Wiki Pedagogy – A Tale of Two Wikis

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Abstract—This paper reports on a research project investigating the deployment of two different wikis in two Masters of IT subjects. As well, two different learning task designs were used (weekly whole class extension question tasks versus semester long group projects) providing further basis for comparison and contrast within the project. Data collection mechanisms included a 22 item student survey, interviews with academics and observations on student contributions to the wikis. Key results regarding students’ patterns of behaviour, the impact of learning task design upon contributions, the effect of training, and the quality of the wiki applications themselves are discussed. Based on these results, a set of 12 principles for implementing wiki based learning tasks are recommended.

Index Terms—collaborative learning, online learning, pedagogy, wikis.

I. INTRODUCTION

In order to ascertain the utility of deploying wikis to facilitate collaborative groupwork in our Information Technology courses, Postgraduate Professional Development Programs at Macquarie University conducted a research project involving two different two different learning task designs using two different wiki applications in two of our Master of IT subjects. The research was performed during semester two of 2005.

Wikis had been identified as a particularly interesting e-learning technology to deploy in our Masters subjects because of their identified potentials for developing expert thinking. Whereas synchronous technologies such as instant messaging and desktop sharing were seen as important for novice programmers to instantaneously share declarative and troubleshooting knowledge, the ability to dynamically yet asynchronously edit and restructure web content using wikis was seen to afford Masters students the opportunity to develop and share the sophisticated and highly structured knowledge schemas more akin to expert thinking.

Before embarking upon the project the following research questions of interest were identified:

1. To what extent does the structure of the learning task influence students’ patterns of behaviour?
2. To what extent does the wiki application itself impact upon the learning experience?
3. How much and what type of training is required for students to use wikis effectively?
4. How do wikis compare to other e-learning tools (such as discussion boards) and face to face approaches for facilitating collaboration?
5. What principles can be suggested for successful implementation of learning activities using wikis?

The two wiki applications used to explore these research questions were the wiki built into the Moodle Learning Management System and a Jotspot wiki. The first learning design involved weekly whole-class extension question tasks being posed in an Object Oriented Technology subject, and student responses being elicited via the Moodle wiki. The second learning design involved a semester long group project in an Advanced Web Technology subject, facilitated through the Jotspot wiki. This paper begins by describing how this work relates to other research on the use of wikis for educational purposes, and then goes on to articulate the research methodology adopted in this case, the results observed during the data collection process, and proposes recommendations for deploying wikis in tertiary courses based on the observations and analysis performed.

II. PREVIOUS RESEARCH ON WIKIS IN EDUCATION

When the first wiki was released by Ward Cunningham in 1995, the efficacy of the tool for educational purposes was self evident. The capacity to create, edit, and restructure web based content could allow students to represent data in a more freeform manner than existing asynchronous collaborative tools, such as discussion boards. Since then there have been numerous documented cases of using wikis in education generally, and computer science education specifically [1, 2].

Some of the learning designs based on wikis that have been utilised include:

- collaborative artifact creation tasks
- review activities
- construction of a case library
- straight information distribution
- wiki Micropedias
- FAQ wikis
- Consensus documents
- Branching story/Tree simulation tasks
The flexibility of wikis to dynamically restructure and hyperlink information contained within a web space obviously affords educational developers a myriad of learning design opportunities. However, there has been relatively little research into how best to deploy wikis for educational success. The scarce work in the area is summarized below.

In his research into the use of wikis for distributed asynchronous brainstorming, Davies [5] identifies understanding, trust, and value as significant factors for successful deployment. On the basis of his case study and analysis, he recommends:

- “careful seeding” with appropriate modeling but not so extensively so that students lose ownership
- training (both technical and social)
- encouraging successful behaviours via reference to other examples.

Davies emphasizes the relationship between the convener and the student and the importance of explicitly developing positive student behaviours as crucial.

Georgia Tech has been exploring the use of wiki-like tools for several years, with a variety of learning designs. As a result, their CoWeb catalog instructor’s guide [1] recommends:

- introductory activities to get students thinking about the role of the tool and to learn about its mechanics
- some not-required-but-useful activity to convince students that it can be valuable to participate
- a period of open use by students, with a few activities
- some closing activities.

This is an explicit approach to developing positive patterns of student behaviour within the wikis.

On a different tack, other research proposes that an effective strategy to improve implementations of wiki-based learning tasks is to analyse the roles adopted by students. According to Guzdial et al. [6] users may be authors, purpose agents, central users, peripheral users, site designers, developers, administrators, or even support staff. By analysing the roles adopted in the wikis and implementing tactics to support each of them, users are able to collaborate more effectively and thus the quality of overall learning can be improved.

The different features and functionalities of the various wikis themselves can impact upon the effectiveness of the learning experience. Tonkin [7] rates features such as version control, permissions, file attachment capabilities, and so on for nine popular wiki tools, and suggests ways in which the different features of the various wikis will be more appropriate for certain tasks but not others. The key idea that Tonkin emphasizes is that during the tool selection process the functionality of the specific wiki tool needs to match the collaborative requirements of the learning task.

Despite the identified potential of wikis to offer afforances beyond discussion boards and email for online asynchronous communications (afforances such as restructuring of information, version control and dynamic markup of pages), in many cases teachers have found the use of wikis in educational contexts to be unsuccessful, or at least not meet design expectations [5, 8].

The study described in this paper attempts to extend upon this previous work in the area to ascertain important principles for successfully implementing wiki-based learning activities, both in tertiary education generally and IT education specifically.

III. METHODOLOGY

Our multiple case study design commenced by selecting two Master of IT subjects within which to apply wiki based educational approaches. These subjects were ITEC802 – an Object Oriented Programming unit with 28 students enrolled, and ITEC831 – an Advanced Web Technology unit with 29 students enrolled. The learning objectives of each subject were used to develop appropriate wiki based learning tasks. Then two different wiki tools were assigned to each subject based on these requirements, providing further means for contrast and comparison within the project.

A. The two cases

1) Weekly whole class extension question tasks in an Object Oriented Technology subject

“Object Oriented Programming” is a core unit for Macquarie University’s Master of IT program. This unit used the Moodle wiki that comes bundled with the open source Moodle Learning Management System to implement a weekly extension question task for students.

Different styles of questions were proposed each week for the “WikiWork” activities, in order to provide further insight into how the type of cognitive engagement required by students (not just the learning task structure) affects their patterns of contributions. Styles of tasks included:

- Hints, tips, and wish-list tasks – such as “describe some useful features of Java that may not be known by your peers”
- Coding questions – requesting that students write a program that achieves a certain specification
- Descriptive tasks – such as “describe the meaning of covariance and contravariance”
- Compare and contrast tasks – such as “compare and contrast the event handling mechanisms of different languages”
- Evaluative tasks – requiring students to evaluate the validity of a claim or the quality of an artifact.

As well as contributing to the WikiWork tasks, students were expected to complete tutorial and practical exercises and attend face to face lectures.
The Moodle wiki that was used to collect the weekly student responses provides basic wiki functionality, including the ability to:
- create new pages
- link to existing pages
- format text using WYSIWYG interface
- ability to roll back the wiki to previous versions.

![Figure 1 - The Moodle Wiki](image)

An assessment weighting of 10% was allocated to the WikiWork in order to avoid lack of participation problems observed in other research projects [5]. Students were required to provide a significant contribution to at least one of the twelve WikiWork extension activities and a minor contribution to five others in order to score full marks. Minor contributions could be restructuring or commenting upon other people’s contributions. Students were able to contribute to each week’s WikiWork task until the end of semester.

2) Semester long group project tasks in an Advanced Web Technology subject

The Advanced Web Technology subject is an optional unit for students completing a Master of IT at Macquarie University, but a compulsory one for those completing a Web Technology major. A Jotspot wiki was used to not only facilitate group collaborations during the students’ major project but also facilitate the subject’s administration (such as dissemination of subject related information, distribution of tutorial exercises, and so on).

The group project itself involved teams designing and then developing a multi-tiered web-based application. Students self selected themselves into one of eight teams of between two and five members, based on the type of application they wished to develop. Teams were then allocated a group space on the wiki and could choose to use that space in any way they designated. Other than collaboration via the wiki, students had two hours of face-to-face contact every fortnight where they could choose to either complete the (non-assessable) tutorial exercises, or to meet with their group.

The Jotspot wiki is a fee for service, https secured application that incorporates all the functionality of the Moodle wiki, plus the ability to:
- Attach files to pages and email to and from them
- Set a sophisticated variety of permissions to pages
- Insert “applications” into wiki pages.

![Figure 2 - The Jotspot Wiki](image)

Jotspot calls itself an “application wiki” because it allows tools such as blogs, calendars, forms, discussion boards and so on to be integrated into the wiki by embedding simple scripts within the wiki pages. However, in order to draw a more direct comparison of how wikis were used within the two subjects, these extra applications were not applied in the Advanced Web Technology case.

An assessment weighting of 15% was attached to student’s contributions to the wiki as part of their group project mark. Once again this was deemed necessary to encourage participation.

Note that in the Object Oriented Programming subject contributions were made by the whole class to the same wiki but to different tasks each week. On the other hand, in the Advanced Web Technology unit the same task was prescribed throughout the semester but was being completed by different groups. Designing the study in this way allowed researchers to observe variations in patterns of contributions based on different learning tasks in the first case, and variations between groups on the same learning task in the second case.

Also note that the wiki was used as the Learning Management System (LMS) in the Advanced Web Technology unit, but within the LMS in the Object Oriented Programming unit. This allowed researchers to observe two different ways in which wikis could be situated in relation to other e-learning technologies.
B. Student Training in Using the Wikis

A minimalist approach to training students how to use the wikis was adopted, for the following reasons:

- As Master of IT students it was assumed that participants would possess a degree of IT competence, and thus only require minimal technical support on how to use the wikis to develop proficiency.
- As a first case investigation into the use of wikis at Macquarie University, researchers were interested in how far students could progress with minimal training—a control case of sorts.

Students completing the weekly whole class extension questions were given a half-hour face to face introduction on how to use the wiki. As well, part of the first week’s WikiWork task requested that students contribute hints and tips on how to use the wiki, and a document explaining the nature of the WikiWork tasks was also distributed.

Students undertaking the semester long group projects were also provided with a half-hour introduction on how to use the wiki. However rather than requiring students to contribute hints and tips to familiarize themselves with their wiki, students were referred to the range of multimedia online tutorials available from the Jotspot website for information on how to use the various features and facilities integrated into the tool.

C. Data Collection

Data on how students used the wikis and their perceptions of them was collected via three techniques:

1. Observations of students’ wiki contributions
2. A 22 point student survey
3. Interviews with academics involved in the project.

Academics deliberately made no contributions to the student collaborative spaces. This allowed researchers to observe how students interacted with one another without any outside interference, and thus provide another baseline for future research in the area.

The 22 point survey was designed half way through semester, based on observations of student contributions to that point and also the initial research questions identified for the study. The survey included both open-ended and Likert scale questions. The Likert scale used in each case contained 7 rating points (“Strongly Disagree”, “Disagree”, “Mildly Disagree”, “Neutral”, “Mildly Agree”, “Agree”, “Strongly Agree”). The survey instrument itself was distributed after completion of the coursework but before the final examination for each subject. In this way students had fully completed their experience with the respective wikis and this experience was still familiar to them. Students could choose to complete the survey anonymously so as to not bias their responses in any way.

The survey instrument is attached as an appendix to this paper (ref. Appendix A).

Statistical analysis was performed upon student responses to Likert scale questions, based on a numeric allocation (of 0 through to 6) to the 7 possible response categories. While this approach is commonly used by researchers, academics involved in this project note that performing such a transformation from descriptive to quantitative data is not without limitations and any results need to be considered in context. All tests performed on Likert scale question responses were two-tailed student T-tests.

In addition to the observations on the wikis themselves and the survey, academics involved in the running of each unit were interviewed for their impressions of how the wiki was used. This interview data was then triangulated with observations of contributions to the wikis and survey responses to provide a more complete and consistent representation of the events that had transpired throughout the study.

IV. RESULTS

Key results derived from observations of student contributions to the wiki, the student survey, and academic observations are summarized in turn below. These results are then drawn upon in the next section of this paper to propose causal relations between tasks, training, tools, and the collaborations that occurred on the wikis. These relationships are then used to make recommendations about ways in which these variables under the control of academics (task, training and tools) can be leveraged to improve collaborations.

A. Observations on student contributions – Patterns of Behaviour

The analysis of student contributions provided greatest insight into the patterns of behaviour for both the weekly extension question tasks and the semester long groupwork task.

1) Weekly extension question tasks

According to responses to the survey, students in the Object Oriented Programming unit spent approximately 1 hour per week on the weekly WikiWork tasks. Different patterns of behaviour emerged, according to the type of task prescribed:

- Tasks requesting hints, tips and ideas resulted in piecemeal contributions. The final page or series of pages was not well integrated.
- Coding questions produced wikis that evolved and contained contributions that were well integrated. Students indicated that they valued this style of more “concrete” task specification more than open ended tasks.
- Descriptive tasks were also generally well integrated.
- Compare and contrast tasks could be well integrated but could also result in piecemeal wiki work.
• Evalitative tasks resulted in piecemeal, list style contributions that were only loosely integrated.

In summary, tasks that require a singular solution (such as a single document or program) resulted in a more integrated product. For tasks that require individual opinions (be they declarative or evaluative in nature) a more linear and fragmented pattern of contribution evolved.

Students generally didn’t take advantage of the ability to hyperlink to new pages – assumedly they either felt that the quantity of information didn’t warrant new pages or that it was advantageous to have all information represented on a single page.

2) Semester long group project

Students in the Advanced Web Technology unit spent approximately 3.5 hours per week using the wiki. The number of pages in each group’s wiki space ranged from between 2 pages to up to 15 pages. There was a great variety in the way that teams used the wiki space. Some groups simply posted textual descriptions of their project outline and intended outcomes, while other groups used their wiki space to facilitate the entire project collaboration process.

Uses of the wiki for the groupwork project included:

- Brainstorming ideas
- Forming a design specification
- Creating a repository of technical information
- Project Management (establishing timelines, allocating responsibilities)
- Providing a noticeboard / discussion forum facility
- Posting meeting minutes
- Sharing documents and resources

No groups incorporated all of these features into their wiki, and some groups only integrated one or two of these uses.

There was also a noticeable difference in the degree of integration that occurred within each group’s wiki space. Some groups had individuals creating the entire content of a page, which was then not modified by other members. This implies that the final product has not benefited from the suggestions or refinements of others. On the other hand, some groups had all members contributing to several of the pages in their wiki space on a regular basis.

B. Responses to the student survey

For the student survey, 39 responses were received. For the weekly extension question tasks 17 out of 28 students responded (61%), whereas 22 out of the 29 students who completed the group project provided responses (76%).

The student survey addressed several different dimensions of the experience, including student perceptions of:

1. the training provided
2. the features of the wikis
3. the learning tasks prescribed
4. how the wikis compared to face to face collaboration
5. how the wikis compared to collaboration via discussion boards.

As previously mentioned, a combination of Likert scale questions and open ended questions were incorporated into the survey instruments. Key results from the students’ responses are summarized below.

1) Training

In response to Likert scale item 5 on the survey “I received adequate training to use the wiki”, students completing the group project expressed a significant belief that they had ($\bar{x} = 3.59, \sigma = 1.37, p = 0.042$).

Figure 3 - Distribution of responses to survey question 5

This may have been due to the multimedia tutorials they could access via the internet, but more likely their increased familiarity with the wiki by the end of the semester as a result of using it more frequently than students in the weekly extension question group.

In an open ended question asking them to describe what extra training they would like to have received, most students commented that the wiki was intuitive and didn’t require much training. Some students suggested that some guidance should be given on ways in which the wikis should be used (ie, propose patterns of contribution rather than technical advice).

2) Features of the wikis

Based on the response to survey question 7 “What features and functionalities of the wiki enhanced your learning experience in this unit?” Students completing the weekly extension question tasks felt that the most valuable features of the Moodle wiki were the capacity to see what others had written on the topic, to share knowledge, as well as editing each other’s work. In contrast, students undertaking the semester long group project indicated the most valuable feature of the Jotspot wiki was simply as a communication tool, not as a learning tool:
"I see the wiki pages as a tool which makes it easier to communicate between lecturer and students and also between the group members, but not as a tool that enhances learning experience."

(Group project student)

In response to question 8 “What additional features and functionalities would you like to see incorporated into the Wikis in order to improve your capacity to learn using them?” students completing the weekly extension question tasks had very few requests, indicating that the Moodle wiki was sufficient for the types of activities prescribed for them to complete.

On the other hand, students completing the semester long group project requested a gamut of additional features, including:

- notices of change
- interactive whiteboard
- real-time chat
- voice capabilities.

This indicates that the features available in the Jotspot wiki did not adequately match the (more sophisticated) collaborative requirements of the group project task, or that students were not able to use the tools to their full potential.

3) The learning tasks prescribed

In response to survey questions 9 and 10 which asked students to evaluate the learning tasks that had been prescribed, those completing the weekly extension question tasks asked for more concrete problems requiring an objective solution (rather than more subjective tasks involving discussions or opinions). Also, requests were made for more lecturer feedback.

Some students completing the semester long group project seemed to struggle with the “clean slate” that was presented to them and would have preferred a template by which to structure their team space:

“I would be tempted to have [the same?] ‘starter’ project(s) allocated to each group, and then let the group revise, enhance, release as they see fit.”

(Group project student)

Note that in both cases students request intervention by academics.

4) Comparison to face to face

Based on the Likert scale survey question 12 asking whether they felt they learnt more by collaborating using the wiki than if they had collaborated on the same learning task face-to-face, students completing the weekly extension question task felt that collaborating via the wiki was significantly less time effective than collaborating face-to-face ($\bar{x} = 1.88, \sigma = 1.62, p = 0.013$). Explanations that students provided for this included that it took longer to type than to talk, and that when you type you need to express yourself more carefully. As well, for any creative tasks that would benefit from immediate feedback by others, students suggested that wiki based

- the ease with which complicated concepts could be discussed
- the ability to draw diagrams and perform non-textual discourse
- the capacity to receive immediate feedback.

However, there were some remarks made in favour of wiki based collaboration on the bases that information could be processed and provided at a time and pace of the student’s choosing.

Students involved in Advanced Web Technology group project mentioned the value of meeting their group members face to face as a means of not only interacting in ways that were not possible via the wiki, but also in order to better establish a sense of team and interpersonal connection.

Figure 4 – Distribution of responses to survey question 12

Based on responses to survey item 13 “My time was used more efficiently in conducting collaboration via the wiki than via face to face”, students completing the weekly extension question tasks felt that collaborating via the wiki was significantly less time effective than collaborating face-to-face ($\bar{x} = 1.76, \sigma = 1.48, p = 0.004$).

In the subsequent open ended question, the following reasons were provided for this:
Figure 5 – Distribution of responses to survey question 13
interaction extracted the collaborative process over a far greater time span than if working face to face.

A student completing the semester long group project identified other reasons that collaborating via the wiki could be more time consuming as opposed to collaborating face to face:

- "the need to 'find' the latest update buried somewhere in the wiki
- the need to log into it to check what had changed [maybe there was an email notification mechanism, but we didn't use it...?]
- the need to restructure information and the wiki organisation as the design progressed & as the team identified different roles for individuals
- the need to use electronic drawing programs to share pictures rather than sketches drawn on paper or a whiteboard
- the need to figure out why a change to the wiki page had been lost, or why a damn link was broken."

(Group project student)

Students also alluded to the fact that the capacity for informal interactions (such as thanking someone or discussing non-course related matters) was another benefit of face to face collaboration over collaboration via wikis.

However students did identify that collaboration via wikis afforded some opportunities that face to face interaction couldn’t provide. Advantages that students cited included:

- the ability to share ideas and knowledge
- providing a central space to access information
- 24/7 access to data
- The ability to trace the history of the collaborations
- The capacity to interact asynchronously.

5) Comparison of wikis to discussion boards

Students were also asked how they felt learning through the wikis compared to using a discussion board. Student responses to the open ended survey questions were divided on this – they enjoyed the ability to modify and restructure contributions but this sometimes came at the expense of a more amorphous set of information.

Figure 6 – Distribution of responses to survey question 22

In response to question 22 “Using a wiki allowed our group to form a more negotiated meaning than if we were working face to face”, students completing the group project expressed a significant preference for wikis over discussion boards for forming negotiated meanings ($\bar{x} = 3.61$, $\sigma = 0.98$, $p = 0.020$).

The ability for students attempting the design based (group project) task to have greater control over the structure of the information was considered more valuable in terms of developing a common vision than for students attempting the weekly extension questions.

C. Observations by Academics

Observations by academics allowed the data collected through observations of student contributions to the wikis and student responses to the survey to be confirmed and contextualized. As well, academics were able to provide information that analysis of student contributions and survey responses could not, such as an overall technical evaluation of the two wikis being used.

1) General observations made by academics

Academics involved in the project appreciated the ability to monitor and trace student collaborations. They also noted that the ability to restructure information allowed a set of skills to be assessed that were not observable using other approaches such as discussion boards (due to the rigidity of such tools) or face to face (due to the pragmatics of observing all collaborations).

Also, academics were more explicit in identifying the physical temporal flexibilities that were afforded by wikis than were the students. To try and implement a whole class collaborative extension question exercise face to face, or to have students complete a semester long group project task without the wikis would not have been nearly as successful, in the academics' opinions.

Finally, academics also noted that there were no cases of wiki vandalism, which because of their open and editable nature has been an overriding concern about the use of wikis for
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2) Technical Evaluation of the two wikis
In the opinion of academics involved in this study, the JotSpot wiki did not perform as reliably as the Moodle wiki. Some technical issues were experienced with the JotSpot wiki:

- Browser crashes were also reported several times by students.
- There were several instances where special characters were added into the wiki as a result of a bug.
- Password changes needed to be performed by the system administrator (the only other security alternative was to have everyone able to change everyone else’s password!).

As an indication of how significantly this impacted the student experience, the most common response by students using the JotSpot wiki to the request for additional features, was “improved stability”.

On the other hand no major technical problems were reported with the Moodle wiki, which didn’t include file attachment capabilities or sophisticated embeddable applications, but performed much more reliably. It is a tried and tested wiki with which academics involved in this study experienced no significant difficulties.

Another advantage of the Moodle wiki is that it is open source, and as such tools can be custom designed for use with the wiki. For instance, the convener of the Object Oriented Technology subject made a purpose built tool to retrieve every contribution that each student made to the wiki throughout the semester, and compare them to other contributions from the page where they occurred.

In terms of ease of use, both the Moodle wiki and the JotSpot wiki performed comparably, with one tool not significantly outperforming the other, according to academic perceptions.

V. DISCUSSION

By triangulating students’ contributions to the wikis, data collected from interviews with academics, and responses to the student survey, researchers were able to derive some important recommendations for future implementations of wikis, which are outlined below. As well, some general matters of interest that arose from this study are discussed at the end of this section.

A. Proposed principles for integrating wikis into courses

1) Task type effects degree of integration reflected in the wiki
Based on observations by academics on the student responses to the weekly extension questions, tasks requiring a single product (such as a description or a piece of code) produce a wiki containing more integrated student responses. Researchers note that Wikipedia is exactly this type of task, where each object represented in the encyclopedia requires definition, and contributions by many different authors are integrated into the one description. On the other hand those tasks requesting individuals contribute hints and tips or evaluations were not well integrated, because information is not required to be related to entries of other people.

2) Wikis are suited to tasks requiring negotiated meaning
Student responses to survey question 22 and observations by academics implied that wikis are well suited to tasks requiring negotiated meaning. If the task requires a single product then the fact that students read all other contributions and place their ideas within that context encourages learners to challenge the meanings proposed by their peers.

3) Tasks requiring less integrated and subjective information are better suited to discussion boards
If the final artifact produced by students doesn’t need to be well integrated, then the information contributed by students will benefit from chronological and linear structure automatically provided by discussion boards. As well, if the information is subjective, then the identity assignment automatically provided within discussion boards better facilitates inter-student discourse. On the other hand wikis are more suitable for more concrete tasks where the identity of the contributor is not essential to the task.

4) Providing students with suggestions for patterns of contribution is desirable
In this study academics involved in leading the group project activity did not provide students with suggestions on how to structure each of the wiki spaces. This lead to a great variety in the extent and quality of the wikis, and it is proposed that by describing ways in which wikis could be utilized more extensive and effective collaborations would have resulted. Researchers note that some student responses to the survey explicitly requested ideas or a “templates” for using the wiki spaces.

5) Time is required for students to become proficient users of the wikis
Even though the participants in this study were Master of IT students, there were several indications that students didn’t know how to use the wiki proficiently. On more than one occasion students completing the weekly extension task inadvertently deleted other students’ responses, or admitted that they didn’t know how to use the tool to perform the operation they intended. On the other hand, the students completing the semester long group project used the wiki more extensively, felt that they had received adequate training and exhibited fewer indications that they did not know how to use the wiki.
6) Technical guidance throughout the use of the wikis can improve the student experience
Although some initial training was provided, students were not using the full range of technical capabilities of the wiki. An example is the failure by students to include RSS feeds into the wiki to notify them of changes to the wiki. As well, it is noted that for students who are not from an IT background it may take longer and more guidance for them to become technically proficient with using wikis.

7) Care needs to be taken to advance match the tool's provided to the collaborative requirements of the learning task
Student undertaking the group project requested a host of additional synchronous features within the wiki in order to facilitate their activities. They indicated that wikis were useful for constructing a shared space for resources and ideas but that for tasks requiring immediacy (such as brainstorming) other e-learning tools such as instant messaging or whiteboarding were desired. Students completing the weekly extension questions did not request these tools, nor even the file attachment facility provided by the Jotspot wiki, because the tasks they were performing didn’t require such functionality. To optimize the effectiveness of the learning experience (and student satisfaction) academics should in advance anticipate the collaborative requirements of the tasks being prescribed, and then make every effort to ensure the tool or range of tools provided meet those requirements.

8) Task authenticity impacts on student contribution
Based on the results to the survey, students completing the weekly extension question task were more opposed to using the wikis than those undertaking the semester long group project. The weekly extension questions were considered by some to simply be an additional workload requirement that wasn’t directly related to developing the skills and concepts required in the unit. On the other hand students completing the semester long group project were completing an authentic activity through the wiki, and provided more favourable responses about its role in the subject. This highlights the need for more authentic tasks, where the wiki serves a valuable function and / or the task produces a valuable artifact in itself.

9) Academics need to be aware of the contribution / review trade off when choosing wikis as opposed to face to face collaboration.
Students completing the weekly extension question activity indicated that making face to face collaborative contributions would have been much faster than using the wiki due to the fact they wouldn’t have had to type in their ideas and could have more easily represent diagrammatic information. As well, if consensus is required, students indicated that the need to wait for other student’s feedback before they could post responses extracted the collaborative process over a far greater time span than if they had been working face to face. On the other hand, the process of reviewing contributions is much more efficient in wikis. When working face to face, students need to listen to each of their peer’s contribution one at a time, whereas in a wiki all contributions can be reviewed at once, at the students’ own pace. The larger the group, the greater the temporal gain in reviewing efficiency that wikis will afford.

10) Wikis are more appropriate than face to face collaboration when you require students to make well considered, asynchronous contributions that are trackable.
In responses to the survey, students identified that they had to reflect more carefully when they post their contributions to the wiki than if they were working face to face. Also, as opportunities for face to face collaboration become less available (as distance learning becomes more prevalent) the appropriateness of wikis as opposed to face to face collaboration increases. As a matter of assessment, a lecturer will often wish to be able to review student contributions to a collaborative process. Wikis are more suitable than face to face collaborations when a learning task has any of these three aforementioned requirements. However, survey responses from group project participants indicated that face to face engagement was a valuable complement to wiki based interactions because it provided the opportunity to conduct richer interpersonal interactions and to create a stronger sense of group.

11) For mission critical implementations, investigating the performance of the wiki tool being considered is time well spent.
Bugs, an unintuitive interface, and poor application design all impact on student satisfaction. Sound performance on all of these dimensions is a baseline for integrating a wiki into a course. Finding and evaluating web reviews from reputable / unbiased sources before selecting a wiki is a necessary undertaking.

12) Making wiki contributions assessable and providing some level of ongoing academic feedback upon those contributions appear effective andragogic strategies for encouraging participation.
Responses to the student survey by students completing the weekly extension task indicated that they would have liked more academic feedback about the quality of the content they were contributing. It could be expected that content evaluation and receiving additional information from academics could improve the degree of learning that occurs. Some students in this group also indicated that they viewed the WikiWork as an additional requirement that needed to be fulfilled rather than as an integral component of their learning. To protect against lack of participation by students who do not value the wiki tasks prescribed, attaching an assessment weighting to contributions may be a necessary strategy.

B. Other matters of interest
Wikis may be an effective tool for facilitating cross ability interaction. The lecturer in charge of the weekly extension tasks noted that all students can participate in contributing to the problem regardless of their expertise in the area. More knowledgeable students can differentiate themselves by
making substantial and indepth contributions. Students who are less expert in the domain can learn from these more adept entries, but at the same time can contribute by reorganising and making minor edits to the submissions of others.

Students may have been more favourable of using wikis in their courses if they had enrolled for distance courses than for face to face units. The fact that these were face to face units meant that some students did not see the point of conducting collaboration via the wiki. An entirely different set of feedback may be derived from applying these techniques in distance courses where students don’t have the capacity to interact face to face and expect to collaborate using online tools.

Students may not be aware of the extent to which the activities they perform within the wikis are facilitating learning. Responses to the survey indicated that students completing the group project saw the wiki as a communication tool and not as a learning tool. Explicitly drawing students’ attention to the ways in which collaborating via wikis is developing their capacities and understanding may improve their motivation and thus the quality and quantity of their contributions. As well, it should be pointed out to students that there is an intrinsic value in learning to interact effectively using wikis; it is a contemporary collaborative competency that may easily be required in future educational and commercial contexts.

As a matter of determining the suitability of a task to wiki use, researchers wonder whether if assessment is required to ensure student engagement, are the tasks being proposed adequately authentic? Also note, adding assessment to wiki tasks can have issues related to other forms of online asynchronous group contribution tasks, such as the race between students to be the first to contribute.

The relationship between wikis and other technologies is an interesting one. For the Object Oriented Programming subject the wiki was adopted within the Moodle Learning Management System, whereas in the Advanced Web Technology subject the Jotspot wiki was used as the LMS. In the Moodle LMS a discussion board was also used as part of the subject’s communication offering. In the Jotspot wiki discussion board type collaborations were occurring on some pages, and indeed Jotspot allows discussion boards to be embedded into wiki pages. As e-learning technologies become more sophisticated and the line between them becomes more blurred, which tools to use and how to integrate them requires more consideration. In each case the main point is to identify the technological requirements of the learning task and provide a suite of tools that meets those requirements.

Finally, some technical and training matters that arose during the study are worth mentioning. First, it should be noted that running several group projects from within the one wiki can lead to problems if two groups wish to create a page with the same name (for instance, “Timeline”). If only one wiki is to be used for group projects – as opposed to separate wiki installations for each group – this potential naming conflict needs to be pointed out to students. Secondly, care needs to be taken to teach students how to be proficient users of CamelCase. CamelCase is the formatting convention used by wikis that indicates a piece of text is to link to a new page. It is especially important to teach IT students how to escape CamelCase so that they can post streams of computer code to the wiki without their variable and method names referring to new pages.

VI. CONCLUSION

Asynchronous e-learning will feature more heavily in courses of the future because of the temporal and physical flexibility that they afford. The question then becomes one of how to most effectively deploy such technologies, and the most appropriate circumstances under which to apply the range of available approaches.

As wikis become more frequently used in educational settings (including secondary school) it will be less necessary to provide explicit direction on how to best collaborate using wiki tools. Many students will have formed the appropriate epistemology and technical skills required to interact effectively using wikis and will be able to act as exemplars to less proficient students. Until then, however, it seems necessary to provide some explicit instruction on how to interact and “think” in wiki based tasks, yes from a technical perspective but more so from a collaborative perspective.

Several areas for further research have been raised as a result of conducting this study:

- Can changing people’s learning objective from individual learning to form a collaborative understanding of a subject through wikis affect the quality and quantity of contributions to the wiki?
- Does creating this sort collaborative understanding described in the previous point alter the quality of learning that occurs for different levels of ability (eg, do weaker students improve more substantially but better students remain at the same level?)
- How do contributions to a wiki differ from contributions to a discussion board for the same task, and to what extent does task type alter the degree of difference in patterns of contributions between the two tools?
- How do contributions to a wiki differ from face to face contributions for the same task, and how does task type alter the degree of difference?
- Does the degree of integration of student responses that occurs within wikis correlate to student understanding?
- Do learning designs that foster a sense of team and take place over an extended time frame lead to more effective collaboration and learning?
- To what extent do preferences for wiki tasks as opposed to face to face depend on learning style preferences? For instance, do oral learners prefer face to face collaborations as opposed to textual learners who prefer wikis? How do other factors such
as face to face confidence and desire for human interaction affect student performance?

Like much research into emerging educational technologies, this study has probably raised more questions than it has answered.

Researchers involved in this study have identified the capacity for wikis to facilitate multi-user asynchronous creation, editing and restructuring of information as affording educational opportunities that other e-learning tools cannot. The data described herein demonstrates the large variations that can occur between tasks and between groups, based on the task specification and capacities of students to collaborate using the wikis. This variation indicates that careful approaches to educational design and implementation have the potential to greatly affect the success of learning tasks. It is hoped that sharing the data, analysis, and resulting recommendations derived from this study allows other academics considering deploying wikis in their courses to do so more expertly.

VII. ACKNOWLEDGEMENT

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REFERENCES

VIII. Appendix A – Student Survey Questions

1. What is your student number?

2. Which unit are you enrolled in this semester? (ITEC802, ITEC831)

3. On average, how many hours a week did you spend using the wiki? (Drop-down menu: 1-20+ hours)

4. How much and what type of training did you receive in order to use the wiki?

5. I received adequate training to use the Wiki. (Strongly Disagree, Disagree, Mildly Disagree, Neutral, Mildly Agree, Agree, Strongly Agree)

6. What type and how much training do you think you should have received in order to use the wiki? (If you feel like extra training should have been provided, please describe.)

7. What features and functionalities of the wiki enhanced your learning experience in this unit? How?

8. What additional features and functionalities would you like to see incorporated into the Wikis in order to improve your capacity to learn using them?

9. What aspects of the learning tasks set using the wiki do you think enhanced your learning experience? (E.g. What did you like about the way this learning task was designed and run?)

10. How could the learning tasks set in the wiki have been improved?

11. Besides using the wiki, in what other ways and how often did you collaborate with your peers in this unit (e.g. group meetings, emails, formal and informal discussions)?

12. I learnt more from my peers through collaborating via the wiki than if we were completing the same learning task face-to-face. (Strongly Disagree, Disagree, Mildly Disagree, Neutral, Mildly Agree, Agree, Strongly Agree) (Describe.)

13. My time was used more efficiently in conducting collaboration via the wiki than via face to face. (Strongly Disagree, Disagree, Mildly Disagree, Neutral, Mildly Agree, Agree, Strongly Agree) (Describe.)

14. What are the advantages of using a wiki to collaborate for IT related tasks?

15. What are the disadvantages of using a wiki to collaborate for IT related tasks?

Can you see other possible applications for wikis in IT related learning tasks?

16. I was more willing to contribute to the task when working through the wiki than if working face-to-face. (Strongly Disagree, Disagree, Mildly Disagree, Neutral, Mildly Agree, Agree, Strongly Agree) (How come?)

17. I was willing to modify and restructure other people's work in the wiki. (Strongly Disagree, Disagree, Mildly Disagree, Neutral, Mildly Agree, Agree, Strongly Agree)

18. For the assigned task, the wiki was a more effective learning tool than a discussion board. (Strongly Disagree, Disagree, Mildly Disagree, Neutral, Mildly Agree, Agree, Strongly Agree)

19. In general, what are the advantages of a wiki as compared to a discussion board for collaborative learning tasks?

20. In general, what are the disadvantages of a wiki as compared to a discussion board for collaborative learning tasks?

21. Using a wiki allowed our group to form a more negotiated meaning than if we were working face to face. (Strongly Disagree, Disagree, Mildly Disagree, Neutral, Mildly Agree, Agree, Strongly Agree)

22. Using a wiki allowed our group to form a more negotiated meaning than if we were using a discussion board. (Strongly Disagree, Disagree, Mildly Disagree, Neutral, Mildly Agree, Agree, Strongly Agree)