Artifact-centered Q&A for Learning

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ABSTRACT

In this paper, we propose to create descriptive pages with question position indicators and filters (e.g. which chapter or page number) in a Q&A(Question and Answer) system for all the learning artifacts that offline courses are using. In this way, we extend the concept of artifact-centered online discourse to applications in classroom and out-of-class learning. We verify the hypothesize that organizing online course Q&A content around course artifacts increases the usefulness of peer questions and answers, and in particular that organization around course artifacts makes prior-course Q&A useful to students taking a subsequent course or engaging in self-study of a course between offerings. From a longitudinal perspective, it is shown to be beneficial to index student-generated artifacts of interaction with their position information to help answer future students' questions. We design and deploy this interface on the GopherAnswers(gopheranswers.umn.edu) platform, which is a Q&A site maintained by GroupLens (grouplens.org).

Author Keywords

Artifact-centered discourse, Community of Questions and Answer, Computer-Supported Collaborative Learning.

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI)

INTRODUCTION

CQA (Community of Question and Answer) has been increasingly popular to get help when we have questions about information or knowledge, such as StackOverflow and Yahoo! Answers. This could potentially serve as an way of seeking help for students when they're studying in school as well. However, one scenario that current interface of CQA doesn't serve well is when students have questions about learning artifacts in the courses they're taking. For example, students may have to indicate which book they're using and which chapter or page number they're talking about. This also happens in MOOCs such as Coursera where discussion forums and learning artifacts are

organized separately. From a longitudinal perspective, it could be beneficial to index the Q&As that students have before by the learning artifacts with position information to help answer current students' questions when they're using the same learning artifacts.

This idea of organizing discussions around learning artifacts is called artifact-centered online discourse firstly proposed by Suthers [1]. Artifact includes the learning material itself and the figures or other kinds of components in it. Most of the previous work on artifact-centered online discourse focused on pure online learning scenarios or synchronous discussion [3, 4, 6, 7, 8]. The learning artifacts dealt with in previous work are electronic versions of texts, books or videos. It's difficult to transfer this way of indexing discourse into classroom learning, because the majority of learning there happens offline and embedding all these learning artifacts into online learning environment requires huge amounts of work.

In this paper, we propose to create descriptive pages with position indicators and filters for all the learning artifacts that offline courses are using in a Q&A system which extends the concept of artifact-centered online discourse to its application in offline learning. First, we did a survey on how students subjectively think about organizing Q&As together with their relevant learning artifacts. The results of the survey favor it over organizing Q&As and learning artifacts separately. Then, we did data analysis on the discussion forum data collected from several selected past courses in Cousera which demonstrates that questions with position reference to the learning artifacts have lower reply rate than questions without position reference and implies possible improvement of reply rate if the questions are organized together with their context or relevant learning artifacts. Lastly, we design and deploy this interface based on GopherAnswers which is a Q&A site maintained by GroupLens. The research question we ask about this interface is how artifact-centered indexing of Q&As influence students' behavior of Q&A during learning compared with organizing learning artifacts and Q&As separately. Specifically, we study students' behavior of tendency to ask, find and answer relevant Q&As and their efficiency during this process. We also initially test the influence of students' learning outcome because of this artifact-centered Q&A interface. This research gives experimental evidence that artifact-centered indexing of Q&A corpus could potentially increase its archival value and knowledge transferring from previous learners to current learners.

RELATED WORK

Artifact-centered discourse is built on the learning theory of Social Constructivism, which was developed by post-revolutionary Soviet psychologist Lev Vygotsky [2]. Vygotsky distinguished between two developmental levels: the level of actual development and the level of potential development (the "zone of proximal development"). He explained that a child's actual developmental level defines functions that have already matured, that is, the end products of development, while the zone of proximal development defines those functions that have not yet matured but are in the process of maturation, functions that will mature tomorrow but are currently in an embryonic state. Learning happens in the zone of proximal development which requires guidance from senior learners or social interactions with peers. Based on this theory, timely assistance when students have questions about learning artifacts could enhance their learning outcomes, which therefore makes the work of designing better interface of online Q&A for this learning scenario significant.

Suthers [1] introduces the concept of representational guidance for discourse and firstly propose the concept of artifact-centered discourse. Based on this work, several systems that support artifact-centered annotation and linking functions are developed and researched. Pink [3] is one of them which supports multiple types of artifacts and annotation patterns while maintaining appropriate separation of content and view through a three-tier architecture. Lauer el. [4] propose a model for anchoring group discussions in learning contents in a fine-granular way, which is independent of document and media types. After outlining the generic framework and data model, they describes its application to the scenario of group discussions around lecture recordings. The study described in [5] sets out to investigate the merits of knowledge representations and of two alternative ways they may be related to discussion tools: embedded or linked. Van el. [6] show that anchored discussion is more directed at processing the meaning of texts than discussion in the traditional forum, which is more oriented towards the sharing of personal opinions and experiences. Lauer el. [7] introduces the concept of scripted anchored discussion as a means to facilitate net-based group collaboration around multimedia lectures. Discussion contributions are anchored at specific spatial and temporal positions within the document, allowing both document-centred and discourse-centred views of the discussion. Eryilmaz el. [8] reports a theory-driven experimental study that evaluates the effects of an annotation functionality on online social interaction and individual learning outcomes. The results indicate that annotation functionality decreased coordinative interaction costs and stimulated more elaborated discussions that favored greater gains in individual learning outcomes.

Compared with myriads of online discussion tools and forums, CQA is an online community where people tend to seek help with questions. One example is Answer Garden [9], which is designed to help in situations where there is a continuing stream of questions, many of which occur over and over, but some of which the organization has never seen before. Our work lies in the combination of these two areas. On one aspect we mainly focus on situations where students seek help in formal learning or informal learning settings and on the other aspect, Q&As are organized with an artifact-centered way which has several potential benefits based on previous research work.

METHOD

Survey

A survey was done on the following two topics: how people learn and how to design an effective interface in an artifact-centered way. In order to come up with questions to solicit more information from the participants, we interviewed seven students at the Computer Science Department at the University of Minnesota. Two of them had work experience before, in which one student has more than ten years of work experience. We noticed that students' way of learning largely differs from whether they had worked before or not. So, we ask for the participants' number of years of working both full-time and part-time for following data analysis. To make the survey concrete and also general enough, we ask the participants to give a topic they've recently learned for at least one month and base our further questions on their learning process around this topic. The survey takes about 15 minutes and has 24 questions about the way of learning and 8 questions about Q&A habit. So far, we collected 20 completed responses. (Because the data is limited, only descriptive statistics is done at this moment. I plan to continue collecting data. Since this paper is about Q&A interface, here shows the results about Q&A habit. See the report for more results about way of learning.)

Cousera Data Analysis

In order to further validate the potential benefit of organizing Q&As together with learning artifacts, we did a comparison on the reply rates between two groups of questions from the discussion forums of several selected courses in Cousera. The first group is questions with obvious position description when they were asked. This group is called *position specific*. The second group is questions without obvious position description, e.g. on specific topics etc. and is called *Position irrelevant*. Two examples are given for these two groups respectively in the following table.

Table 1. Examples of the two groups of questions being researched

	Example 1	**Example 2**
Position specific	Title: Week 3, Lecture 1	Title: Lecture 5b, quotation about

	Content: When referring to Elizabeth Kolbert's work, Roth repeatedly refers to her as 'he'. Am I the only one that caught this or finds it really weird?	psycologist Wayne … Content: Sorry, but I couldn't get the surname of the psycologist named Wayne and quoted by Prof. Hinton during lecture 5b. Please, does anyone know about him and about his paper? I'm quite interested about his studies, it sounds to me possible to apply such studies to sentiment analysis of textual data, a subject I am trying to understand better. Thank you very much for your help. LM
Position irrelevant	Title: Recommended text book for hyper-dimensional geometry? Content: ... most things in my industry are 3D ;)	Title: Does The Trigram Language Model Work with All Languages? Conent: Prof. Collins says that this model is very useful in practice. But since there are so many languages, each with its own unique rules, I'm wondering if there is a language where the second-order Markov assumption fails?

	Cheers,

We restrict our research on questions that are relevant to the knowledge of the course and therefore remove questions that are about logistics and technical problems. Six courses are selected to do the data collection, which are "How to Change the World"(changetheworld-001) from Wesleyan University, "Introduction to Psychology as a Science"(psy-003) from Georgia Institute of Technology", "Human-Computer Interaction"(hciucsd-001) from University of California, San Diego, "Probabilistic Graphical Models"(pgm-003) from Stanford University, "Natural Language Processing"(nlangp-001) from Columbia University and "Neural Networks for Machine Learning"(neuralnets-2012-001) from University of Toronto. The reason why we selected these courses is because it spans different categories of the science and gives us more robust results through data analysis on it. The discussion data from "lectures" sub-forums of the courses are collected. In the data set, every record is a question posted in the forum including its title, content, the number of views and the number of replies. A basic statistics about the data is listed in Table 2. The three groups: removed, position specific and position irrelevant are labelled manually by the author.

Table 2. Basic statistics of the Cousera data

	Removed	Position Specific	Position irrelevant	Total
changetheworld-001	9	25	17	51
hciucsd-001	9	7	6	22
neuralnets-2012-001	17	53	25	95
nlangp-001	9	66	76	151
pgm-003	4	34	37	75
psy-003	33	13	33	79
Total	81	198	194	473

Three variables are analyzed about these questions from the above two groups: ratio in all the questions, reply rate which is the ratio of reply number and total view number and the mean of views.

Apparatus Design
We design two versions of Q&A interface to answer our research question. Our design process references the current practice of CQA systems such as StackOverflow etc. and MOOC platforms such as Coursera, Udacity and Khan Academy etc. Following is the main page of

GopherAnswers Q&A system, which paginates the questions as lists without indexing. It does support tagging which is a popular way of organizing content of online communities. Students rarely ask learning questions as the Figure 1 shows.
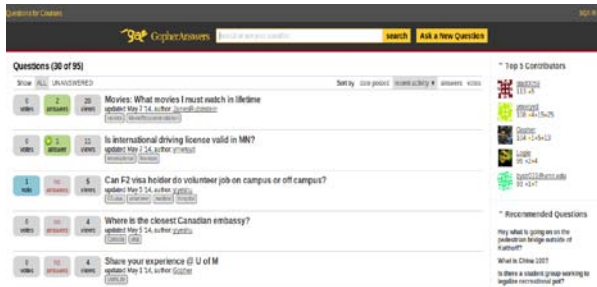

Figure 1. The main page of GopherAnswer which shows that students seldom ask learning questions

Then we add three kinds of pages in the system to support artifact-centered Q&A, list page of learning artifacts in Figure 2, list page of questions for one specific learning material in Figure 3 and asking question page in Figure 4. You can see that in Figure 3, users can filter Q&As by position in the learning material and indicate position when asking a new question in Figure 4.

Figure 2. The list page of learning artifacts for courses

Figure 3. The list of relevant questions for one learning material

Figure 4. Asking a new question page

Online Field Study

We announce this feature in the classes we choose to test our interface. Users who visit the pages shown in Figure 2, 3 and 4 will be randomly divided into two groups A and B. Users in group A will see the interface as the above figures show. However, users in group B won't see the position filter and indicator in the list page of questions for one specific learning material and asking a new question page respectively. The variables we'd like to measure for those two groups of users are as follows. Besides, we also would like to compare users' activities in the site with Moodle forum which is used as the course management system at the University of Minnesota. We hypothesize that users in Group A will participate significantly more in the site than users in group B.

1. number of page visiting

2. number of asked questions

3. number of answers

4. other behaviors, like voting and searching

RESULTS

Results For the Survey

One important finding in the survey is that half of the participants think it's difficult for them to ask questions or discuss when they have questions or want to discuss as Figure 5 shows.
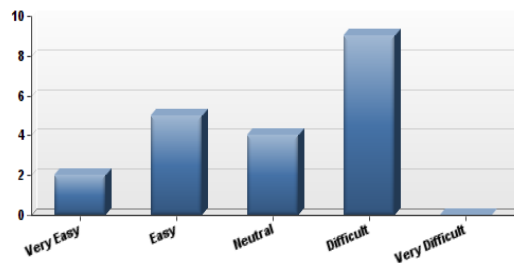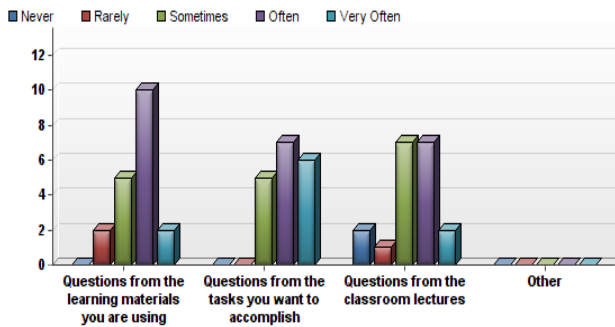

Figure 5. The results for "When you have questions or want to discuss, is it easy for you to find others to ask or discuss?"

To figure out what kinds of questions the participants usually have, several categories are given for them to

choose for the type of their questions. Another reason to do this is that the interface we propose is hypothesized to be better to serve the questions about learning artifacts. So the following figure also shows the significance of our work.


Figure 6. The results for "How often do you have questions that are in the following categories?"

More than half of the participants think it's useful to create an online discussion page for every learning material they're using for the courses, which confirms with our hypothesis and is show in Figure 7.
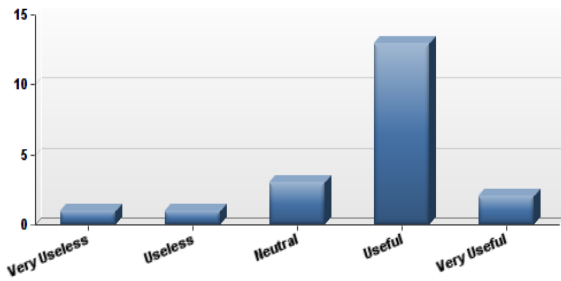

Figure 7. The results for "Do you think it's useful to create an online discussion page for every learning material you use like books, lecture notes, videos etc.?"

As mentioned that Coursera and other online learning platforms organize the discussion forums and learning artifacts separately, however, it turns out more than half of the participants prefer organizing the discussion forum together with its relevant learning material. Shown in Figure 8, the result supports our interface design.
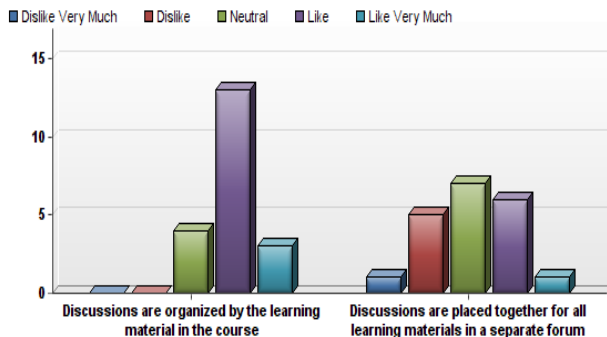
Figure 7. The results for "When taking an online course, which way of organizing the discussions do you like?"

In our interface, we give users the option to explicitly indicate the position information of their questions by specialized input controls. How useful is this design choice? The questions is answered by Figure 8. As it shows, this scenario of Q&A happens frequently in online discussion.
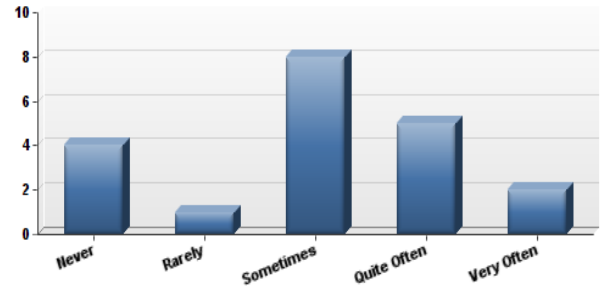
Figure 7. The results for "When asking questions online, how often do you indicate section number, page number or time point(if it's a video) to describe your questions?"

Results for the Cousera Data Analysis

From Table 2, we can see that position specific questions play a big part in students' questions about learning the knowledge from the courses. In all the questions, position specific ones take 41.8% and are slightly bigger than position irrelevant ones(41.0%). It demonstrates the significance of improving users' interactions with the Q&A or learning systems specially on this type of questions. This is also consistent with the survey results about the categories of questions that students have when doing online learning.

Following table gives the reply rates of the two groups of questions in consideration. It is shown that position specific questions have significantly (p-value=2.5473e-08) lower reply rate compared with position irrelevant questions. It implies that having to reference the position context in the learning artifacts prevent students answer each other's questions and improvement on the organization of the Q&As like direct link etc is needed.

Table 3. The reply rates of the two groups of questions(p-value = 2.5473e-08)

	Position specific	Position Irrelevant
Reply Rate	0.042	0.053

From another perspective, mean views of the questions could be a useful signal to describe the archival value of the questions. More views of the question mean that it gives future learners more value as a knowledge source. Position specific questions may have lower mean views compared with position irrelevant questions when they're organized

separately from their relevant learning artifacts because lack of context prevents future learners going further to look at the questions. This hypothesis is not validated in the collected data. It turns out the two groups of questions basically have the same mean views which are listed in Table 4. A possible explanation would be that users in Cousera don't have access to the previous discussions of the course if they are not enrolled. This mimics offline classroom learning in universities. Most views take place when the course is open and there are no future views from future learners who are not enrolled.

Table 4. The mean views of the two groups of questions (p-value=0.6554)

	Position specific	Position Irrelevant
Mean Views	105.82	112.85

Results For the Field Study
To be added.

DISCUSSION AND FUTURE RESEARCH
As we hypothesized in the introduction of the paper, organizing Q&As together with their relevant learning artifacts could increase the Q&As' archival value and be beneficial to future learners. However, most of the Q&As in online learning platforms are not organized in this way and the position information in the questions is expressed in free text. It would be useful to extract those position information automatically with machine learning techniques and integrate those Q&As with learning artifacts themselves which may help future learners to study them and improve the learning outcomes.

ACKNOWLEDGMENTS

REFERENCES
1. Suthers, Daniel D. "Collaborative representations: Supporting face to face and online knowledge-building discourse." *In System Sciences, 2001. Proceedings of the 34th Annual Hawaii International Conference on*, pp. 10-pp. IEEE, 2001.

2. Vygotsky, Lev S. Mind in society: The development of higher psychological processes. Harvard university press, 1980.

3. Takeda, Toshiyuki, and Daniel Suthers. "Online workspaces for annotation and discussion of documents." *In Computers in Education, International Conference on*, pp. 1294-1294. IEEE Computer Society, 2002.

4. Lauer, Tobias, Stephan Trahasch, and Bernd Zupancic. "Anchored discussions of multimedia lecture recordings." *In Frontiers in Education, 2005. FIE'05. Proceedings 35th Annual Conference*, pp. T2H-12. IEEE, 2005.

5. Suthers, Daniel, Ravikiran Vatrapu, Samuel Joseph, Nathan Dwyer, and Richard Medina. "Representational effects in asynchronous collaboration: A research paradigm and initial analysis." In System Sciences, 2006. *HICSS'06. Proceedings of the 39th Annual Hawaii International Conference* on, vol. 1, pp. 3b-3b. IEEE, 2006.

6. Van der Pol, J., Wilfried Admiraal, and P. Robert-Jan Simons. "The affordance of anchored discussion for the collaborative processing of academic texts."*International Journal of Computer-Supported Collaborative Learning* 1, no. 3 (2006): 339-357.

7. Lauer, Tobias, and Stephan Trahasch. "Scripted anchored discussion of multimedia lecture recordings." *In Scripting computer-supported collaborative learning,* pp. 137-153. Springer US, 2007.

8. Eryilmaz, Evren, Jakko van der Pol, Terry Ryan, Philip Martin Clark, and Justin Mary. "Enhancing student knowledge acquisition from online learning conversations." *International Journal of Computer-Supported Collaborative Learning* 8, no. 1 (2013): 113-144.

9. Ackerman, Mark S., and Thomas W. Malone. Answer Garden: A tool for growing organizational memory. Vol. 11, no. 2-3. ACM, 1990.