Wiki Technology as a Design Tool for a Capstone Design Course

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Abstract

Technology is a key component to the net generations social interaction, study skills, and professional practice. It is prudent to investigate the potential benefits of new technology in education. In this study, we incorporated a wiki into a senior design course, and investigated its benefits and downfalls with respect to implementing and learning design. We found it improved organization and interaction amongst the students and between the students and the professor and teaching assistant. We also discovered the potential wikis can contribute towards pedagogical research. For example, a wiki can provide insight into the thought process of a student with respect to how they approach design.

Introduction

Web 2.0 technologies, like wikis and blogs, are becoming an integral part of the net generation's social and academic life[1]. Educators and students, alike, benefit from incorporating these technologies into the classroom[2]. With wiki technology, student interaction, idea collaboration, and organization of information can be improved upon compared to traditional ways of teaching[3].

A wiki is a website where users edit and add content as needed. Different users can add content, and review material added from other users. A wiki provides potential for collaboration within groups.

According to a survey conducted by the Educause Center for Applied Research (ECAR), the use of information technology and web 2.0 technologies is astonishing[1]. Out of the 20,000+ students surveyed, engineers spent more time online (an average of 21.9 hrs/week) than any other discipline. Specifically pertaining to wiki usage, 41.7% of all of those surveyed access or use wikis on a weekly basis. According to the conductors of the study, this number may be understated because the students may not know what a wiki is or realize their internet searches direct them to a wiki site. Another note is the survey does not distinguish between access and contribution. Another part of the survey reported 32.6% of the students liked learning through contribution to wikis and blogs. Again, this number may be skewed due to the ignorance of what constitutes a wiki.

Even though technologies like these are invading all facets of the net generation's life, doesn't mean educators should rush to implement them all into every facet of a class's curriculum. It is up to the teacher to decide the most appropriate use of this technology. The main point to keep in mind when deciding to include new technology (or a new approach in general) is what will benefit the students. According to Oblinger and Oblinger, even though the net generation values what older generations consider new technology, wikis and podcasts, what they value most is interaction[4]. Professors can't replace interaction with technology, but must

augment and enhance interaction with technology. Interaction and learning are the keys when bringing something new into your classroom.

Of course, it is hard to know whether or not something new will enhance interaction or learning, which is why we conducted this study. We wanted to understand how to introduce wikis to students and what their value was as a design tool. In this article, we present a description of wikis, the details of our study, what we learned from the study, and suggestions for further wiki use in the engineering classroom.

Wikis and their Features

Wiki is a Hawaiian word for quick, but in the context of this study it is a type of website any user can view and edit like any word processor without the knowledge of html or similar programming languages. A nice illustration of wikis and their possibilities can be found online: http://www.youtube.com/watch?v=-dnL00TdmLY[5]. There are many wiki hosts on the web, but we chose to use www.pbwiki.com, because it was very user-friendly and it was free.

Wikis have a number of features appealing to engineering and engineering education. First, there is a complete revision history for each page in the wiki. From the student's perspective, they can go back to any version and not only see what has been changed, but they have access to the version in order to make it the current version if mistakes were made. From an educator's perspective, a professor can track the progression of the project through the student's eyes. Also, the teacher can observe specific changes between versions.

Every saved change to a page can be tracked to a specific user and that change is time-stamped. This means a professor can really enforce accountability with respect to each team member. If Jean and Tom say Billy isn't working, the professor can go to the wiki and confirm Billy made four minor additions to the wiki. In addition, a professor has verification if a group is being lazy or if they are procrastinating.

A final feature is the ability to add comments. If a professor doesn't feel comfortable editing a student's work, they can leave a comment on a page of interest. Instead of a meeting at key points in the semester, a professor can go to the wiki and look at how things are going. If something of concern exists or if the students have questions or concerns, the professor can address those concerns or notify the group of his/her concerns. The ability to do this ties directly into the goal of integrating technology into the classroom, while promoting interaction between students and the faculty.

Senior Design Project and Wiki Study Details

The participants of our study were the seniors enrolled in our Chemical Engineering Process Design course at Vanderbilt University. Their final project was the 2008 AIChE National Student Design Competition project. In short, the project was to design a process to convert coal into methanol and perform a complete economic analysis.

Ten groups of three students were given 30 days to complete their design and present their results to the rest of the class. At the start of the project, the students were introduced to the use and potential of wikis, and were encouraged (although not required) to add content to the

wiki as part of the project. Each week, weekly reports were received, some from the wiki, and the group's progress was discussed in a weekly meeting. In addition, throughout the project, the authors of this article would monitor the wiki of each group and add comments/questions/concerns when necessary and reply to comments/questions/concerns expressed by the group within their wiki.

At the end of the project, 25 out of the 30 students were given a survey asking about their experience with the wiki, their opinions of the wiki's use, and their suggestions for further use. Within the survey, there were three sections: positive and negative statements requiring a numerical allocation from the student on a 6-point Likert scale, a list asking which project items were included in the wiki, and open-ended questions about the good and bad points of the wiki and its implementation.

Survey Results

In the first section of the survey, there were twelve statements, and the students were asked to circle a number between 1 and 6 to describe how much they agreed with the statement where a choice of 1 indicated strong disagreement and a choice of 6 indicated strong agreement. To prevent a neutral response, an even number was chosen for the maximum. Also, a mix of positive and negative responses was included to ensure valid results from those surveyed.

The scores were analyzed and (for the most part) students liked the use of wikis in the design course. One group didn't add any content to their wiki in any form, and their responses were negative with respect to the wiki. Their open-ended comments were helpful, but their responses were excluded from the numerical analysis of the survey. We decided the absence of their participation didn't qualify them for a valid opinion about the implementation and general opinion of the wiki.

The first step in evaluating wiki use in a design course was taking the average score for each statement. If the score was greater than 4.0 or less than 3.0, we considered that score to have a significant positive or negative agreement. The statements with values between 3 and 4 were regarded as a neutral response. Table 1 lists the average score for each statement and you can see, the students agreed with six statements:

- (I.) They will tell others about wiki technology for collaboration
- (II.) They would like to use a wiki in their future career
- (III.) They recommended use of the wiki for other senior design courses
- (V.) They used the wiki only because it was required
- (VI.) The wiki helped organize their work and findings
- (XII.) There was more interaction from the professor and the TA in this project than others in the past.

In addition, the students disagreed with three out of the twelve statements:

- (IV.) Adding to the wiki took more time than it saved
- (IX.) The wiki overcomplicated the project
- (XI.) The wiki was confusing, and it made the project more difficult.

There was not a definitive agreement as to whether the wiki was a key component to finishing the project (VIII.), if the wiki helped them finish the project more efficiently (VII.), or if the student had better understanding of their team member's progress because of the contributions to the wiki (X.).

Table 1. Average Score for Survey Statements

I.	I will tell others about wiki technology for collaboration	4.18
II.	I would like to use a wiki in my future career	4.02
III.	I believe the wiki should be implemented in next year's senior design course	4.52
IV.	Adding to the wiki took more time than it saved	2.91
V.	If it wasn't required, I wouldn't have used the wiki	4.32
VI.	The wiki helped organize our work and our findings	4.00
VII.	This design project was finished more efficiently than other school projects	3.59
VIII.	The wiki was a key component to finishing this project quickly and thoroughly	3.18
IX.	The wiki overcomplicated the project	2.80
X.	I had a better understanding of my team member's progress because of their individual contributions to the wiki	3.36
XI.	The wiki was confusing, and it made the project more difficult	2.25
XII.	Dr. Debelak's and Kevin's interaction/involvement in this project was more productive to my progress than other professor/TA's involvement in the past.	4.82

Taking these numbers into account, statement V. was the only one expressing a negative opinion towards wikis. From the rest of the statements, the benefits outweigh the shortcomings. The students may have realized this if the project was longer term and/or involved more members per group who didn't have a history of working with each other. In addition, the neutral statements may have shifted towards a positive response if the project was changed with respect to the two factors mentioned in the previous sentence.

Another criteria for acceptance of the wiki was average individual and group scores for each statement. For the negative statements, the scores were adjusted by reflecting their value across the median of the Likert scale. The score for each statement was summed. We looked at the average score for all of the statements to evaluate if an individual/group had a positive response to the implementation of the wiki, as shown in Table 2. To ensure anonymity, chemical names are given to the group names and their members. On an individual basis, three students had a negative response, eight had a neutral response, but the rest had a positive response with four individuals having an average score of 5 or greater. On a group basis, half of the groups had a positive response, four had a neutral response, and the group who didn't use the wiki had a negative response.

Table 2. Average Positive Response of Each Student/Group

Student	Score	Group	Score
Hydrogen 1	1.58	Hydrogen	1.86
Hydrogen 2	1.83	Oxygen	3.08
Hydrogen 3	2.17	Uranium	3.29
Uranium 1	2.58	Aluminum	3.46
Oxygen 1	2.67	Fluorine	3.53
Oxygen 2	2.83	Sodium	4.08
Aluminum 1	3.08	Sulfur	4.22
Fluorine 1	3.08	Nitrogen	4.44
Nitrogen 1	3.33	Carbon	4.61
Sulfur 1	3.58	Lithium	4.83
Oxygen 3	3.75		
Fluorine 2	3.75		
Fluorine 3	3.75		
Aluminum 2	3.83		
Carbon 1	4.00		
Uranium 2	4.00		
Sodium 1	4.08		
Sulfur 2	4.42		
Lithium 1	4.58		
Carbon 2	4.67		
Sulfur 3	4.67		
Nitrogen 2	5.00		
Nitrogen 3	5.00		
Lithium 2	5.08		
Carbon 3	5.17		

The frequency, volume, and quality of content added to a group's wiki correlates with the average opinion of the group. In other words, the groups who utilized their wiki liked using the wiki, but it is difficult to evaluate cause and effect with respect to recommendation of the wiki and wiki contribution. However, if the wikis was implemented throughout the entire senior design course versus a 30 day project, the students might begin to see the appeal of the technology and have a more positive reaction. We have other ideas as to what might have increased the positive opinion of the use of wikis in design, but those are discussed in a later section.

Table 3 summarizes student use of the wiki. From the open-ended responses, the ability to have a central hub for shared files like Excel© files or Aspen© files was a very appealing feature of the wiki. The students also used the wiki to organize their meetings and update the specifics of the group's timeline and task allocation. Finally, most of the students utilized the capability of the wiki to quickly make links to important references.

Table 3. Summary of how many groups included each item in their wiki.	
Task Allocation	6
Coordinate Meeting Times	6
Timeline/Calendar	8
Attaching files (I.e. Aspen)	8
Premeeting Agenda	3
Meeting Notes	8
Links to References	7
Group/Professor Discussion	7

Positive Reactions to Wikis from the Student's and Educator's Perspective

The last section of the survey asked open-ended questions regarding their likes and dislikes of the wiki, in general, and its integration into senior design. A lot of what the students liked about wikis didn't surprise us. The main thing commented on was the wiki serving as a central hub for files and information. They said it depleted inconsistencies in the content of files (i.e. weekly reports) and everybody had easy access to the most-up-date files. Finally, in cases where certain individual tasks of the project overlapped, a student could find the necessary details in their partner's added content to help steer the progression of their portion of the project.

Another appealing feature to the students was the dynamics of the wiki. Instead of sending multiple emails, it was much easier to come to a consensus on meeting times or have discussions without having to schedule a formal group meeting. Like instant messaging, the students could add little pieces to a discussion or make slight alterations to a plan (meeting schedule) until the group was satisfied with the final result. Unlike instant messaging, the whole discussion is automatically recorded and archived.

The other thing related to the appeal of the dynamics of the wiki was the interaction from the authors of this article. Students felt their questions and concerns were addressed frequently and timely. The wiki provided more interaction on this project compared to other projects. It is critical to reiterate what was said in the introduction about new technology in the classroom. Students perceive enhancement of interaction as a main requirement when deciding to integrate technology into a class[4]. From the responses to the survey, wiki use seems to have met this requirement.

A lot of the appealing qualities of the wiki are shared between the educator and the student. With respect to the wiki acting as a central hub for information, it was easy for us to find what we wanted/needed and evaluate it. With the students adding content, we could see what options the students were exploring, what decisions were being made, and sometimes see why those decisions were made. Also, in terms of correspondence with the students, it was easy to find what information was shared versus hunting through a slew of emails.

From a pedagogical standpoint, wikis provide a great potential for study. Wikis allow easy sharing of information amongst a group. A professor may get a lot more information about what went on throughout the semester, than they might get within a weekly or final report. Also, because of its revision history, we can observe the dynamics of the design process from the student's point of view. If the students utilize the wiki and add content as information is gathered and decisions are made, an outside observer can start to see the thought process of the designers. Another appealing piece of the revision history is the record of who added what and when. As observed by Heys, individual accountability can really be enforced[6]. Early in a project, if there is a lack of content added or participation by an individual, the group or teacher can take steps to prevent further laziness or problematic procrastination.

Another reason we believe makes wikis a great tool for students, is the faculty interaction with the wiki better simulates the interaction they'll receive in practice. In industry, an engineer doesn't collaborate solely by writing a report every month or at the end of a project. The supervisor keeps constant tabs on a group's progress, so the project gets completed on time and the results are valid. With respect to the students' comments about the frequency of interaction from the professor and the teaching assistant (TA), it was easy to address concerns and questions of the students. If a change had been made to a wiki (whether it was a question or addition of information), it was easy to go to the site and see what content was added since the last time it was observed. Specifically, pbwiki will highlight the differences between two versions of a page. If a student/group had a question or uncertainty about their design, it took no more than 15 minutes to see the question and answer it in a place all of the members could see it. Also, the response would be on record and be easily accessible to reference for further viewings by either the student or the teacher.

Negative Response to the Wiki

Not every tool you expose to students is 100% well received. However, this study was to investigate what was good and bad about the wiki. From the opinions pointing out the flaws of the wiki and its implementation, we could make constructive decisions about what to change in the future and how.

The students' three main arguments against the use of the wiki involved the preference of email, the small size of the groups, and the small scale of the project (amount of work required and time to finish). A large percentage of the students commented on how they "prefer to use email." They thought the wiki was more work and it was easier to use email. In addition, they thought it was easier to use email because of the size of the groups. It was much easier to meet up with two other people or email two other people, then to add their content to the wiki. Another factor related to the size of the groups was the familiarity of the group members. Each group member shared at least two (if not more) classes with their teammate, they socialized in their personal time, and they saw each other outside of group meeting times very often.

With the project lasting only 30 days, the students didn't think it was worth adding content to the wiki. One student is quoted as saying, "…given more time than four otherwise busy weeks with graduating and major life changes approaching, we would have had time to use it for effective group and time management." Because there was no requirement for the content added, some students minimized the content added to save them time.

There were other hurdles preventing or discouraging the students from adding to their wikis. The students began the study with minimal familiarity with wiki technology. Some embraced the new technology, but others strayed away from it because it was new. This is consistent with what was seen in the ECAR study. They found students who considered themselves early adopters of new technology had a greater affinity to using wikis in the classroom, than those who utilize technology at the same rate as the average population.

Other hurdles were the organization of the wiki, the limited amount of file storage, and full group participation. Some students thought the wiki could be a great tool if the information was organized, but it took a lot of time to organize to a point where it would be useful. With respect to the amount of storage, the free pbwiki account only allows a maximum of 15.0 MB worth of files to be uploaded. There is no limit on the amount of content added directly to the wiki, but pictures and actual files saved to the wiki count towards the maximum. Finally, there was at least one group where one of the members didn't attempt to contribute to the wiki, discouraging the rest of the group from also adding to it.

Suggestions for Future Use

In general, we believe the wiki is a good design tool for students and recommend it to all design groups in education and in industry. The authors have been communicating with the design team at pbwiki.com in order to improve what the wiki has to offer. Since the beginning of this study, some of our suggestions for changing pbwiki have been implemented into the newest version, or the feature is being tested as a beta version.

Our suggestions for change try to address all of the things that prevented students from embracing the wiki. To address the problems with organization, we suggest having a preconstructed skeleton structure for the wiki. The designers have come up with a way to make this very easy for an educator. First off, any previously made wiki page can serve as a template for future pages made. Another feature in beta is the ability to "clone" a wiki. In this fashion, not only does the structure of one page get copied (as in a page template), but all of the links and the whole structure of the wiki can be carbon-copied. Utilizing these two new features, we plan on making one wiki with headings and space for new additions in a manner we, as supervisors, prefer. We will clone this wiki to make each group's beginning wiki exactly the same.

Being able to give the students a skeleton structure of the wiki helps alleviate a lot of problems with how the wiki was initially implemented. The biggest benefit is organization. The students can appreciate this, because they don't have to spend as much time organizing, and can spend more time adding content. The teacher can utilize this organization to allow them to find exactly what they want and where, i.e. the results of a decision matrix. The teacher won't need to go through page after page looking for the justification for the use of a piece of technology. Another helpful aspect is how it will take away the intimidation of the wiki and deemphasize the lack of familiarity with it by giving them a head start on the project.

Changing the logistics of the project could solve the other issues with the use of the wiki in the class. To address the issues discovered from this study, we are planning on doing the following:

- Increase the number of members in each group
- Randomize the members of the group to deplete familiarity
- Increase the scale of the project and assign it the first day of class
- Require specific entries into the wiki (not just weekly reports)
- Require equal contributions to the wiki by all members
- Incorporate other major's for an interdisciplinary design project

Considering what the student said prevented their wiki contribution, we think the above will alleviate those problems.

Being digital immigrants, we didn't enforce using wikis over email. Throughout the project, some students would email us with their concerns and questions (versus putting them on the wiki) and we would reply using email. The main advantage of wikis over email is the centralization of data and its organization. By responding to the students over email, we decentralize correspondences and add to the disarray of information. In short, a project manager or professor needs to be consistent about adding to wikis if all group members are expected to use wikis over email.

Conclusions

Web 2.0 technologies like wikis and blogs have great potential in the classroom for the net generation. However, these technologies should be used with caution. We as educators can't integrate these technologies into our classes because we want to seem novel and up-to-date, but we should integrate them to improve student learning. By doing studies like the one from this article, we can decide the best way to involve technology in lectures and teaching design.

Wikis have a lot of potential in the classroom. Heys used wiki technology for a class project to improve the learning of his Mass & Energy Balances class[6]. Some educators are using wikis as a replacement for traditional textbooks, where the students add problems and edit the educational content[3]. In this study, we utilized wikis as a design tool.

Overall, the students liked using the wiki and recommend it for further use. They liked how the wiki improved interaction amongst the group members, the professor, and the TA. In addition, they utilized how wikis centralize their findings and its dynamic nature for collaboration. They didn't like taking the time to organize their wiki and prefer using emails for a variety of reasons. Email can be used for collaborating, but for a large design project, we think organized wikis are more beneficial. As a result, we have suggested changes for further usage of the wiki in a design course. Finally, we think wikis have great potential for pedagogical research. If the students properly add content to their wikis, we can delve into how students approach and implement a design project. Also, research can explore what factors affect group productivity and design quality.

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