Promoting Interaction by Integrating a Question and Answer Forum with a Digital Textbook

Erin Walker, Arizona State University, erin.a.walker@asu.edu
Rohit Chakravarthi, Arizona State University, rchakra5@asu.edu
James Rodriguez, Northern Arizona University, jprodri4@asu.edu
Ruth Wylie, Arizona State University, ruth.wylie@asu.edu

Abstract: As digital textbooks become more common in formal learning environments, there is an opportunity to embed technology that represents our growing understanding of best pedagogical practices into the textbook itself. Integrating collaborative technologies into a textbook platform provides substantial opportunities for facilitating classroom discourse surrounding the textbook content. However, to be successful in a digital textbook, these technologies have to be perceived by students as useful, and must function well on the tablet platform. This paper proposes the integration of Q&A into a digital textbook platform as a way of facilitating productive collaboration, designing for the tablet, and engaging students with the technology. We describe our implementation of an integrated Q&A system and digital textbook, and outline the results of a pilot study that demonstrate how the Q&A system might be effectively used by groups of students.

Keywords: digital textbooks, question and answer forums, tablets, introductory biology

Motivation

Despite decades of technology in classrooms, textbooks remain the primary instructional resource used by teachers and students (Lewin, 2009). They are designed to serve as a grounding tool for classroom instruction, and to facilitate students in forming an intellectual community through the co-construction of knowledge (Zhao & Kuh, 2004). Digital textbooks are gradually replacing physical textbooks in the classroom, and are projected to represent 35% of the total textbook market by 2016 (Uzwyshyn, 2012). Today's digital textbooks, however, are often analogues to their print counterparts, with additional features such as better search, navigation, and annotation (Marmarelli & Ringle, 2011). With the transition from the physical to the digital medium, there is an opportunity to reflect on how textbooks can be reimagined to best scaffold student learning.

Our work investigates how to incorporate collaborative activities directly into the digital textbook platform. Collaboration is already a natural part of textbook use, but it typically occurs externally to the textbook itself, as students use textbook content as a starting point for face-to-face interaction (Rossing, Miller, Cecil, & Stamper, 2012; Li, Pow, Wong, & Fung, 2010). By incorporating collaboration directly into the textbook platform, students can co-construct knowledge asynchronously, from any location, and yet still ground discussion in textbook content. In some cases, researchers have built computer-mediated collaboration into their textbooks by having students share notes or collaboratively annotate the textbook, and have noted that these activities motivate the students to engage more with the course material (Tront, 2007; McFall et al., 2004). These functionalities are also making their way into commercial digital textbooks such as Inkling and Kno. It is important to note that while these textbooks do enable collaboration, they do not scaffold students in engaging in productive collaborative behaviors. Students must engage in particular promotive interactions in order to benefit from collaboration (Johnson & Johnson, 1990), and in the digital textbook context, they receive little guidance on how to do so. Given the growing ubiquity of digital textbooks, facilitating scaffolded collaboration within the textbook platform might have the potential to improve student learning at a large scale.

In this paper, we design a Q&A model of interaction into a digital textbook environment that satisfies the constraints of the particular design problem, principles of collaborative learning, and student perceived needs. In our Q&A system, students ask and answer questions of their classmates while reading a digital text. Thus, there are two constrains of the design problem: (1) the system will be used by a closed group of students (the number depends on class size), and (2) the system will be used on a tablet platform. We chose Q&A because, in properly designed interactions, *answering questions* has several benefits: students attend more to domain material, reflect on what is required to solve problems, and elaborate more on their own knowledge (Roscoe & Chi, 2007). Taking on the role of help-giver can also improve students' academic self-efficacy and attitudes towards school (Robinson, Schofield, & Steers-Wentzell, 2005). In contrast, students see a main benefit of collaboration as a way of getting immediate support from peers on learning content, and thus tend to embrace course-related Q&A systems (Hung, Yang, Wang, & Shih, 2006). The Inquire textbook, which

implements automated answers to student generated questions, has received a similar positive response from students, but does not give students the opportunity to construct knowledge by answering their peers' questions (Chaudhri et al., 2013). In the following sections, we describe a prototype we developed to implement key features of a textbook-embedded Q&A, and then a pilot study where we examine how students used and perceived the features.

Textbook-embedded Q&A prototype

We built a prototype that drew from existing Q&A sites, collaborative learning theory, and the constraints of the digital textbook platform to extract and adapt Q&A-style features that may facilitate collaborative learning within the digital textbook. The prototype was developed in Objective-C for the iPad, and loads textbook content encoded using the epub standard. For the Q&A feature we modified the open source project www.question2answer.org to make it suitable for the textbook platform. Our prototype facilitates both anchored and sequential discussion and provides a means for validating and organizing content.

Typical use of our prototype proceeds as follows. Students read the text in landscape mode, and can see two windows: the textbook content on the left, and the Q&A system on the right (see Figure 1). As students turn the page, only questions relevant to that page (i.e., added when a student was on that page) are displayed. To compose a new question students touch the "Ask a question" button, and the compose question window appears on the right half of the screen. Students can fill in the title of the question, information about the question, and any content-related tags they would like to add using hashtags. Their question is then added to the list of questions for that particular page. Each question represents its own discussion thread. To answer the question, students touch the question, and on the right half of the screen can see the question title, additional information on the question, the user who posed the question, all replies to the question, and relevant hashtags. If the student composes a reply to the thread, it is added sequentially to the bottom of the thread. For each reply, students can up-vote it or down-vote it by touching either an up arrow or down arrow located just to the left of each answer. These arrows also show previous votes received by the particular answer, as shown on the right side of Figure 1. Voting on answers does not change the order of the replies in the thread. In general, students have a lot of choice in the way that they view the questions and the text. At any point, in landscape mode, students can view all questions asked or all questions related to a particular content hashtag by clicking on the tag. Turning the tablet to portrait mode allows students to read the text without viewing the Q&A forum.

This prototype design is an implementation of *anchored discussion* (Guzdial & Turns, 2000), where students immediately see which questions are relevant on particular pages and determine whether they can engage in a discussion surrounding those questions. Anchored discussion is the process of creating links between the content space and the discussion space, such that it is very clear which idea from the content is currently under discussion. For a successful anchored discussion, students should be able to access the textbook content and discussion forum in tandem, without losing sight of either, thereby lending focus to the discussion (Alrushiedat & Olfman, 2013). Anchored discussions have been demonstrated to promote effective discussion among individuals on a computer mediated forum, potentially because they help students attend better to key details of the text (Guzdial & Turns, 2000; Van der Pol, 2006). In our prototype, students view the discussion content and text content side by side, with relevant questions linked to relevant pages. This arrangement allows for side by side comparison of the Q&A and the textbook content, and allows students to ask and answer questions that are most relevant to what they are reading. Our prototype is also an implementation of *sequential threaded discussion*. Threaded discussion forums keep track of relationships between posts, and students can easily identify which posts are in response to what, to easily find points of interests and get a sense of the overall discussion. The persistence of the posts in the thread also helps students to return to earlier posts at a later time for reference or to post a reply (Guzdial & Turns, 2000). In our implementation of threaded discussion, each question represents its own thread, replies to the question are added sequentially to the bottom of the thread, and this sequence is preserved throughout the interaction. Our implementation shares both similarities and differences with the model used by typical Q&A forums, which we illustrate in this paragraph using the example of StackOverflow (www.stackoverflow.com), one of the most successful Q&A sites (Mamykina et al., 2011). In StackOverflow, as described by Mamykina and colleagues (2011), students up-vote and down-vote answers, with the best answer presented higher in the thread. While in our prototype students can still vote on the best answers to reward quality contributions, we viewed answers not as individual responses to the question but as components in a sequential discussion. This design decision facilitates students in interacting directly with each other to build on and refine each other's ideas, prioritizing inter-student interaction over the correctness of individual responses. StackOverflow also allows students to reply to individual answers, but because of the small screen real estate of the tablet platform and the nature of the closed system (only users from the same class interact) we chose to consider the question as the unit of discussion for threading purposes.
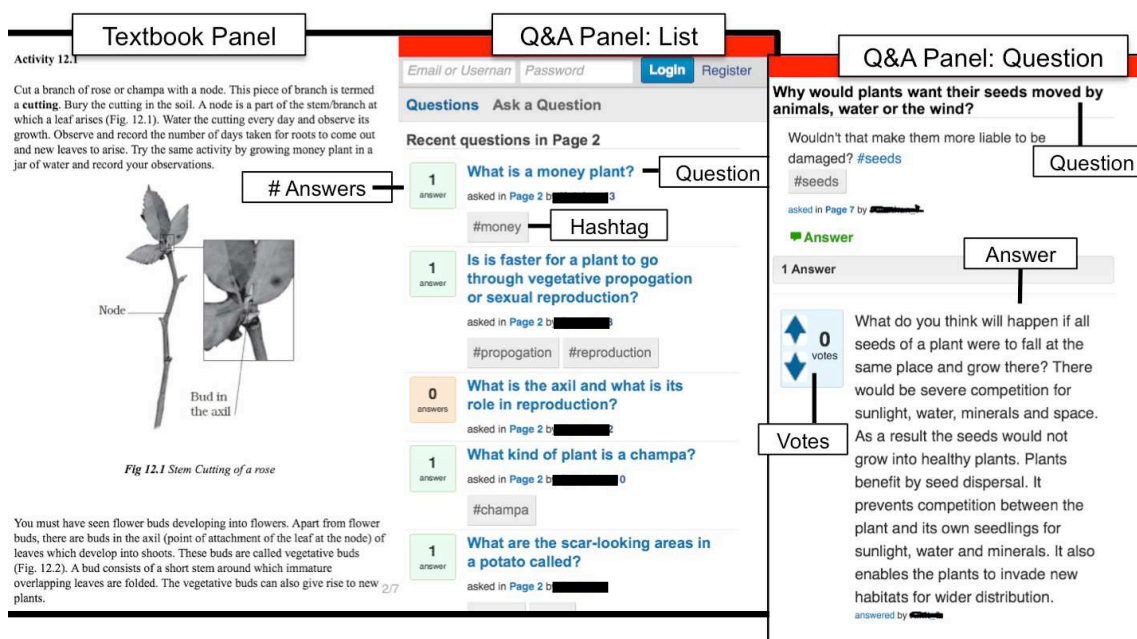
Figure 1. Screenshot of the Q&A prototype. The left side is the "Textbook Panel," with the domain content. The right side is the "Q&A Panel." This figure shows two views of the Q&A Panel, one containing the anchored list of questions, and one containing the interface to a single question.

Pilot sessions

We ran 3 pilot sessions with a total of 9 undergraduate students (6 women) with ages ranging from 19-30 to explore the key features of the Q&A prototype. The domain of the textbook we used was a plant reproduction unit for introductory biology. Students spent 30 minutes reading the text and simultaneously engaging in computer-mediated Q&A with the others in their session. They were instructed to ask and answer at least one question. After they engaged with the prototype, we conducted a focus group where we asked them about their experiences with the textbook. The following results are presented based on student activity in the Q&A forum and their responses to interviewer questions. We use the notation S3P1 to mean session 3, participant 1.

Table 1 presents results related to how students used the prototype. Each student asked an average of 2.89 questions (SD=1.97) and made an average of 2.78 replies (SD=1.99). Most questions asked were factual and received a single answer. For example, "*What kind of plants go through vegetative reproduction?*" received the response, "*If a plant has roots, stems, leaves, then it has the necessary vegetative parts to go through vegetative propagation. This is a type of asexual reproduction*". While students asked and answered more questions than instructed to, questions almost exclusively led to a single reply rather than an in-depth discussion. The one question that had more than one reply left room for longer explanation and debate ("*What is the difference between self pollination and cross pollination?*"). Students had general positive comments regarding the Q&A activity (S1P2: "*It's good that you have, like, the ability to ask a question immediately and immediately get an answer while you are...reading or studying*").

The anchored discussion functionality was heavily used; all students used the prototype in landscape mode for the entirety of the pilot session, even though both orientations were demonstrated. S2P1 said having Q&A embedded in the text helped with understanding, "*I like the feature of being able to read and see what other people's questions are as I read because then I can find the answer to it...Instead of all the chapter and then the questions in the end at once, it is easier to focus on if it is in little bits.*" The anchored discussion was also helpful for composing contextually-relevant questions (S2P4: "*I like the landscape feature because if I had to ask a question, I didn't have to go through five different steps*"). S1P1 wanted even more anchoring ("*I'd like it if I could cite a portion of the text when I want to ask or answer a question. I think this helps us reassure if it is the right answer*"). Students appreciated the specific features we adopted from existing Q&A sites. Each student up-voted and down-voted an answer a mean of 1.56 times (SD=1.26). S3P1 said that voting added credibility, saying: "*You could figure out how credible your answer was.*" S2P1 requested having a feature where they could explain why they wanted to down-vote an answer: "*If you're going to down-vote it say why... say I'm down-voting this because its wrong this isn't entirely correct, cause then I can learn from that too.*" In total, students used six different hashtags (e.g., pollination).

Table 1. Descriptive information about each session.

Session #	# students	# questions	# answers	# votes
1	2	11	11	5
2	4	9	8	4
3	3	6	6	5

Conclusion

In this paper, we described an implementation of Q&A within a digital textbook that facilitated anchored discussion, threaded sequential discussion, voting on answers, and tagging question content. We found the students responded positively to the prototype and, in particular, found the anchored discussion useful. However, our prototype did not prompt as much interaction around questions as we had hoped. Perhaps students were inhibited by the fact that the source material lent itself to factual rather than conceptual questions, or by the challenges of typing on a tablet compared to a keyboard. Future exploration will probe deeper on how our features influence student collaboration and how our features interact with the content being discussed. Overall, we see this as a promising direction for facilitating collaborative knowledge construction and community building while meeting student perceived needs and design constraints related to digital textbooks.

References

Alrushiedat, N., & Olfman, L. (2013). Facilitating Collaboration and Peer Learning Through Anchored Asynchronous Online Discussions.

Chaudhri, V. K., Cheng, B., Overtholtzer, A., Roschelle, J., Spaulding, A., Clark, P., ... & Gunning, D. (2013). Inquire Biology: A Textbook that Answers Questions. AI Magazine, 34(3), 55-72.

Guzdial, M., & Turns, J. (2000). Effective discussion through a computer-mediated anchored forum. The journal of the learning sciences, 9(4), 437-469.

Hung, J. C., Yang, C., & Wang, C. & Shih, T. K. (2006). An Application of Question Answering System for Collaborative Learning. 26th IEEE International Conference on Distributed Computing Systems Workshops (ICDCSW'06), 49–49. doi:10.1109/ICDCSW.2006.15

Johnson, D. W., & Johnson, R. T. (1990). Cooperative learning and achievement.

Lewin, T. (2009, August 8). In a Digital Future, Textbooks are History. New York Times.

Li, S. C., Pow, J. W., Wong, E. M., & Fung, A. C. (2010). Empowering student learning through Tablet PCs: A case study. Education and Information Technologies, 15(3), 171-180.

Mamykina, L., Manoim, B., Mittal, M., Hripcsak, G., & Hartmann, B. (2011). Design lessons from the fastest q&a site in the west. In Proceedings of the SIGCHI conference on Human factors in computing systems (pp. 2857-2866). ACM.

Marmarelli, T., & Ringle, M. (2011). The Reed College iPad study. The Reed Institute.

McFall, R., Dahm, E., Hansens, D., Johnson, C., & Morse, J. (2004). A Demonstration of a Collaborative Electronic Textbook Application on the Tablet PC. In World Conference on Educational Multimedia, Hypermedia and Telecommunications (Vol. 2004, No. 1, pp. 3957-3958).

Robinson, D. R., Schofield, J. W., & Steers-Wentzell, K. L. (2005). Peer and cross-age tutoring in math: Outcomes and their design implications.Educational Psychology Review, 17(4), 327-362.

Roscoe, R. D., & Chi, M. T. (2007). Understanding tutor learning: Knowledge-building and knowledge-telling in peer tutors' explanations and questions.Review of Educational Research, 77(4), 534-574.

Rossing, J. P., Miller, W. M., Cecil, A. K., & Stamper, S. E. (2012). iLearning: The Future of Higher Education? Student Perceptions on Learning with Mobile Tablets. Journal of the Scholarship of Teaching and Learning, 12(2), 1-26.

Tront, J. G. (2007). Facilitating pedagogical practices through a large-scale tablet PC deployment. IEEE Computer, 40(9), 62-68.

Uzwyshyn, R. (2012). The Evolving eTextbook Landscape Introduction: The eTextbook Marketplace. Journal of Digital Media Management, 1(1), 69–77.

Van der Pol, J., Admiraal, W. F., & Simons, P. R. J. (2006). The affordance of anchored discussion for the collaborative processing of academic texts. International Journal of Computer Supported Collaborative Learning, 1(3), 339-357.

Zhao, C., & Kuh, G. (2004a). Adding Value: Learning Communities and Student Engagement. Research in Higher Education, 97(2), 115–138.