Group Projects in Chemical Engineering Using a Wiki

Jeffrey J. Heys
Assistant Professor
Chemical Engineering
Arizona State University
Tempe, AZ 85287-6006
jheys@asu.edu

Abstract
Group projects are common in undergraduate chemical engineering course. Wikis are a new medium for group projects because they are webpages that are edited using the same software used to view the webpage. Advantages include the ability to record changes made by each individual (helpful for grading), ability to continuously monitor progress, and a reduced need for face-to-face meetings for the group members. We also discuss challenges and potential improvements associated with their use.

Introduction

Group projects are frequently assigned in chemical engineering courses to achieve a number of different objectives. First, we want to improve students' understanding of group dynamics so that they can work more effectively in teams [1]. Second, a group of students can frequently achieve a greater depth of understanding on a given topic than a single student working alone. Third, grading a single group project normally requires less time than grading four (or more) individual projects. There are many other advantages to group projects for specific courses, but these three advantages are nearly universal and apply to any course. There are also a number of disadvantages or perceived disadvantages that are often cited by either the students or the instructor. First, it is difficult to determine the workload distribution among the students in the group making it a challenge to give individual grades [2]. Second, some groups unable to schedule enough meetings when every group member can be present. Third, the collecting of the individual pieces of a project into a single coherent document or presentation can be difficult and frustrating for some groups.

Despite the disadvantages, group projects are an important and integral part of the educational experience in the chemical engineering curriculum. However, team projects in an industrial setting are changing because geographically dispersed teams are becoming more common [3, 4]. Often, the team members can be located in two or more different cities or different countries. Of course the team members will meet at important times during the project, but much of the day-to-day work will be completed by communicating over the phone or internet (e.g., email, instant messenger). At Arizona State University (ASU), we recently began using a 'Wiki' for group projects in the Introduction to Chemical Engineering: Mass and Energy Balances course to overcome some of the difficulties associated with traditional (paper) group projects and to give the students experience in working on a group project where the group members are not necessarily located in the same physical location.

The term 'wiki' is a Hawaiian word meaning 'quick', but the term is used here to refer to a specific type of website. The definition in this case, taken from Wikipedia (www.wikipedia.org), is that a wiki is a website that allows visitors to add, remove, and edit content. It is frequently used as a collaborative technology for organizing information on websites. One of the most commonly cited examples is Wikipedia, an online encyclopedia whose entries can (normally) be edited by anyone using a modern browser such as Internet Explorer (from Microsoft), Firefox (from the Mozilla Foundation), or Opera (from Opera Software). Wikis are used for collaborative or group projects for two main reasons: (1) they are *easily* modified (you do *not* need to learn HTML programming) using any modern browser instead of requiring every group member to use the same software (how many group projects have been interrupted by incompatible software versions or operating systems?), and (2) the changes made are immediately available to other group members. A group project completed using a wiki results in a webpage, and, since it is a wiki, that webpage can be edited using the same software that is used to view it.

Depending on the type of wiki used (see the next paragraph), a wiki can overcome many of the difficulties given above that are normally associated with group projects. First, the

computer server that hosts the wiki can store every change to the individual project webpage, and students can be required to log in to make any changes. This means that when grading the wiki, the exact contributions made by each and every student are available to the instructor. This includes every change made and when the change was made. Second, editing the project webpage only requires that a student have internet access so the group does not need to meet face-to-face as frequently to work on the project. Their discussions and editing can happen online instead. Third, instead of having group members produce individual pieces that are glued together the night before the project is due, the group project can ideally be produced over time with each member editing the contributions of others to produce a more coherent final document. A few other advantages include:

- the instructor always has access to the current state of the group project while it is being completed,
- group projects from the past are easily available to later classes for their reference, and
- students can be required to edit and/or view other group projects.

Setting up a Wiki

There are basically three options for setting up a wiki for group projects.

(1) Many colleges and universities have servers and software in place for hosting a wiki. For example, at ASU the webpage wiki.asu.edu allows you to create a wiki for group projects with a simple click of a button on the webpage. You only need to give the wiki a name (e.g., CHE 211 Projects) and the students can then create and edit their own group project webpages on that wiki.

(2) There are a number of companies that host free wiki websites (e.g., www.wikia.com).

(3) Install MediaWiki (www.mediawiki.org), which is the software behind Wikipedia, on your own computer or webserver. We used a basic desktop computer (Dell computer with and Intel Xeon processor) running Linux (Red Hat

Enterprise Linux 4), and the installation of MediaWiki took about 1 hour. In hind sight, we recommend running the Ubuntu or Fedora flavors of Linux because the one small difficulty we encountered was specific to RHEL.

Options 1 and 2 are clearly simpler and avoid the need for a continuously running desktop computer with Linux, but there are also some important advantages to option 3. First, running your own copy of MediaWiki provides outstanding flexibility in terms of what is possible to include on the group project page. For example, we utilized the 'math' add-on extensively because it provides a straightforward method for displaying complex mathematical equations on the project webpage using a syntax that is similar to LaTeX (i.e., this is equivalent to the equation editor in Microsoft Word). Similar add-on's include displaying chemical reactions and including animations or movies. A second advantage to option (3) is that it provides a fine level of control over access to the wiki's webpages. We chose to require a log-in for editing of the webpages, but no log-in was required to view the pages. This means that students can modify the project of any group they want, but those changes are logged under their name and can be "undone" at any time. While the advantages to option (3) listed so far do not require any programming knowledge whatsoever to implement, the final advantage to option (3) is that MediaWiki is largely a collection of PHP files that can be edited to achieve any desired behavior. Just purchase a PHP book at the local bookstore and any missing feature or any desired change can be made by the instructor.

The upper part of the 'Main Page' for the wiki used for the Mass and Energy Balances course is shown in figure 1 (see [5]). At the top of the page is an introduction explaining the goals of the project and a list of important dates for the project during the semester. Also on the Main Page, but not shown in Figure 1, are a list of links to the various group project pages and some instructions on using the wiki. Near the upper right corner in figure 1 is a link to "Log in/create account". The wiki was set up so that users were required to log in to edit any of the webpages, but account creation was disabled. Accounts were created for all registered students in the class using a unique ID, and by clicking on the "Log in" link, students could enter their unique ID and have a randomly

generated password emailed to their registered email address. Also note the "edit" links near the top of the page and along the right edge. Clicking on these links allows the entire page or subsections to be easily edited.

Clicking on an edit link brings up the editing window that is similar to a normal word processing window. We chose to require a log in before the editing of any pages, and the upper right corner of the page indicates which user is logged in. The editing process is similar to using any word processor, and the buttons above the editing window allow for the insertion of objects like mathematical equations, lines, bold face text, and links to other webpages. The 'discussion' tab, shown in Figure 1, is a similar window where group members can discuss their plans with each other and the instructor can leave comments for the group.

Clicking on the 'history' tab in any window brings up a page showing a detailed list of the changes that have been made to the webpage. For example, the history tab for the main page shows that the page has mostly been modified only by the instructor, 'Jheys'. However, it also shows a student changing the name of a project (the only part of the project appearing on the main page), and another student corrected the instructor's spelling and grammar (oops!).

Group Projects Using a Wiki

The group projects from our first semester of using wikis (Fall, 2006), can be found at http://hood.eas.asu.edu/che211/wiki. We chose to give the students the option of using one of the suggested project topics or proposing their own topic, and >90% of the groups chose one of the suggested topics. The topics loosely fall into four different categories.

(1) Advanced topics that are not covered in lecture, but are presented in the textbook (e.g., commercial process simulation packages).
(2) Topics covered in class that students frequently struggle with understanding, and the goal is to provide future classes with an additional reference on this topic (e.g., recycle streams).

(3) Topics covered in other courses that may be useful to the students in Mass and Energy Balances (e.g., numerical integration).
(4) Popular topics related to the course material (e.g., future energy sources).

For category (1) projects, the students typically read the material in the textbook and then obtained some of the books and articles referenced by the textbook [6]. For commercial process simulation packages, company websites also provided important information. Category (2) projects involved the students presenting course material in a new perspective that they found more intuitive, and they often included additional example problems. Some excellent projects resulted from topics in categories (3) and (4), but the students often recycled material from other classes, limiting the amount of new learning. This is not a limitation of using a Wiki, but it is a common difficulty in all types of group projects. Figure 2 shows the very beginning of the numerical integration group project as an example. The entire numerical integration project as well as the other 19 projects competed in the fall of 2006 are available on the website given above.

Based on the results of our first semester of using a wiki for the group project and based on feedback from the students, we offer a couple suggestions for using this format. First, because students are often unfamiliar with wikis, it is important to set early milestones or due dates for parts of the project. For example, we required students to visit the webpage and get their password during the first month of the semester, before they were prepared to choose a topic. We also required each group to create a nearly blank page containing only their names early on so they could get a little experience editing a wiki. To facilitate this project, a sample page was created in class so that students could see the process for themselves, which greatly reduced the level of intimidation. A second suggestion is to provide students with multiple links to documentation for the use of wikis in general and MediaWiki in particular. During the fall of 2007, a group of students at Arizona State University created a wiki entitled “How to Create a Wiki-Project”, and this wiki, as well as many other examples, can be found on the ChE 211 site given above.

Two problems were noted when the group projects were moved to a wiki format. First, the level of plagiarism appeared to increase because students found it incredibly easy to cut and paste from existing webpages. This problem was identified early in the semester, and in-class warnings appeared to reduce the level of abuse. Numerous tools are available (e.g., Ephorus) that can be used to detect plagiarism with little effort. Second, some of the students had extensive experience in using HTML (thanks to myspace.com, etc.) and this knowledge allowed them to introduce specialized features to the webpages beyond what is possible using the normal 'editing' features. This is not a problem except those individuals would dominate the actual editing of the group's webpage reducing the instructor's ability to determine individual contributions. This difficulty was avoided by requiring students entering material for other students to note that they were doing so in the 'discussion' area of each page.

We have found the wiki format to be useful for projects in a Mass and Energy Balances course, but this does not mean that this is a useful format for projects in other courses. For example, the rigorous formatting requirements of a senior laboratory reports, such as flowsheets, equipment diagrams, and numerous chemical and mathematical formulas, would make the use of a wiki difficult. Also, if a project report is more than 10 pages, the wiki format may not be appropriate because it requires that the person preparing the report be actively connected to the internet during the entire time they are writing. In summary, we tend to prefer using wikis in larger, undergraduate courses where they can be an interesting and useful way for groups of students to prepare a report that is equivalent to 5-10 pages.

Level of Participation

One of the advantages to using a wiki is that each contribution by each student is recorded in a database. The individual changes may be as small as correcting a spelling mistake or adding a period, and the changes may be a large as adding numerous paragraphs to the group report. On average, an individual change was equivalent to adding one or two sentences. In the fall of 2006, there were 67 students enrolled in the ChE 211 course at ASU, and they completed 20 group projects. On average, projects

received about 61 edits each, and the average student made about 18 edits or individual changes to his/her group project webpage. However, the standard deviation for the average edits per student was 20, indicating that the students varied greatly in the number of edits made. In fact, a few students only made two or three edits, but a few other students made over 100 edits. Figure 3 is a histogram showing the number of students making edits over different ranges.

This data should not be interpreted as an exact measure of the distribution of work performed by the various group members because an 'edit' could be a large or small change. (N.B. There have been a number of studies that have tried to examine work distribution among members of a groups, and studies on improving group performance [7, 8].) However, there is some correlation between the number of edits and the amount of work done, and we were surprised at the large distribution. Typically, a group of 4 would have 1 or 2 individuals making 20 or 30 edits and 1 or 2 individuals making less than 10 edits. This observation encourages more study on the distribution of work in group projects and ways to measure that distribution. It also motivates us to more closely monitor the work that every individual in the class is doing on the group project throughout the semester so that students can be alerted when they are not doing their share of the work in the group. We also plan to increase the percentage of the final grade that is tied to the individual's contributions to the group project from about 25% to 40-50%. Historically, we have used the smaller percentage because individual contribution was difficult to measure, but, now that the data is available, we plan to increase the percentage.

Conclusions

Using a wiki as a medium for group projects has advantages and disadvantages over the traditional oral and paper mediums. The advantages include:

- the ability to continually monitor and measure the work being done by each group and each individual student,
- straightforward methods for archiving the projects and making them available to future classes, and

- providing the students with experience in working as part of a virtual or web-based team.

Disadvantages include:

- the need to invest time setting up the wiki (especially if the instructor elects to install MediaWiki),
- possibly an increased potential for plagiarism, and
- a few students are intimidated by the software.

Based on our experience, the advantages were greater than the disadvantages, and we plan to continue using the wiki. The only significant change we plan to make is to more closely monitor the contributions of individual students throughout the semester so that we can alert students when they are not contributing sufficiently to the overall group effort.

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Figure Captions

Figure 1. Upper part of the Main page for the ChE 211 – Mass and Energy Balances wiki.

Figure 2. An example of a group project report on Numerical Integration. The figure shows less than 10% of the final project, but it illustrates a typical result.

Figure 3. The number of students (frequency) making different numbers of edits. The average number of edits made was 18.