# AC 2012-4769: APPLICATIONS FOR SUPPORTING COLLABORATION IN THE CLASSROOM

**Dr. Edward F. Gehringer, North Carolina State University**

Ed Gehringer is an Associate Professor in the departments of Computer Science and Electrical & Computer Engineering at North Carolina State University. He received his Ph.D. from Purdue University and has also taught at Carnegie Mellon University and Monash University in Australia. His research interests lie mainly in computer-supported cooperative learning.

# Applications for Supporting Collaboration in the Classroom


## Abstract

*In recent years, many applications have become available for supporting collaboration between students in a course. This presentation offers an overview of several of them, so that new engineering educators can judge which they might be interested in adopting. All of the tools discussed are free for instructors and their students, at least at the entry level. We first discuss applications (**Twitter** and **Live Question**) for sharing questions and answers among students and between instructor and students during a class. For out-of-class questions, the social-networking application **Piazza** is powerful and easy to use. **PollEverywhere** and **ChimeIn** are two applications that let the instructor send questions to the students and automatically record and check their answers. **Google forms** provide some of the same functionality for free and without the need to install software on a server. Google forms can also be used to survey students. **SALG** is a specialized survey program to assess how much students have learned. For taking graphical feedback from students on tablet computers during class, **Classroom Presenter** and **Ubiquitous Presenter** are two open-source tools. The most widely used peer-review application is **Calibrated Peer Review**. **Expertiza** is a peer-review system that incorporates functionality for topic selection and team formation by students. Wikis are a well known collaborative space, which can be used by students to write reports and other documents cooperatively. Google docs serve much the same function, allowing more flexibility but less uniformity in formatting. More powerful features are available through **Google sites**, which allow the instructor to set up templates to track student progress, including the time that they have spent on the project. **CATME/Team Maker** is a tool for creating teams based on student schedules or other criteria, and collecting feedback from team members on the contributions of their partners.*


## 1. Introduction

Over the last 20 years, there has been a movement to adopt collaborative learning in engineering classes, based upon the results of studies that show it is decidedly more effective in promoting student learning. This trend has been coincident with the rise of the World-Wide Web, and the increasing computerization of our classrooms. Today's new engineering faculty can expect to teach in classrooms that have data projectors and wireless access. This has allowed students to communicate with the instructor and with each other in ways that would've been impossible in earlier years.

All of the applications covered in this paper are free to use, though a very few of them charge for large classes or extra functionality. Most of them are intended for use in the classroom. However, some of them are useful for homework done collaboratively. Explicitly excluded are learning management systems (LMSs), formerly called course management systems. These are systems such as Blackboard, Moodle, Desire2Learn, Sakai, etc., that provide a suite of tools for managing a class. The individual instructor rarely has a choice of which LMS to use, and comparing their features would require a much deeper analysis than is possible in a paper of this size. However, any of these applications can be

used with an LMS; one simply needs to link from the LMS class to the external application.

## 2. Backchannel applications

In a large class, students have less opportunity to ask questions—both because more students compete for a limited amount of time devoted to questions, and because they are often reluctant to speak up to a large audience. It's possible to use Twitter to encourage interaction in the classroom. Students can tweet answers to questions, or even comments during a lecture. Other students can answer them, and the instructor can monitor the Twitter channel to get a pulse for the class.

While some instructors have used Twitter effectively in a classroom, it can be a distraction. If used for instructor-student interaction, it requires the instructor to "multitask," watching the Twitter feed while speaking. Even if the instructor pauses, for example, while students

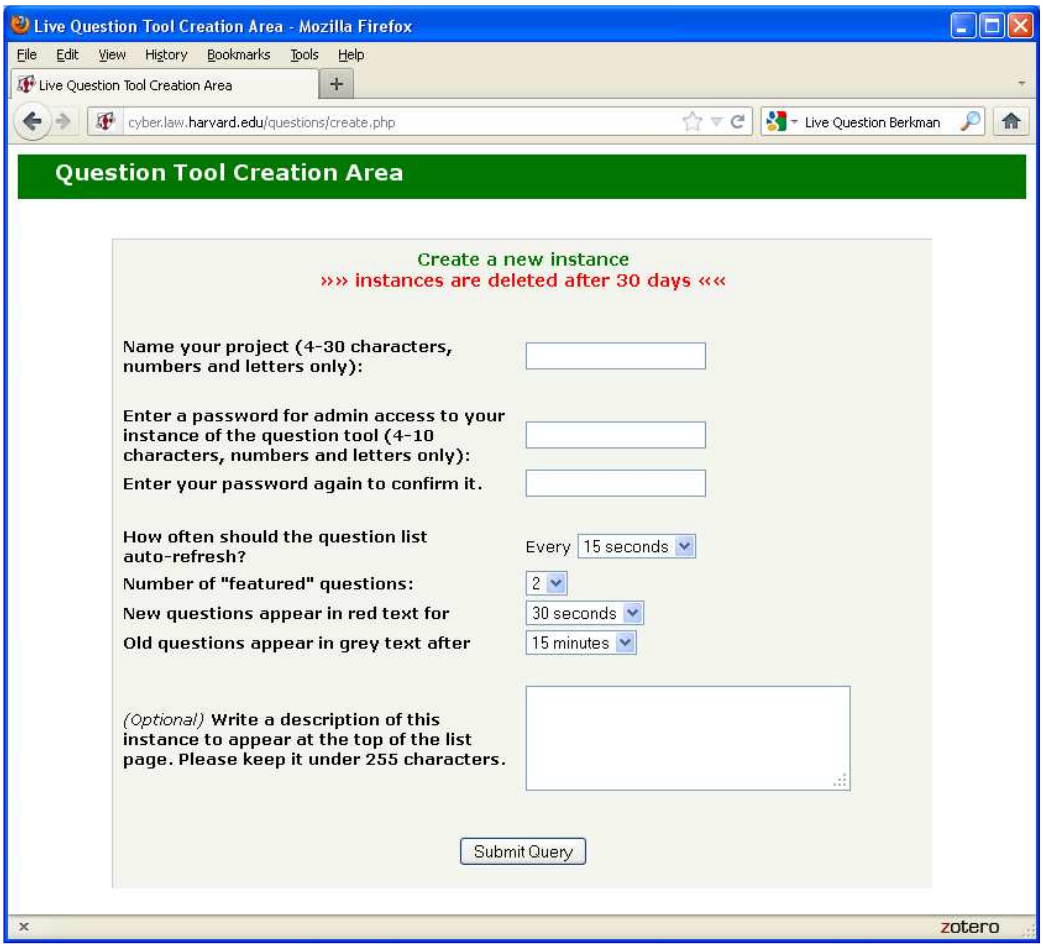


**Figure 1.** Creating a course using the Live Question tool

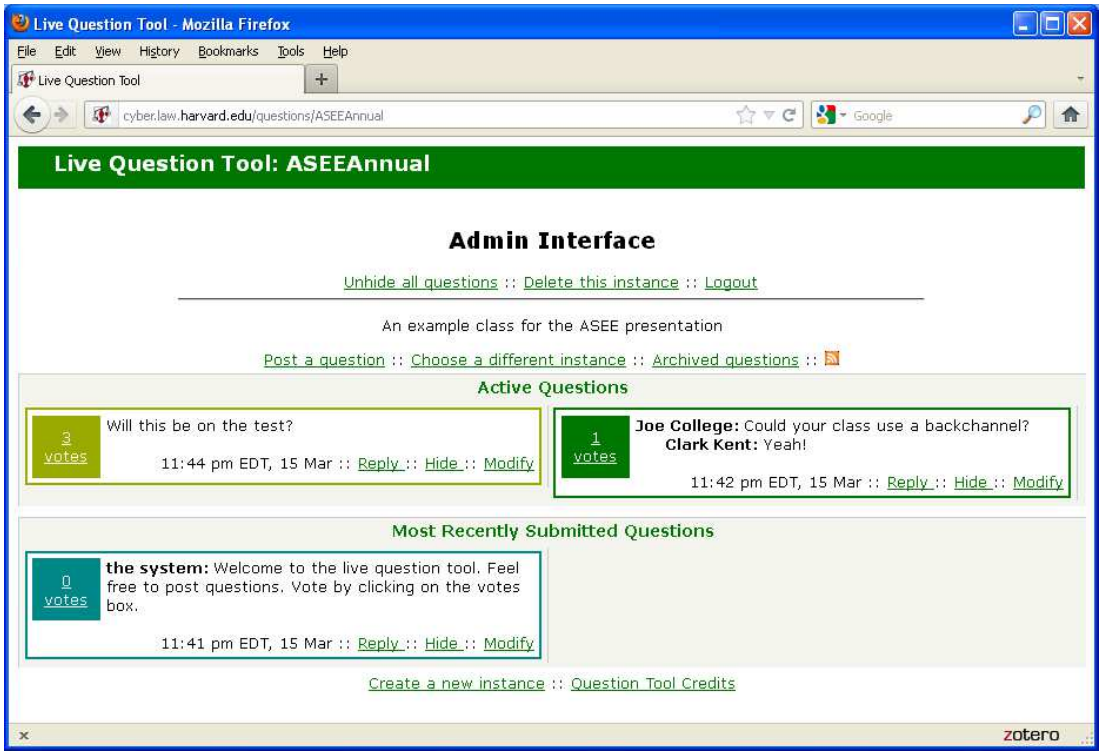


**Figure 2.** Live Question in operation

do an in-class exercise, it's quite difficult to determine what has been happening, as the instructor must scroll back through the Twitter channel and read it sequentially.

Live Question (Figures 1 and 2) is an application that allows students to post short comments, as they would with Twitter. It also allows other class members to vote on those questions, with the most frequently voted-for questions rising to the top. This makes it easy for the instructor to get the pulse of the class at a glance. Right underneath the most popular questions are shown the most recent questions. It's easy to create an instance of Live Question for a class (see Figure 1). However, there are some limitations:

1. A Live Question class lasts only 30 days, so multiple classes must be created to span a semester. Questions posted early in the semester are not even visible when the semester ends.

2. When used over multiple class days, the most popular comments from the previous day remain at the top of the display unless manually deleted. This means that maintenance is needed after each class session.

3. Even though one can tell at a glance which questions are most popular, it is awkward to keep switching back and forth between the Live Question screen and the rest of the class presentation. This means that for effective use, the instructor should have two screens to look at—e.g., a laptop in addition to the classroom computer.

One of our respondents recommended CoverItLive as a backchannel application for class. Unlike Live Question, it shows posts in strictly chronological order. But students can post pictures, Web pages, or videos during class. The instructor may open polls, and have any number of polls active at a time. A dashboard displays results of active polls on a rotating basis. It is easy to create impromptu polls on the spot. CoverItLive is a commercial application, but it is free for up to 25 users.

## 2. Social-networking applications for posing questions

Twitter and Live Question can be considered to be social-networking applications, because their purpose is to take posted comments and "push" them out to a wider audience. This functionality is also useful outside of class. Students should be able to answer each other's questions on what is required in a homework assignment, for example. In many LMSs, message boards provide this kind of functionality. However, the Piazza application takes it to a new level.

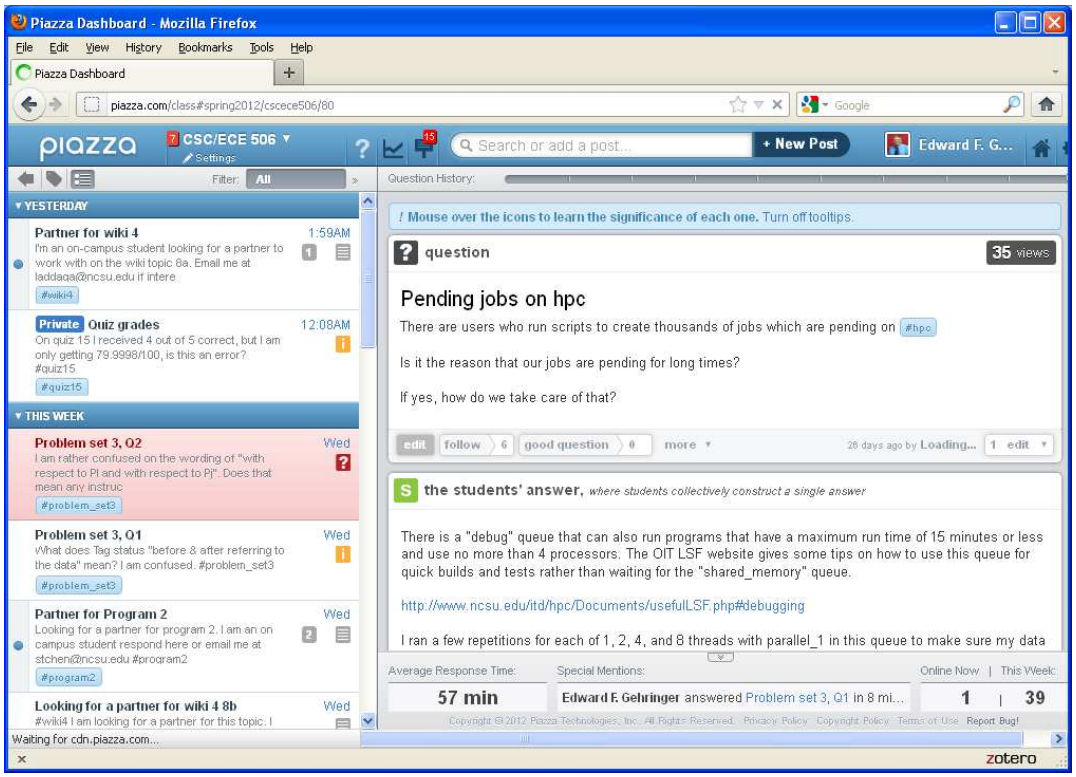


**Figure 3.** Piazza, showing how students can answer students' questions

1. Students can pose questions (i) anonymously if they wish, or (ii) semi-anonymously, so their identity is only visible to the instructor, not to their classmates. This allows students to ask questions without fear of them being seen as "stupid." Students may also (iii) choose to reveal their identity when they post.

2. A student can answer another student's question, and if the answer is right, the instructor can endorse the answer. Or, if the answer is not quite correct or complete, the instructor can edit the student's answer before saving it for the rest of the class to see.

3. Questions can be tagged by topic, assignment, etc., and searches can be performed based on these tags.

4. Equations can be inserted in questions or answers using TeX source code.

5. One question thread can be linked to another thread, using @ + the thread number, e.g., @101. This means that instead of answering a question for the second time, an instructor can simply link to the previous answer.

6. The system keeps a running average of the response times to questions, which serves as a metric for the effectiveness of the staff and students in responding to student questions. Average response times of 20−30 minutes are common.

In our instructor survey, Piazza was cited most frequently for adding value to a class.

### 3. Classroom response applications

The applications mentioned so far deal mainly with handling student-to-instructor questions or comments. The flip side of the coin are applications that allow the instructor to ask questions of students during class, i.e., classroom response applications, which emulate classroom response devices ("clickers"). Clickers, of course, are not free because they are specialized hardware. But several applications can be used to accomplish the same purpose using hardware that students already own.

PollEverywhere is an application that allows the presenter's questions to be responded to by SMS text messaging, Twitter, or via a Web browser. It is free for classes of up to 40 students, unless the instructor wants to identify the results by person. So, one could take polls for free, but not give credit for answers except with a paid account.

Similar to PollEverywhere is ChimeIn from the University of Minnesota. It

1. grants access (only) to students who are registered for the course;

2. allows the instructor pose questions that are answered anonymously, as well as questions for which students are accountable;

3. allows the instructor to "open" questions to student responses at appropriate times during class;

4. allows students to text answers to a specific phone number (students' identities are recognized via phone numbers that have been registered in the system);

5. determines which student answers are correct, and gives them credit for them;

6. allows students to change their answers, perhaps as a result of discussion with their neighbors, and displaying a tally of students' *current* answers; and

7. updates a graph showing responses in real time as answers come in.

ChimeIn is available for download and installation at other sites. However, some customization will be necessary to get it to work with your campus authentication system. This is a task that is best left to IT staff.

Google forms and spreadsheets provide much of the same functionality [1] for free, and without the need to install software on a server. The instructor poses questions in a Google form and makes the URL available to the students, who can answer it on their laptop or smartphone. Figure 4 shows an example of a Google form that contains several related

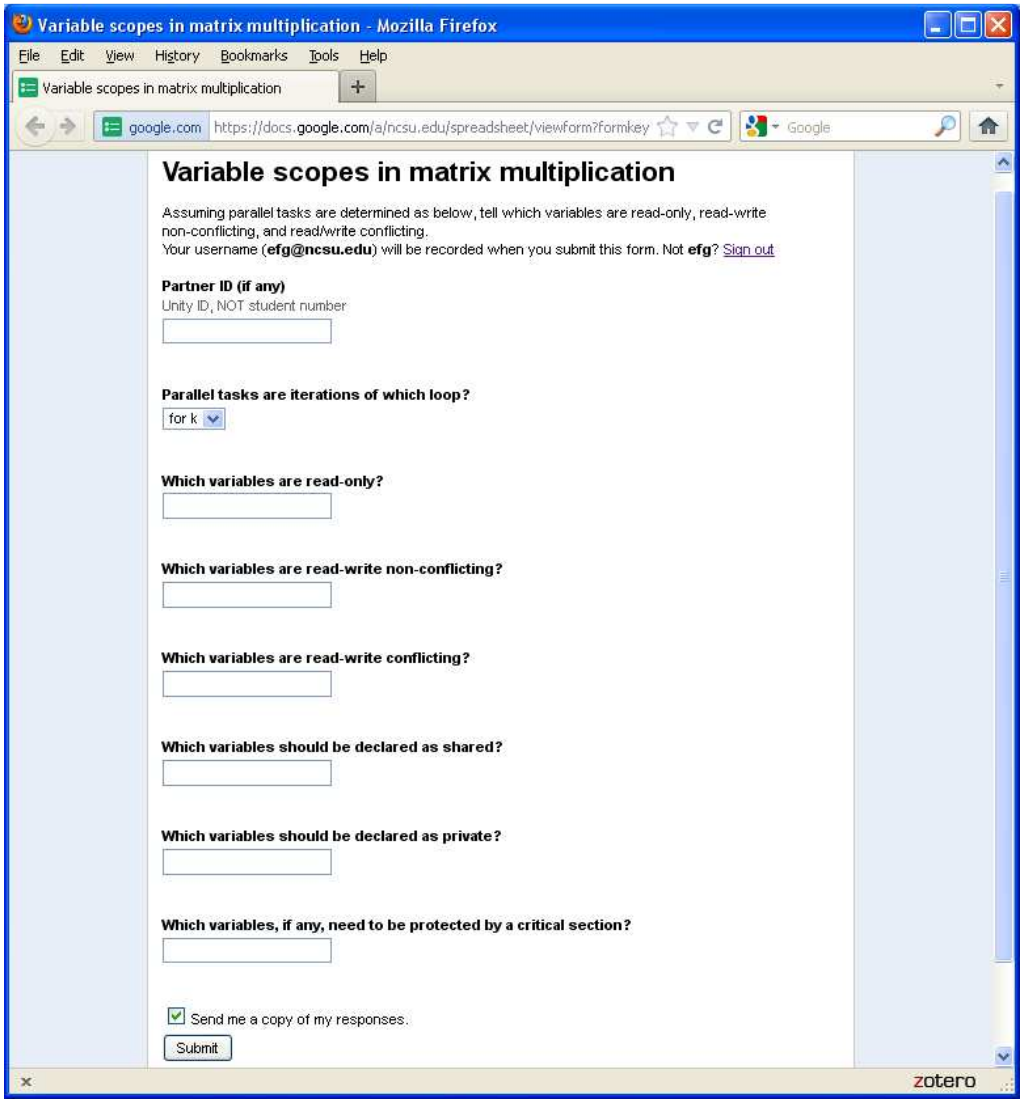


**Figure 4.** Google form used to pose questions during class

questions about a parallel program. Figure 5 shows the resulting spreadsheet, which the instructor can peruse and share with the class. We are currently developing a free application to automatically grade mutliple-choice or fill-in-the-blank responses, display a real-time graph of student answers, and keep track of students' answers on forms submitted throughout a semester.

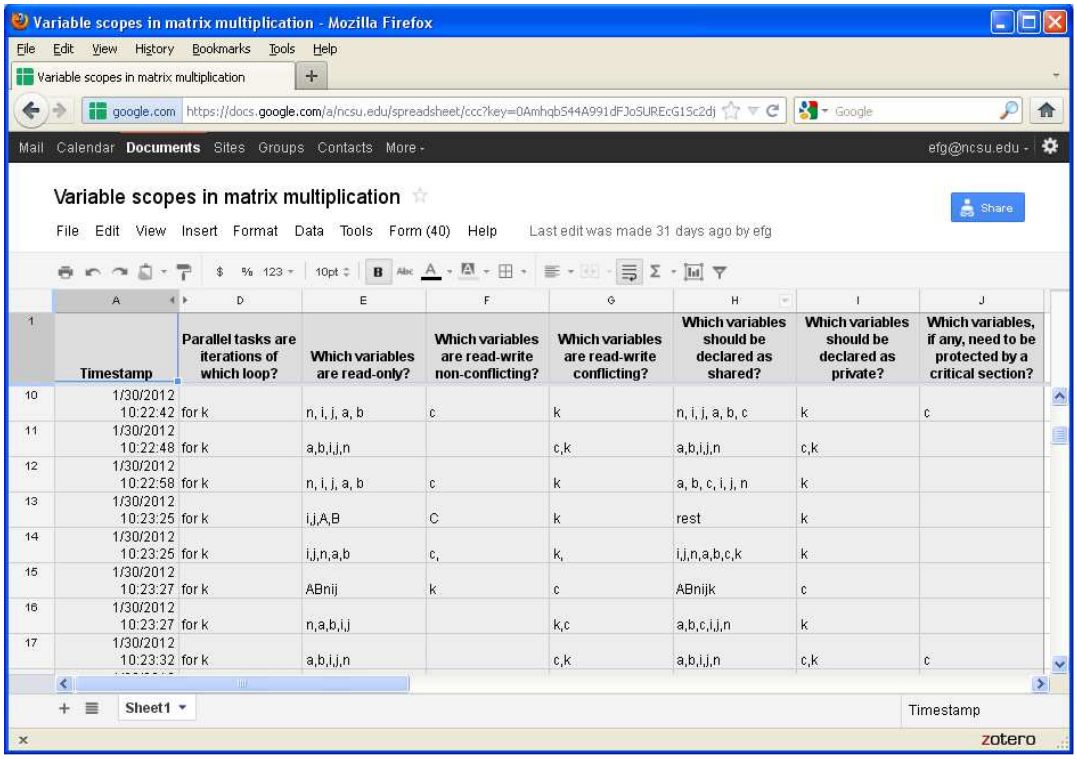


**Figure 5.** Spreadsheet produced by filling out the Google form

Google forms have these limitations, compared to ChimeIn:

1. It is not currently possible to answer questions via SMS texting.

2. If your campus has configured Google Apps for Education, then you can determine the identity of respondents, but otherwise, there is no way to tell automatically who has sent a specific answer. Of course, you can *ask* students to fill in their name on the form, but nothing prevents them from filling in the name of another student.

3. As with ChimeIn and PollEverywhere, you can display graphs for a multiple-choice question that show how many students have chosen each answer. However, unlike these systems, the graphs do not update as students enter or change their answers. You can manually refresh them to show updates, but, instead of changing their previous answers, students may have instead submitted new answers (by filling out another copy of the blank form), and in this case, both new and old answers are counted in the graph.

## 4. Taking surveys

Google forms can also be used to survey students in a class [2]. One can use them to survey students anonymously, but there is no way to stop a student from submitting more than one response. Focused surveys are provided by the NSF-funded SALG (Student Assessment of Their Learning Gains) application. As stated on its Web site, "The SALG instrument focuses exclusively on the degree to which a course has enabled student learning. In particular, the SALG asks students to assess and report on their own learning, and on the degree to which specific aspects of the course have contributed to that learning." It has a wizard that makes it easy for an instructor to set up a new survey, or reuse a survey created by another instructor. The "basic survey" for lecture-based classes is shown in Figure 6.

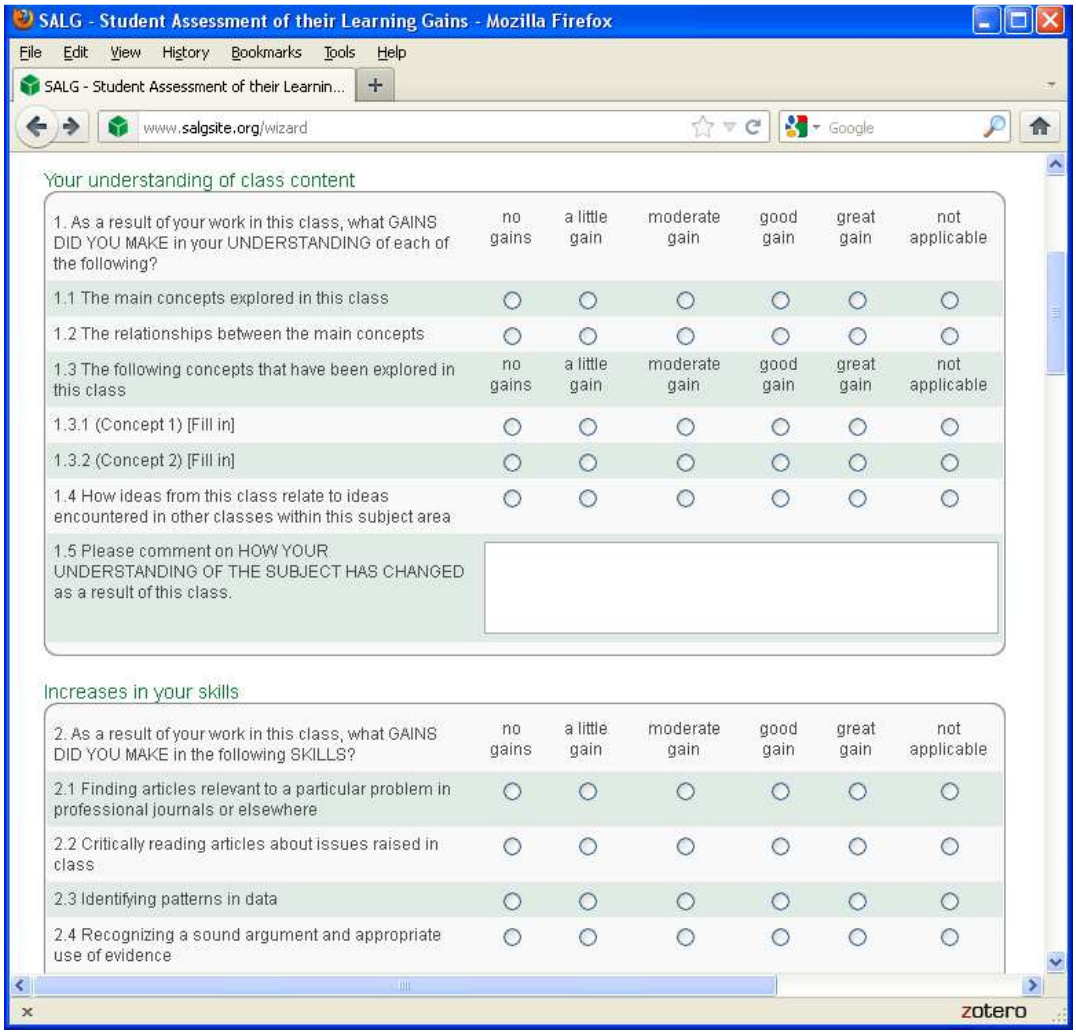


**Figure 6.** A basic SALG survey

## 5. Feedback using tablet computers

If your students have tablet computers, you may want to pose questions that are answered with a diagram, or annotation of a diagram you have given them. Two widely used systems will allow you to do this. DyKnow is a commercial application, while Classroom Presenter, and its derivative, Ubiquitous Presenter, are open-source applications. Classroom Presenter allows students and instructors to send graphical content back and forth to each other. Students can use digital ink to write on slides, for example, and send them back. Ubiquitous Presenter has the same functionality, but is Web based. DyKnow seems to have better ability to manage interaction between students, and between student and instructor [3].

## 6. Peer review

Students learn by assessing other students' work, and they can also learn from other students' assessments of their work. Thus, peer review has been common in classrooms for the last 40 years. In the last 15 years, online applications have been available to present students' work to each other for blind review. The most widely used peer-review application in engineering is Calibrated Peer Review (Figure 7), It boasts thousands of pre-written rubrics and assignments in almost any academic field, which can be adapted to suit the needs of most instructors.

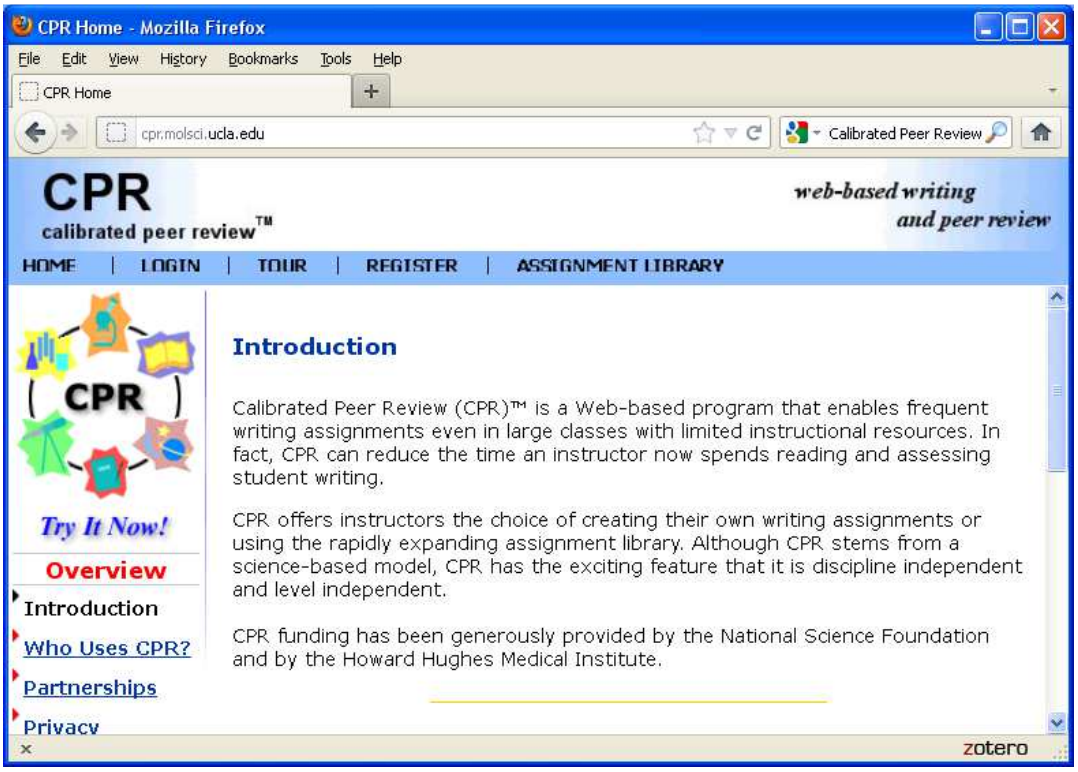


**Figure 7.** Calibrated Peer Review

The author's own Expertiza [4, 5] system allows students to review projects by student *teams*, and also allows students or teams to sign up to work on particular topics. It is suitable when a class is dividing up a large topic (say, writing a "textbook" on all the material covered during a semester), with each team working on a piece of that topic. It also has social-networking features that allow students to suggest resources to teams working on other topics. The students can get credit for making good suggestions.

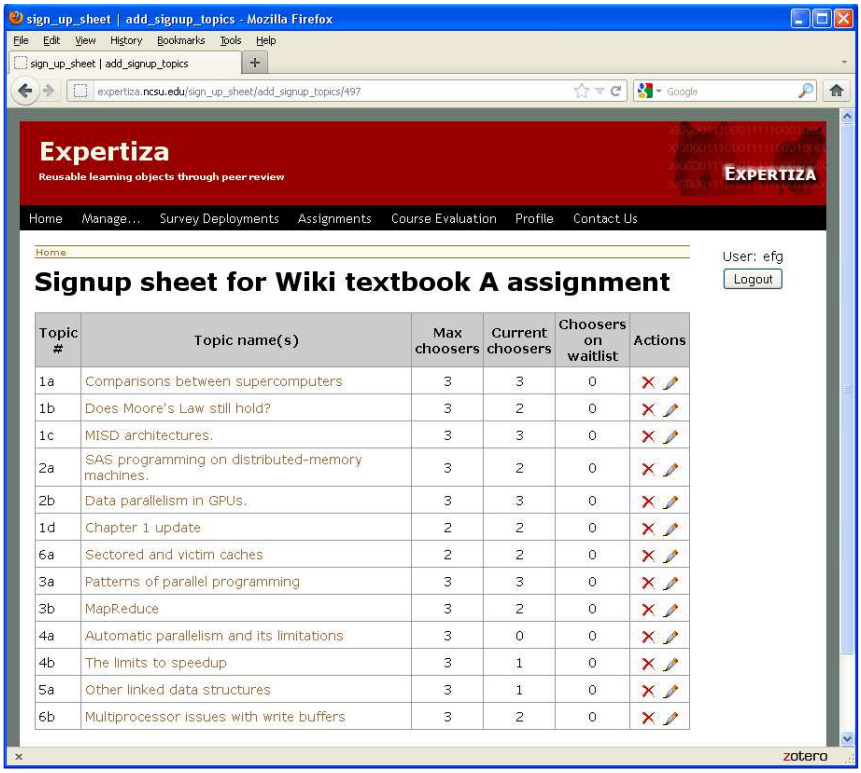


**Figure 8.** A signup sheet in Expertiza

While Calibrated Peer Review has much more complete support for peer review of writing, it doesn't have a way for students to sign up for topics, form teams, or rate other members of their team. Expertiza is the only application that we know of with all of these facilities.

## 7. Collaborative spaces

When multiple students work on a single document, it's useful to use a document that allows "editing in place," so students don't each have to have their own copy, with the danger of copies getting out of date. A wiki can fill that need nicely. So can Google sites, which include revision histories and can be set up to notify the instructor when students edit content. The instructor can see who is working on the project, and what they have

completed. A time tracker shows how much time students have spent on the project.

The fact that wikis, Google docs, and Google sites allow editing in place can be used to good advantage in working remotely. Students in different locations can work on the same document at the same time, talking via Skype or IM. They can immediately see each other's changes. Alternatively, they can use remote desktop software, such as VNC, to work on *any* document (even wordprocessor or code files) at the same time, sharing control of keyboard and mouse. This is great for distance-ed courses, since it allows remote students to work in teams almost as conveniently as on-campus students.

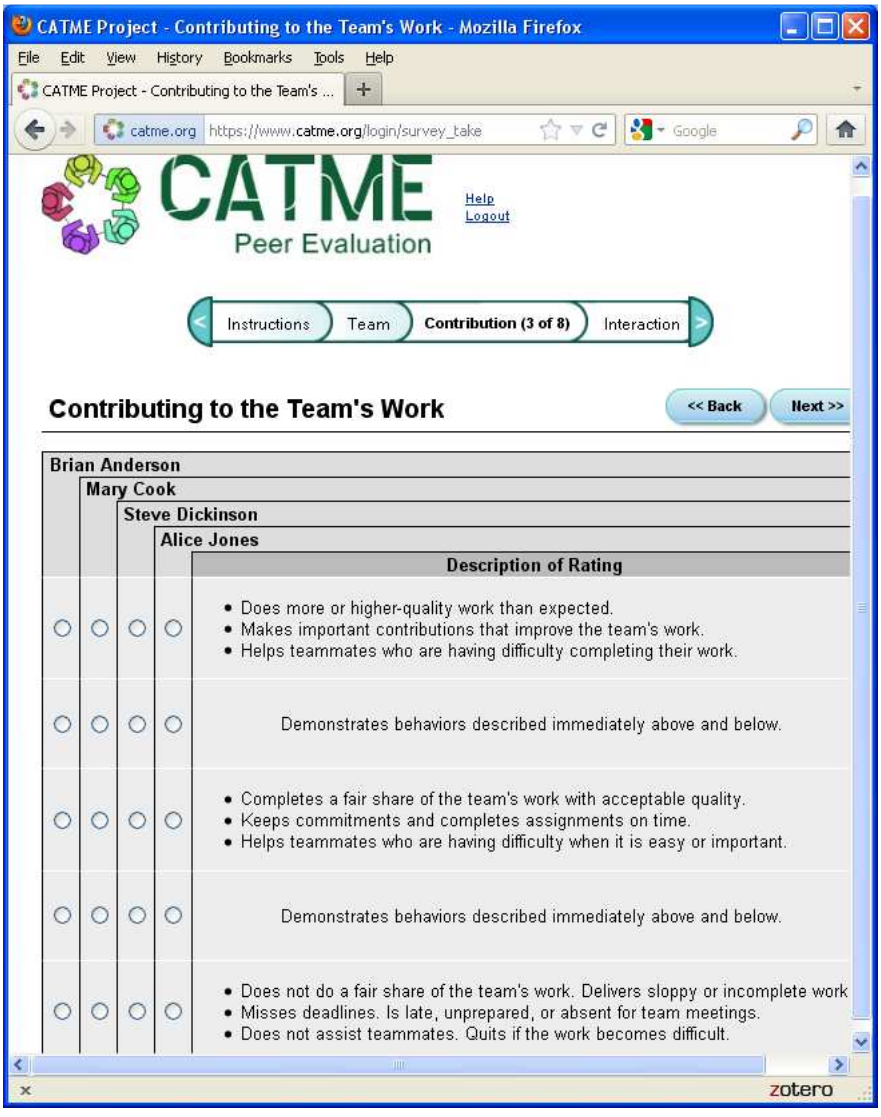


**Figure 9.** A sample CATME question

## 8. Managing teams

Collaborative learning usually means that students work in teams, whether in class or on homework. Sometimes instructors are reluctant to assign team projects, fearing that one team member will do all the work, and the others will share equally in the credit. This concern can be addressed by having team members assess each other's contributions periodically throughout the semester. The NSF-funded CATME application provides a detailed, configurable survey (one screen is shown in Figure 9) that can be administered to a class any number of times.

A related issue is how to form teams so that students can work effectively with each other. This means forming teams whose members have compatible schedules, allowing them to meet several times during the week for an extended period of time. The Team Maker application, a companion program to CATME, provides this functionality. Student submit data on their schedule through a survey, and the system uses it to make up teams. Team Maker can also be set up to take into account other information, such as demographics or GPA, in assigning teams. It can be set to keep the same teams for different assignments, or scramble them.

## 9. Summary

This paper has presented a wide array of tools that you can use in your classroom to get students working together. Table 1 lists them. Some of them (e.g., Live Question, Piazza,

**Table 1.** Comparison of applications mentioned in this paper

| Purpose | Application | Response device | | | Est. time to learn | Lit. cita-tions* |
|---|---|---|---|---|---|---|
| | | Lap-top | Tab-let | SMS | | |
| Backchannel | Twitter | √ | | √ | + | ++ |
| | Live Question | √ | | | + | + |
| | Cover It Live | √ | | | ++ | |
| Msg. board/soc.network | Piazza | √ | | | + | |
| Classroom response | PollEverywhere | √ | | √ | ++ | + |
| | ChimeIn | √ | | √ | ++ | + |
| | Google forms | √ | | | + | + |
| | Classroom Presenter | | √ | | +++ | +++ |
| | DyKnow | | √ | | +++ | +++ |
| Survey | SALG | √ | | | + | +++ |
| | CATME/Team Maker | √ | | | ++ | +++ |
| Peer review | Calibrated Peer Review | √ | | | +++ | +++ |
| | Expertiza | √ | | | +++ | + |

*"Lit citations" is the rough number of articles from Google Scholar that mention this particular tool for classroom use. "+" means a dozen or two, while "+++" means hundreds. In some cases, e.g., Piazza, it is very difficult to tell, because the application name is a term that is widely used in other contexts.

SALG) require almost no preparation. CATME/Team Maker has a fairly short learning curve. The classroom response systems, on the other hand, require considerable time to

install and/or configure. In either case, a little effort on your part can pay off in a better learning environment for your students.

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