AC 2009-493: IMPROVING STUDENT LEARNING BY ENCOURAGING REFLECTION THROUGH CLASS WIKIS

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Improving Student Learning by Encouraging Reflection through Class Wikis

Abstract

A cohort of students enrolled in a chemical engineering was required to contribute to a collaborative reflective document with the objective of more rapidly assimilating new knowledge into the problem solving process. Motivated by prior work in the literature describing the use of portfolios and by the successes of collaborative learning, selected elements of each were tied into a simple project requiring minimal student time to collaboratively develop a reflective learning document using a wiki. A wiki is a web-accessible document that can be edited by multiple users. For this project, students in a material and energy balance course were assigned the weekly task of maintaining a wiki page on the current textbook chapter by entering what they perceived as the most important items learned during class. This was similar to other active learning activities suggested in the literature, but in this case the student contributions were collaborative and archival. Students were encouraged to be complete and accurate with the promise that their entries would be available during an exam. Other wiki pages the students developed included a set of suggestions in preparing for the first exam for future students enrolled in the course. Student assessment suggested that the project was accepted as a valuable part of the course, and instructor assessment indicated that students more rapidly assimilated core concepts into their problem solving repertoire as a result of this activity.

Introduction

At the end of a lecture there is a tendency for a student to rapidly move as far away from the classroom and the topics discussed as possible. This apparent instinct to flee and thereby free their mental energies from class work discourages reflection on the lecture subject by the student. This tends to reduce retention and absorption of the concepts presented during the class.

One effective means of encouraging reflection as a mode of learning is portfolio development. A portfolio has been defined as “a purposeful collection of student work that exhibits the student’s efforts, progress, and achievements”[1]. Portfolios foster active learning and give the student the perspective needed to ensure that they are progressively learning over time[2]. One of the primary benefits over standard educational practices is that work is placed into context through a reflective process[3]. The downside of portfolios, whether paper-borne or electronic, is that they take significant student time to prepare and manage. McGourty[4] notes that “full portfolios are very labor intensive and are sometimes abandoned due to the work required in assessment, despite the richness of results.” The time element is one area of research suggested in a recent review of using technology in support of collaborative learning[5].

Portfolios have been used as both a learning tool and an assessment tool for engineering programs[6-10]. Use of portfolios serves to promote engagement with learning objectives and to improve reflection [11]. Portfolios demonstrate that students are indeed learning new things, an important fact not only to the instructor, but to the learner.

In this project, the reflective element of portfolios was extracted and applied in a collaborative, online setting using an electronic wiki. A wiki is essentially a text document that can be edited by multiple users using a web browser interface. Working collaboratively to develop a wiki entry breeds additional benefits. It is a mode of collaborative learning, which builds “a positive interdependence that moves everyone forward”[12]. It builds the foundational step on a multi-loop learning model, where students learn by interactive with peers, followed by interaction with individuals with increasing levels of authority[13]. The use of social software such as wikis has been termed “the architecture of participation”[14].

Wikis have been previously applied as a means of facilitating collaborative learning in chemical engineering courses. Heys used a wiki to aid students in completing a group design project[15]. Hadley used a wiki in a similar way for the capstone design course[16].

Implementation

A wiki was established, tied to campus computer authentication servers, using Microsoft SharePoint Server 2007 running on Windows Server 2008 on a dual-core Intel PC. The structure of the wiki was simple, consisting of an instructional page (edited from the default provided by the SharePoint program), and a single page corresponding to each chapter in “Elementary Principles of Chemical Processes”[17] beginning with Chapter 2. Links were created on each page to simplify navigation between chapter pages.

Students were first assigned a contribution to the wiki with the first homework problem assignment for Chapter 2 of the text. A link to the wiki was provided on the paper assignment, and the course website had links to the locally-hosted (and intranet-only accessible) wiki server. The server was configured to allow modifications made by each editor to be viewable, so the instructor would always know who made what contribution.

The assignment was explained and use of the site was demonstrated in class on Thursday. Students first accessed the site the following Tuesday after a reminder during class on Monday to have done so prior to the next class meeting on Tuesday. The first 10 minutes that students used the site were spent typing messages to each other and then deleting those messages. Following that “getting comfortable” period, students entered questions and statements about what they would like to see on the wiki. This was not the intent of wiki entries, so students were corrected during class that afternoon. Prior to the next class, students answered their own questions on the wiki, satisfying the instructor that students fully understood the assignment.

Beginning with Chapter 3 entries (process variables), the wiki entries began to take the shape of the intended summary of key points from lectures. Students experimented with formatting text (Greek characters, superscripts and subscripts) and collectively developed a useful collection of information, explanation, formula, and physical constants. Students were required to make at least two updates to the wiki, one each (partial) week spent in the chapter.

The last chapter for which contributions were mandatory (and part of the homework grade) was chapter 4, non-reactive material balances. This was the most complete and detailed set of entries. The instructor was also pleased to note that some key points stressed during class were emphatically incorporated into the wiki. A screen capture of part of this page is presented in Figure 1.

For the remainder of the course, a number of techniques to encourage wiki entries were attempted. The first was the "carrot" approach, where students were promised that the wiki pages would be provided during the exam if the pages were worthwhile and contained contributions from the entire class. The chapter 5 and 6 entries (phase equilibrium) were deemed insufficient when the exam was prepared (though students did make improvements prior to the exam date), so this promise was fulfilled for the exam covering chapters 7 and 8 (non-reactive energy balances). When no incentive was offered, only a single entry to the wiki was made (chapter 9, reactive energy balances).

The wiki was also used for one additional purpose. Following the first exam, students were given a memo published by Dr. Richard Felder entitled "Memo to students with disappointing test grades." They were also given an assignment asking them to consider some questions suggested by Felder regarding their study habits, sources of information, and a plan for improvement. Students were then required to contribute to a wiki page with their ideas on what would be both an effective warning to future students and a declaration of what they learn during the first month of the course. A screen capture of this page is given in Figure 2.

Assessment

The project was assessed by instructor observation and student survey. The survey was conducted at the end of the course and consisted of 14 statements for which students were asked to indicate agreement or disagreement on a 5 point Lickert scale (1= strongly disagree, 5= strongly agree). Several additional free- answer questions were also asked. Results of the quantitative portion of the survey are presented in Table 1.

Table 1. Results of Student Survey (n=5). Results given on a Lickert scale with 1 indicating strong disagreement and 5 indicating strong agreement.

	Average	StDev
I made an effort to contribute to the Wiki periodically	3.4	0.89
Using the Wiki was reasonably easy.	4.8	0.45
Off campus access to the Wiki would have increased the frequency of my contributions to the Wiki.	4.4	0.89
Reading the Wiki helped me learn more in this course.	2.8	0.84
Contributing to the Wiki helped narrow my focus.	3.6	0.55
When I made entries in the Wiki I thought more about what I learned during lectures.	3.8	1.10
I would have preferred to create my own private document and submitted it at the end of each chapter.	2.8	1.10
I would have preferred to create my own private document and submitted it at the end of the term.	2.4	1.14
The Wiki project was not worth any of my time.	2.4	0.55
If I had more time during the term, the Wiki might have been more useful reading.	3.8	0.84
If I had more time during the term, the Wiki might have been more useful for reflective writing.	3.8	0.45
Reflecting on lectures is an important part of the learning process.	4.8	0.45
Using the Wiki was much easier after Chapter 3 than before.	2.8	0.84
The Wiki was a distraction from the real business of the course.	2.2	0.45

Some of the results of the survey were surprising to the instructor. Students did not consider the Wiki entries to be a distraction, nor would they have preferred to maintain a private document akin to a traditional portfolio narrative. Instead, students saw value to the Wiki entries, value in reflection, and more value in contributing than in reading.

Students were asked to name the best and worst things about the Wiki project during this class. Students again stated that being forced to "think back" on the lecture was a good thing. The lack of off-campus access was commonly expressed as the biggest problem. Students also expressed an interest in receiving credit contributing to their course grade for Wiki entries, and one suggested that individual students be assigned particular topics to summarize.

The instructor noted that after Chapter 4, some fundamental items of knowledge which students in previous sections had difficulty absorbing despite frequent use of active-learning exercises (in-class group problems, end-of-class reflective exercises, think-pair-share), were readily expressed by students during collaborative problem solutions and examples. As an example, the concept of the number of independent material balances available on a system being equal to the number of components in the system was a challenge to previous students during the first week or two of material balances. During the class meeting immediately following the introduction of that concept (and its subsequent entry in the Wiki), students clearly had a grasp of this basic idea. This was unprecedented in the previous 9 years of teaching this course by the author.

The biggest concern of the author in implementing a portfolio in the material and energy balance course has been that it would take time away from the problem-solving emphasis of the course. In practice, extracting the reflective writing element of the portfolio method of assessment and placing it online seemed to minimize the time footprint while retaining the key benefits for learning.

Assessing improvement in student learning is particularly difficult with small numbers of students. Comparing exam performance by this semester's students with previous terms students show no statistically significant differences. Instructor assessment on learning indicated that once students understood the expectations of the reflective wiki entries they more rapidly demonstrated understanding of the key points made during previous lectures. The students in this small course section rapidly formed the sort of positive interdependence relationship that Johnson[12] describes as a result of collaborative learning. Students that the instructor suspected at the start of the course would be unable to complete the course were successful early in the course and were able to demonstrate learning sufficient to pass the course with a 'C' or better.

Future implementation

The biggest issue cited by the students (aside from time availability) was the on-campus restriction for accessing the Wiki. The structure of the network prevents local servers not part of the official campus administrative infrastructure from being available from outside the local network. Consequently, students could not make entries from home or work, which was a significant problem for non-traditional students in the class.

The importance of students having continuous access to the Wiki requires that the service be moved off-campus. Fortunately, there are numerous options to accomplish this; including commercial websites (i.e. www.wikispaces.com) and open source software that can be hosted on externally accessible University servers (see "Free wiki software" on Wikipedia.org).

Contribution to the Wiki will now be more explicitly tied to the student's grade, comprising 5% of the total grade. Criteria for this graded component will be expressed on a rubric including elements such as consistent participation, quality of entries, relevance of entries, and accuracy of entries. Minimum frequency of contribution will be weekly, but a contribution after each lecture will be required for full credit (with some exceptions depending on the class content).

Conclusions

Students were required to contribute to a collaboratively-edited reflective learning portfolio narrative using an online Wiki. Multiple methods of motivating students to participate were attempted, with the most effective method being offering some form of course credit for participation. Students appeared to learn fundamental concepts more quickly after contributing to the Wiki compared to previous terms where reflective writing was not extensively used. Students were convinced of the value of the project, suggested that accessibility should be improved and that a more significant portion of the course grade depend on contributions to the Wiki.

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Chapter 4

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Material Balances and the Meaning of Life

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Today we learned about the different types of processes (Continuous, Batch, and Semi-Batch). When doing a material balance it is important to know what type of process you are dealing with. If the process is steady state there is no accumulation. If there is no reaction taking place, then there is no generation or consumption. When approaching a material balance problem it is best not to worry about memorizing specific cases. Rather we should apply reasoning to the general equation. We should ask ourselves whether there is a reaction, accumulation, whether the process is differential or integral, and if there is an input/output.

Knowing the different kinds of processes (Batch, Continuous, and Semibatch) is important because material balance equations are directly related to the type of process they represent.

A Batch Process involves material being put into the system at the beginning and removed at the end- Think of a large vat being filled with chemicals prior to the reaction process, and the products being removed after the reaction is over.

A Continuous Process involves material continually flowing in and out of the system- Think of a liquid flowing into a tank and fluid flowing out at the same time.

A Semibatch Process- "Anything Else"- An example would be material flowing into a tank, but not flowing out; or, material flowing out, but not in.

input+generation-output-consumption=accumulation

Differential balances, or balances that indicate what is happening in a system at an instant in time. Each term of the balance is a rate and has units divided by a time unit. This is usually applied to a **continuous process.**

Integral balances, or balances that indicate what happens between two instants of time. Each term of the equation is an amount of the balanced quantity. Usually applied to a **batch process.**

An important question to ask yourself when you begin a material balance equation is: "when does mass cross the system boundaries?" this can help narrow the type of system to whether it is a **batch process**, **continuous process**, or **semi-batch process**.

Remembering then initial equation, (stated above) is vital when simplifying, but simplified forms are not important, because they can be easily worked through. Just remembering that for balanced species there is no **generation of consumption** if there is no reaction, for a total mass balance again there is no **generation or consumption**, and for steady state there is no **accumulation.**

The most important topics to remember from this chapter are the definitions of steady-state, unsteady-state, continuous, batch, and semi-batch processes as well as the general material balance equation and what terms can be eliminated corresponding to the above mentioned processes.

Remembering to work the Degree-of-Freedom analysis before beginning to solve for any equations is crucial. Having a positive Degree-of-Freedom most likely means somewhere a basis can be added to help simplify the equations. Also remember the equation to find the Degree-of-Freedom: **n**df=**n**unknowns-**n**independent equations. If **n**df=0, then you are good to go, if not, check your basis. But, if you have a negative value, you most likely have equations that lead to the same conclusion and can be disregarded.

The definition of scaling is important to material balances as it allows quantities to be "scaled" up or down according to what is required by the problem. Flow amounts, quantities, and rates can be scaled; however, mass quantities can not be scaled to molar quantities and vice versa.

Also important to remember is that the amount of independent balances for a system always equals the number of different chemical species in

Figure 1. The first part of the Chapter 4 (material balances) wiki composed by students.

Exam 1 Reflection

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If I had only known... a warning to those taking CME200 in the future

A word to the incoming sophomores... While lectures, the textbook, and homework all play a key role in understanding the concepts and material of this course, it is completely and utterly imparative that you do **ALL** the homework, and while it is ok to work with others (sometimes even suggested), it is also very important to completely understand the material yourself. Because come test time, you wont have others to rely on. Some very important things to remember, (while some might be trivial, are sometimes hard to remember on a test):

1. Remember simple things like conversion factors (including temperatures)
2. Be comfortable to work with strictly units, so that you can find if things are dimensionally consistent.
3. Linear regression.
4. Oh, and homework problems and examples.

Also a very important step in preparing for this course (and one that i have been lacking in...) is reading all the materials assigned so that you can not only be ready when the lecture comes, but also you can have a better understanding and get a heads up when new material is introduced.

As a word of wisdom to all incoming sophomores: thou shalt know all the material covered in class, in homework, on quizes, on the review sheet, and pretty well anywhere else. Although this may sound impossible at first, it is possible if you take the proper amount of time to absorb all the information. This is, to me, the most important thing that you can do to succeed in CME 200. Taking the "proper amount of time" involves more than just sitting at home reading. It includes doing the homework yourself as well as learning new methods from others, asking questions in class, and actually looking over test review sheets.

This course covers a range of topics in the first month ranging from significant figures and curve fitting to unit conversion, temperature conversions, and pressure measurements. It should basically be a review from freshman year classes; however, it is very important that you understand chapters 2 and 3 before you go on, because the basic concepts will continue to be used.

For those students who have made it this far, you might think you are rather smart. Perhaps you even feel that you are outrageously intelligent. Maybe you don't even need to work all that hard in your classes. Sure, in the past you could sit back and daydream through class and wait until the night before the exam to even open the book and still make a good grade. You're clever. You're great. Oh, yes, we are all quite impressed. But now you are in Process. And you are about to discover that innate intelligence and stupendous cramming ability do have their limits. Unless you just finished up four years in medical school or have been behind enemy lines, single-handedly fighting for freedom 24 hours a day hiding behind boulders and sleeping on top of fire ant hills, then you likely have never had to work as hard as you will in this class.

Oh, but you still think you are pretty smart. And you are probably dismissing my warning (and the warnings of my colleagues) as a matter of natural reaction to such things. That's fine. Dismiss away. But don't come searching for us in the computer lab, wailing and pulling out random patches of your hair in frustration and agony. (There's enough noise and commotion and idiocy in that room as it is with all the MEs milling about)

Something else to consider that those before me have not mentioned: Think about the style of learning that fits you best. Are you an active learner who must "do" something in order to learn it? Or are you the type who just needs to watch someone else do it? Maybe you learn by reading about how to do something vague and mindnumbing (like anything to do with Calculus or curves or regression or natural logs) just once...in which case, I despise you. However your oh-so-impressive mind might work, figure it out and then approach the course in that manner. If you need to do something, WORK PROBLEMS. If you learn verbally, ask questions, go see the professor, force yourself to pay strict attention in class.

So, while you are still feeling rather smug and confident, take a moment to look back at a time in your own past when you might have thought "gee, if only I could go back and do _____ knowing what I know now, I would have done so much better!" It could be school-related or it may have been a time from just your regular life. We've all had those moments where we wish for a time machine or a cell phone that reaches into the past, or even that if you close your eyes and concentrate hard enough you can slip back through the mists of time. Well, in a way, WE are YOU a year from now. We are you looking back and trying to break through the barrier of time to offer guidance and advice. To borrow from a famous quote on an old painting I learned about in Art History the first time I went to college -- "What you are, I once was; what I am, you will become" -- (okay, I looked it up and it was a Masaccio work from the Early Renaissance called The Holy Trinity).

And I was only kidding about us not helping you in the times of crisis that will surely avalanche upon you. But you better bring us pizza.

Figure 2. Wiki entry composed by students reflecting on their first exam.