest in the information from other users.

We were also able to integrate web browsing into the application without the browser interfering with the text.

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<sup>9</sup> Our design choices here were also influenced by critical reaction to the recently released ebook, "Our Choice" (Gore, A. (2011). *Our Choice: A Plan to Solve the Climate Crisis*. Retrieved from Apple iTunes Store.



(Fig. 6)

*The interactive simulations:*

These were the easiest to transition to high fidelity. Functionally, little changed, aside from integrating the look and feel and the expanded public notes and links.

## Conclusion and Implications for Design

Our primary goal was to research and design what user interface elements and affordances would positively affect information sharing in a non-school, adult population. We believe that what we have learned in this project can contribute to the overall understanding of how to encourage that population's information sharing in a mobile, book-based application.

The process required many steps. We conducted "man-in-the-street" interviews of prospective users within the desired population and gathered information about their concerns to identify barriers and possible encouragements.

This helped us understand how people in this population read books, why or why not they like to discuss books, how do they get to trust someone in this context. This allowed us to conduct a more narrow literature review, which in turn informed our design process.

One challenge was managing the two-way interaction between theory (past research) and design choices resulting from our own research. We could try to extract findings from past studies and build a Digital Companion feature around it, but then user testing revealed to us what related research areas we should review. It was a virtuous circle, but a surprisingly resource-consuming one.

We hope that the findings from our work can be the basis for future research in the following areas.

Creating an interactive prototype would enable testing of animations, transitions, and other visual elements that could perhaps replace the persistent on-screen elements we have, thereby streamlining tasks.

The role of motivation needs to be further explored. Many of the motivating factors one can rely on in a community (even virtual<sup>10</sup>) are not present, or are present to only a small degree, in the Digital Companion's readership.

There is a great deal of interesting work being done on the role "badges", where users can achieve icons or other public awards for completing certain tasks once or many times. This also ties into the rich area of reputation, which can be a powerful incentive or disincentive.

Zuallkernan (2006) explored game-based learning and found this increased motivation in that tested population. "Gamification" is worth exploring with our population and in the Digital Companion context, though designers would need

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<sup>10</sup> "whenever [CMC] technology becomes available to people anywhere, they inevitably build virtual communities with it, just as microorganisms inevitably create colonies" (Rheingold, 1994)

to take care that this does not overwhelm the experience such that the app loses its readability as a book.

A Reddit-style public voting up or down of recent public notes and links could prove more effective in increasing perceived value of these contributions (decoupling them from identity, allowing users to follow notes and links only above a certain rating level). However, the issues of the free rider and social loafing would need to be addressed in the implementation<sup>11</sup>.

One potentially promising idea that we were not able to pursue was that of motivational and volitional email messages (MVEM), as outlined by Kim & Keller (2008). They sent to students motivational email messages (e.g., reminder of how to make study tips, requests for responses after a task, etc.) some with personalization of name and task, others without. They found the group that received the personalized messages showed a higher overall level of motivation and confidence compared to the non-personalized-message group.

It would be worth exploring in later research if an automated system to deliver personalized messages to users, perhaps about updates to topics they've shown an interest in, or if they've been inactive, could have a similar effect in our system and population.

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