AC 2011-702: INTEGRATING GALLERY WALKS AND WIKIS IN A SYNERGIC INSTRUCTIONAL ACTIVITY: AN EXPLORATORY STUDY OF STUDENTS' PERCEPTIONS

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Integrating Gallery Walks and Wikis in a Synergic Instructional Activity: An Exploratory Study of Students' Perceptions

Abstract

The effectiveness of classroom-based active learning environments in transferring their benefits outside the classroom remains nebulous. We present exploratory results of students' perceptions of a synergic integration of Gallery Walks (an active learning strategy) with a course Wiki (a collaborative Web 2.0 tool). This integration was designed to extend the benefits of active learning beyond the classroom and into a more permanent and accessible digital learning community. An anonymous exit survey was administered online at the end of the course to measure students' perceptions on the impact of this instructional strategy. The survey used an involvement scale for both Gallery Walks and Wikis, and a series of open-ended questions regarding the strengths and weaknesses of these two instructional tools. A one-sample t-Test using the middle of the scale (the lecture involvement) as the test value indicated a statistical significant higher involvement for the Gallery Walk than the lecture. No statistically significant difference between Wikis and lectures was found. These findings indicate that students perceived Gallery Walks as out-of-norm-classroom activities, while Wikis were perceived more as an extension of the classroom activities. Students' open-ended feedback on the two instructional tools complemented these quantitative findings.

Context of the study

Instructional Context

Igneous and Metamorphic Petrology (IgMetPet), a course that focuses on identification, description, and origin of igneous and metamorphic rocks, provided the context for this study. This course is a required course for all undergraduate geology and geophysics majors. Petrology courses with similar content are considered essential components of the core curriculum for the bachelor of science degree in geology in the United States[5]. At our university, the IgMetPet course is typically taken in the second semester of the sophomore year. Students are expected to have already completed the mineralogy and chemistry courses as pre-requisites for this course. The course may include graduate students who are meeting deficiency requirements, or desire to refresh their background knowledge in Igneous and Metamorphic Petrology. Enrollment in this course typically varies between 11 and 22 students, but in the last three years the enrollment has moved toward the upper level of this range varying from 18 to 22 students.

Course Goals

The goals for this course have been divided into three categories:

(1) *Technical skills* which pertain directly to becoming proficient in the subject of Igneous and Metamorphic Petrology;
(2) Development of *scientific skills* which provide an opportunity for students to adopt the approach research scientists use to solve problems, and
(3) Development of *personal skills* which are essential to any career and to lifelong learning.

While this course is primarily designed for the training of the next generation of scientists, development of these skills is likely to transcend many disciplines. This course also focuses on providing students with a strong foundation in fundamental technical skills needed to describe and classify igneous and metamorphic rocks as well as knowledge of how these rocks were formed.

Geology students learn to "Read the Earth's Story" as it is recorded in the mineralogy and textures of igneous and metamorphic rocks. This is known as petrography, an essential technical skill for geologists. Petrography is the description and classification of rocks, rock assemblages, and the spatial relationships of different rock types to one another. It involves the investigation of rocks at many scales from microns to well over tens even hundreds of kilometers using many different tools (satellite imagery, microscopes, electron microprobe, etc.). For example, geologists map out spatial relationships among: (1) trace elements within individual mineral grains, (2) distinct mineral species in thin sections analyzed under the microscope, (3) different rock types in the field using a hand magnify lens. Geologists also expand their work across continents, deep into the Earth, and even on other planets.

Concurrent with acquiring these technical skills, geology students are introduced to the current hypotheses and theories describing the formation of different types of igneous and metamorphic rocks and how these origins are ultimately linked to different plate tectonic settings. This is known as petrology, the investigation of the "how and why" different rock types formed. Examples of some of the fundamental questions include: (1) How are different rock types produced? (2) Why do certain rock types commonly occur together? (3) Why some rock types are associated with a particular tectonic environment? Geologists use many techniques to obtain answers to such questions. To develop a better understanding of rocks, they rely upon a sound knowledge of mineralogy, geochemistry (e.g., phase equilibrium and thermodynamics), keen observations in the field and with the microscope, as well as utilizing results from advanced laboratory techniques (e.g., electron microprobe analysis, mass spectrometry, etc.).

All geologists need a basic level of proficiency in igneous and metamorphic petrology to proceed with additional course work towards their BS degree in geology and geophysics as well as be successful in their professional careers. A small number of students will pursue advanced graduate degrees in which they concentrate their studies on some aspect of igneous and metamorphic rocks. A more substantial number of geology students in their future career will be involved in some higher-level projects such as: (1) designing a lab or field experiments, (2) collection and analysis of quantitative and qualitative data needed to solve a difficult, "fuzzy" problem and reach a complex conclusion. Important instructional goals of this course then also include opportunities for students to mature as a "Research Scientist." This includes developing keen observational skills, clear and accurate documentation of data in multiple formats, analysis of data with the intent of developing multiple working hypotheses, critical evaluation and testing of hypotheses, and sharing of observations and ideas with peers. Commonly, the complexity of problems faced by geologists requires multiple types of expertise to solve them. Therefore, the ability to work collaboratively as a member of a team is rapidly becoming an essential skill. The course is also designed to assist students in the development of personal skills which are important to their success in any career: curiosity and imagination, independent thinking, pride in their work, confidence in their abilities, and finally respect for themselves and their peers.

Implementation of Instructional Tools and Strategies

A variety of instructional tools and techniques are utilized to create multiple and diverse opportunities throughout the semester to assist the students in progressing towards achieving the course goals. More traditional approaches include assignments such as "The Rock of the Week". It requires each student to produce a professional description, sketch and analysis of the origin of a selected rock sample that illustrates lecture topics. Students are free to discuss the rock during the course of the week, but are required to produce their own written report and acknowledge significant contributions from others. At the beginning of the last lecture of the week, a "volunteer" gives a short oral presentation of the rock he or she studied, followed by a class discussion-and- answers period. Technology-driven classroom strategies were also utilized to create a more active and engaging learning environment, with the express goal of improving both students' learning experience and their academic performance. Personal response devices or "clickers", popular in large lecture classes, were integrated into this smaller lecture course with the purpose of initiating daily classroom discussions. Clicker questions were specifically designed to emphasize Woelk's[21] *"I learn", "I understand",* and *"I apply"* category of higher learning by presenting questions and giving students several minutes of open discussion time before they were required to "click-in" their final answer. This tool added a new level to the degree of students' daily classroom engagement, a critical element in sustaining an effective learning process. In addition, during the lecture students were actively engaged in complementary exposition modes: audio, visual, and text. The next two strategies that are the focus of this study, Gallery Walks and Wikis, were therefore a natural progression towards integrating active learning and technology tools as effective means of achieving the targeted instructional goals.

Gallery Walks

Several teaching strategies, such as "Gallery Walks", are available for faculty to utilize in creating an active learning environment within the classroom. This active learning instructional strategy has its roots in the development of instructional scaffolds for learning by design[9] and evolved as an effective classroom strategy in science education classrooms[2].

In a "Gallery Walk" small groups of students will spend a limited amount of time (about 5 minutes) on an individual problem or task presented to them on a large Post-it note. Using a color-coded marker, they write their contribution to the solution of the problem on the Post-it note. At the end of five minutes, a bell sounds, and they move to the next Post-it note (Figure 1). There they will find both a new problem and the contributions of all the previous groups in different colors. The task at hand now requires them first to review the validity of the other groups' work and then to contribute new information towards the solution of the task or problem at hand. After all Post-it notes have been viewed at least once by each group, the final group provides the rest of the class with an oral summary of the problem and the solutions offered by all groups.

Gallery Walks can replace a lecture as an effective alternative assessment instrument to measure student progress at the end of a series of lectures and out-of-class assignments.

Topical questions for each Post-it note are designed to pose a problem that requires students to apply skills and concepts that they have been acquiring in previous lectures. Several of the problems are relatively straightforward and simply require the students to demonstrate that they have mastered a particular skill or concept, similar to a homework problem.

Figure 1 Snapshot from one of the Gallery Walks showing the different collaborative groups working different problems.

Those questions are both confidence builders for the students as well as assessment tools for both the student and the instructor. Other questions are designed to be considerably more challenging and open-ended. These questions push students either to apply previously mastered skills and concepts in a novel way or to consider potential solutions to a problem they have not seen before. This last type of problem provides faculty members with an excellent opportunity to integrate their research into the classroom and let students know that what they are learning is of value in solving “real-world” problems.

The Gallery Walk instrument offers many advantages towards student learning such as cooperative learning, peer assessment, practice on a variety of problems and tasks, and written and oral communication within the classroom setting. During the Gallery Walk, the instructor continuously moves from group to group, peering over student's shoulders, asking prompting questions, giving encouragement, coaxing, prodding, but never solving the problem for them. This is an active exercise for the instructor too, because it provides a great opportunity to interact with the students in an informal, more relaxed instructional environment.

In addition, faculty members can readily assess student's ability to complete tasks and solve problems and provide formative feedback in a lower stress environment than formal exams.

Gallery Walks create a dynamic learning environment, yet one that is transient because at the end of the class the momentum evaporates and everyone leaves. Did the students have enough time to fully appreciate each problem, beyond the five minutes they spent on it? To what extent will they retain information for the problem their group summarized, in comparison to all other problems they faced? How can the information contained on each of the Post-it notes be made readily accessible to students after the exercise ends? To mitigate these concerns, the active learning environment created by the Gallery Walk was extended beyond the classroom with the implementation of a course Wiki.

Wikis

As collaborative tools, Web 2.0 applications allow for the joint development of content and the unlimited sharing of information. They may also stimulate learners to get involved with their own construction of knowledge[16]. Wikis (derived from the Hawaiian phrase for quick, wiki-wiki) are asynchronous collaborative authoring tools that allow users, working either as individuals or in groups, to add and edit web pages, monitor changes, and discuss and negotiate emerging issues. Despite its relatively new presence in the educational landscape, Wikis were already adopted across various instructional areas such as computer science[15], information systems[14], marketing[4], management[10], teacher education[12,20] or technical communications[19].

From a students' perspective, Wikis have been previously used in classrooms as tools to document research projects[6], increase the effectiveness of collaborative authoring[1,14], and support students' engagement[3]. From an instructor's perspective, a major strength of this tool is its ability to allow the evaluation of individual contributions in a student collaborative activity[18]. Educators have access to either free Wiki tools such as Google Sites[7], Wiki Spaces[22] or PBWorks[13] or proprietary Wiki tools such as Learning Objects[23].

Integrating Gallery Walks with a Course Wiki

For the IgMetPet course, *Learning Objects* was selected due to its full integration into the content management system (*Blackboard* in this case) which ensured a higher security and easier access for students. The home page for the Wiki contained general information for the students as to why the Wiki was being implemented as a teaching tool, the responsibilities of students when contributing to the Wiki regarding content accuracy, proper citation of sources of material, and guidelines for getting started and editing. The guidelines included the following topics: (1) Make a Difference by Making a Contribution, (2) Avoid Disharmony, (3) Offensive Material, and (4) Vandalism that set the expectations for creating a high-quality document in a professional environment. A separate link brought students to the Gallery Walks assignments page which contained a brief overview of the Gallery Walks and instructions on proper placement of content created by student groups to ensure this material remained organized, readily accessible, and easily located by other class participants. A separate link was created for each of the three Gallery Walks assignments for the current semester.

The initial Gallery Walk exercise consisted of six different problems that were similar to questions posed previously as homework assignments or as clicker questions used to generate discussion during lecture (Figure 2).

What is the original question? You need to tell the reader what this topic is about.

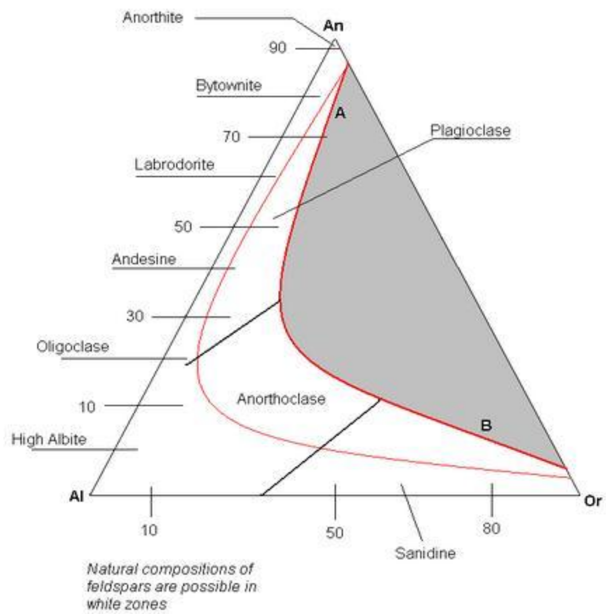

Figure 1: *(You need to include a figure caption that explains to the reader what this figure is about.)*Source: Deer, Howie, and Zussman, An Introduction to the Rock Forming Minerals p393. Rendered in MS-Paint by Bobby Swain. *The Albite component is traditional abbreviated as "Ab"*

Endmember Feldspar Components in the Ternary System An-Ab-Or

Anorthite-$CaAl_2Si_2O_8$

Albite-$NaAlSi_3O_8$

Orthoclase-$KAlSi_3O_8$

A brief explanation of these components is needed.

Exchange Components in the Ternary Feldspar System

Exchange Components used to describe compositional variation among these three phases: KNa_{-1}, $SiNa(CaAl)_{-1}$

Can you provide and example as to how these exchange components would operate? A brief discussion that one is a "coupled exchange" where two elements with different charges on two different crystallographic sites must exchange at the same time to maintain charge balance.

Figure 2 Screenshot of one group’s contribution to the first Gallery Walk Wiki. Answers are extremely brief. (Note: instructor comments are in italics).

Six groups of three to four students were formed to participate in an in-class Gallery Walk exercise as previously described. At the end of the Gallery Walk exercise, each group took ownership of the *Post-it note* with the original problem they started with and the contributions from the all the other groups. Using the material on the *Post-it note as* well as additional resources, each group had the task of creating a contribution on the Gallery Walk Wiki page. This contribution included their answer to the problem as well as other groups’ contributions. In the end, all six problems and their associated answers appeared on the Wiki page.

Each problem was then evaluated using a scoring rubric by the course instructor and two other groups. In addition, any participant in the course, including the instructor, could pose questions change, annotate or add content to the answers already posted in the Wiki.
Typically the only additional comments made were by the instructor and were identified as such by using either italics or a different color text.

The use of Wiki created a certain amount of transparency for this task so that every student had the opportunity to examine and at the same time benefit from comparing the different contributions, instructor’s comments, and evaluation of the Wiki contributions. This transparency also contributed to the dramatic improvement in the quality of students’ contributions to the Wiki as the semester progressed. The final product represented a collaborative set of class notes for this particular set of technical and theoretical course concepts that was readily accessible when preparing for exams.

The final Gallery Walk and Wiki contribution (Figure 3 & Figure 4) was modeled along the lines of a research symposium. The class was divided into three teams. Each team collaborated to create a separate Wiki page for their team report. Each team then used this page to make an oral presentation to the class in the format of a scientific symposium. All teams worked independently of each other. No discussion was allowed between teams and no “espionage” (e.g., looking at other teams Wiki pages) was permitted.

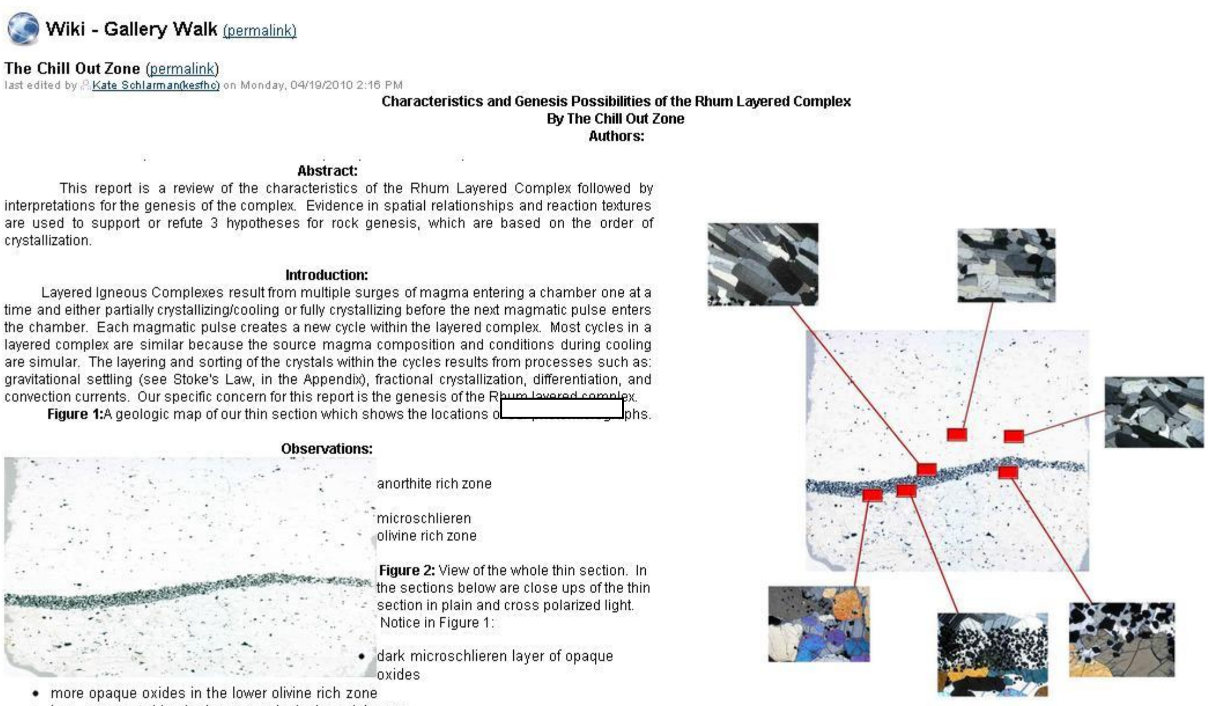

Figure 3 Screenshot of a portion of one group’s Wiki contribution to the final Gallery Walk. A more sophisticated and aesthetic layout with sufficient text is a noticeable change from the first contribution.

This format was intended to create a more scientific debate during the in-class symposium. The purpose of this project was for students to integrate technical skills (e.g., petrographic observations) and petrologic theory (e.g., analysis fractional crystallization with phase diagrams) to develop a comprehensive model for processes that operate within mafic magma chambers.

This last project gave the students the opportunity to pull together many of the skills and concepts they had been acquiring over the course of the semester and apply them to the analysis of a real rock.

Solving this problem required students to also think "out of the class material" and draw on knowledge they had built in other courses. The goal was to provide students with an opportunity to develop skills necessary to operate as research scientists.

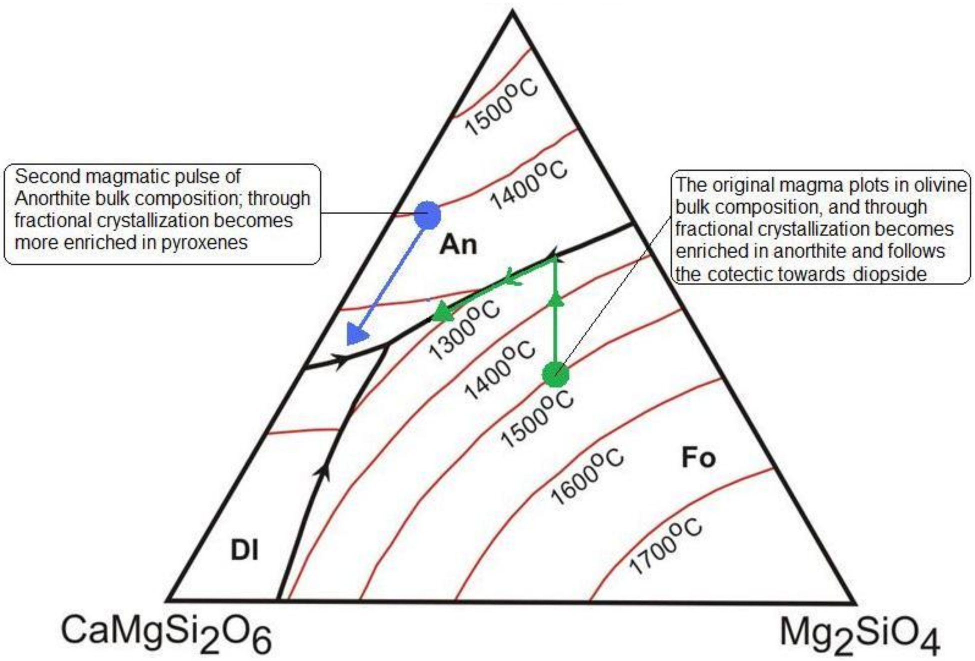

Figure 16: Phase Diagram for entire thin sections.

Discussions for the phase diagram:
The bulk composition of our first magma plots in the olivine section of our phase diagram. By observation of our complex sample and Bowen's reaction series, we can tell that olivine is the first to crystallize, as it is accumulated at the bottom of the series. During fractional crystallization, all the olivine is crystallized and settled out and the liquid composition of the remaining melt migrates toward the olivine/anorthite cotectic, as the magma is becoming enriched in anorthite.
As the melt continues to cool and crystallize, large euhedral plagioclase crystals form from the melt, and eventually pyroxenes as the liquid composition continues toward the diopside field. In the meantime, opaque oxides are forming interstitially. Their presence in cumulate and intercumulate phases suggests that the oxides were forming the whole time, independent of Bwen's series.
However, we must note that there are relatively little pyroxenes in the troctolite, though what we do have are orthopyroxenes. One possible explanation for the presence of Opx might have nothing at all to do with the natural migration of the liquid composition. It could be that a process called stoping, which the mechanical disintegration of the surrounding host rock as it reacts with the interface of the magma. If the host rock is silica rich, the melt will react with olivine in a silica over saturated environment to produce enstatite, and orthopyroxene. This would occur over the following reaction:
Mg_2SiO_4 (forsterite) + SiO_2 (quartz) à $Mg_2Si_2O_6$ (Enstatite)

Figure 4 Screenshot of a portion of one group's Wiki contribution to the final Gallery Walk. Noticeable is the construction of an original diagram, figure captions, and an extensive discussion linking observation and theory to support their hypothesis for the origin of this rock.

A marked difference in the quality of the student contributions to the Wiki from the beginning of the semester to the end of the semester was highly noticeable. The layout of information on the Wiki page was aesthetically appealing and demonstrated creativity in the design of original figures (e.g., figure 3). Answers to the questions had progressed beyond simple phrases to show an integration of material presented in lecture with technical skills typically acquired in lab (e.g., Figure 4).

The Wiki transformed a *transient* cooperative active learning environment into an *extended* cooperative active learning community. It also expanded the opportunities for synthesis and reflection by allowing unlimited access to all the problems and solutions by the entire class.

In effect, the final Wiki contribution provided a comprehensive tangible opportunity for students to demonstrate and evaluate their progress in all of the course goals.

Research Questions

We were interested in finding answers to the following exploratory questions:

1. Do students perceive Gallery Walks and Wikis as having a higher involvement than the lectures as a whole?

2. Do students find Gallery Walks and Wikis different or similar in terms of their perceived involvement?

3. What are students' attitudes toward the two tools used and their potential for enhancing their learning experience and outcomes?

Research Methodology

Due to the exploratory nature of this study, we used a mixed-methods research design that built on a combination of quantitative and qualitative data collected to complement and triangulate each other[17].

Participants

Participation was voluntary, and 18 of the 19 students registered in the course completed the exit survey. Half of the participants were male and the other half female. The group of participants was relatively diverse in terms of educational levels. Most of students (72%) were sophomore and juniors, 17% were master students while the remaining 11% equally split between freshman and seniors. Half of the participants reported a GPA ranging between 3.6 and 4.0, followed by 28% with self-reported GPA between 2.6 and 3.0. The remaining 22% of students equally split between middle (3.1 to 3.5) and lower (2.1 to 2.5) ranges of self-reported GPA.

Procedures and measures

An anonymous exit survey was administered online at the end of the course to measure students' perception of the impact of this instructional strategy. The survey included: (1) a process involvement scale for Gallery Walks, (2) a product involvement scale for Wiki, and (3) a series of open-ended questions regarding the strengths and weaknesses of these two instructional tools. Basic demographics were also included in this survey.

The two involvement instruments used in the exit survey were adapted from a validated set of items initially developed to offer a diffusion of innovation perspective on user involvement with new technology[8]. Twelve items proposed by Kappelman[8] for process involvement were adapted to measure student involvement with Gallery Walk while another 12 items initially proposed for product involvement were adapted to measure student involvement with the Wiki tool.

We proposed this differentiation to capture the major differences between the two instructional strategies. That is, Gallery Walk is typically an activity-driven strategy while Wiki participation is more of a tool-driven strategy.

The major change to the initial instruments was the format of the semantic-differential, 9-point scale, where we made the middle point representing the perceived involvement with the lecture. The middle of the scale was marked with “1” while the two ends with “5”. The middle point was also clearly marked as representing the lecture while the ends the target tool, either Gallery Walk or the Wikis (Appendix 1). The involvement scale showed a very high internal reliability (Cronbach’s Alpha of .96).

Students’ perceptions were collected with a series of open-ended questions grouped for each of the two tools, Gallery Walk and Wikis, respectively. These questions ranged from overall perception of strength and weaknesses of the target tool to highly focused questions related to the effectiveness of that tool to support specific instructional activities.

Results and Interpretation

Quantitative Analysis

Table 1 below summarizes the means, standard deviations and bivariate correlations for the two involvement scales.

Table 1: *Means, Standard Deviations, and Pearson Correlations for involvement*

	N	**M**	**SD**	**2**
1. Process Involvement (Gallery Walk)	18	6.71	1.78	.82**
2. Product Involvement (Wiki)	18	5.88	1.98	

Notes: **$p < .001$;

A one-sample t-Test using the middle of the scale (the lecture involvement) as the test value indicated a statistical significant higher involvement for the Gallery Walk than the lecture. However, even if the value of perceived involvement was higher for Wikis than for lecture, we found no statistically significant difference between them. In addition, we found a statistically significant difference between the strategy involvement for Gallery Walk and Wiki (Table 2). These findings indicate that students perceived Gallery Walks as out-of-norm-classroom activities, while Wikis were perceived more as an extension of the classroom activities.

Qualitative Analysis

For a deeper understanding of student perception and attitude toward the two complementary activities, Gallery Walks and Wikis, we first asked them to indicate what overall strengths and weaknesses they found in these instructional activities.
Of the 19 students participating in this study, 9 (47%) indicated both strengths and weaknesses, 6 (32%) indicated only strengths while 4 (21%) indicated only weaknesses.

Table 2. *Results of the t-Test Analysis for Process, Product and Strategy Involvement*

	Groups		**t**	**df**
	Gallery Walk	**Lecture**		
Process Involvement	6.71 (.42)	5.0 (.00)	4.1*	17
	Wiki	**Lecture**		
Product Involvement	5.88 (.47)	5.0 (.00)	1.9	17
	Gallery Walk	**Wiki**		
Strategy Involvement	6.71 (.27)	5.88 (.27)	3.1*	17

Notes: Values enclosed in parenthesis represent standard error mean; *p < .01

The indentified strengths ranged from a full praise of these activities to more specific of the benefits related to the *use of real problems, classroom interactivity, working in groups*, and *clarification of concepts* introduced in lectures. Below we present some sample student answers that exemplify these benefits.

> "…get people to discuss about real problems and use the materials learned in class" (Student 1)
>
> "I think there is no weaknesses. Everything was strength." (Student 2)
>
> "The gallery walks were an additional way for us to learn and be exposed to the material. Also I liked how it was out of the classroom and do on our own time with our peers." (Student 7)
>
> "…furthering our ability to work with others; the ability to work off campus as a group; allowed us to clarify confusing concepts with peers" (Student 11)
>
> "Working together in groups was excellent practice for the work world. I learned more thinking about these problems and assignments than I do just working out a problem on paper or reading a textbook." (Student 12)

The perceived weaknesses covered issued such as lack of examples to guide the work on these projects, difficulty with Wiki editing, high workload outside the classroom, or ethical issues related to the workload within groups as reflected in the sample answers below.

> "Some people might work harder than others, and if they just divide the tasks, some might not know what's going on the discussion, and conclusions." (Student 1)
>
> "Could be frustrating at times. Usually were up very late at night trying to get them done." (Student 4)
>
> "…The topics were often very confusing and more instruction would have helped a lot in understanding what was needed." (Student 10)
>
> "The wiki technology is very difficult to work with and edit, particularly with pictures…When large groups (6 or 7), longer than a week on an assignment would be helpful because schedule conflicts mean we don't work together as a group much." (Student 11)

When asked what changes would improve this activity, students' answers mapped to a high degree the weaknesses they identified. Most common suggestions targeted Wikis as follows: a) *more time to work on Wikis*; b) *more assignments on Wikis' topics to make better use of these materials*, and c) *creating an overview of each Wikis' conclusions for easier understanding*.

Conclusions and Further Actions

A plethora of strategies exists to create opportunities for active learning in higher education classrooms – however the effectiveness of such transient learning environments in transferring their benefits outside the classroom remains nebulous. We present exploratory results of student perceptions of a synergic integration of Gallery Walks (an active learning strategy) with a course Wiki (a collaborative authoring Web tool). This integration was designed to extend the benefits of active learning beyond the classroom and into a more permanent and accessible digital learning community.

The quantitative analysis of the data collected with a survey tool focusing on involvement with the instructional process used (Gallery Walks) and the tool used to complement this process (Wiki), indicated that students perceived Gallery Walks as significantly more involving than the lecture of the class while the Wikis were perceived on the same level of involvement with the lectures. In addition when directly comparing the two strategies, Gallery Walks were perceived as significantly more involving than the Wikis. This last finding suggest that active learning classroom activities such as Gallery Walks have a stronger and quicker impact on the dynamics of the classroom while online tools like Wikis provide an out-of-class extension of the activities that are initiated and facilitated during the lectures.

Students' open-ended feedback on the two instructional tools complemented these quantitative findings. The strengths indicated by the students clearly indicate the link these strategies made to the real-world problems and deeper understanding of topics at hand. On the other hand, weaknesses and the suggestions related to them by the students showed that Wikis and their related activities need more support.

Based on these findings, the next implementation of these two strategies will include:

a) A warm up Wiki activity that will help students get familiar with the tool and its constraints;
b) Setting rotating roles in the group work such as leader, Wiki editor, technical advisor;
c) Balancing the student load by replacing some of the current homework tasks with the Wiki tasks;
d) Including whole-class reviews of the Wiki problems and making stronger connections of their content with the focal topics covered during the lectures.

The research will follow the same structure to track and evaluate the changes in students' perceptions due to these changes in the instructional strategy.

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References

[1] Bold, M. (2006). Use of wikis in graduate course work. *Journal of Interactive Learning Research, 17(1),* 5.

[2] Carleton College Science Education Resource Center: References on Gallery Walk (n.d.) Retrieved from: (http://serc.carleton.edu/introgeo/gallerywalk/references.html)

[3] Cole, M. (2009). Using Wiki Technology to Support Student Engagement: Lessons from the Trenches. *Computers & Education, 52*, 141-146.

[4] Cronin, J.J. (2009). Upgrading to Web 2.0. An Experiential Project to Build a Marketing Wiki. *Journal of Marketing Education, 31(1),* 66-75.

[5] Drummond, C.N. & Markin, J.M. (2008). An analysis of the Bachelor of science in Geology degree as offered in the United States. *Journal of Geoscience Education, 56(2), 113-119.*

[6] Engstrom, M. & Jewett, D. (2005). Collaborative Learning the Wiki Way. *TechTrends, 49(6),* 12-15.

[7] Google Sites (2011) Available at: http://www.google.com/sites

[8] Kappleman, L.A.(1995). Measuring User Involvement: A Diffusion of Innovation Perspective. *The DATA BASE for Advances in Information Systems, 26(2&3),* 65-86.

[9] Kolonder, J. L. (2002). Facilitating the Learning of Design Practices: Lesson Learned from and Inquiry into Science Education. Journal of Industrial Teacher Education, 39(3), 1-31.

[10] Kosonen, M. & Kianto, A. (2009). Applying Wikis to Managing Knowledge – A Socio-Technical Approach. *Knowledge and Process Management, 16(1),* 23-29.

[11] McPherson, K. (2006). Wikis and student writing. *Teacher Librarian-Seattle-, 34(2),* 70.

[12] Nicholas, H. & Ng, W. (2009). Fostering Online Social Construction of Science Knowledge with Primary Pre-Service Teachers Working in Virtual Teams. *Asia-Pacific Journal of Teacher Education, 37(4),* 379-398.

[13] PBWorks for educators (2011). http://pbworks.com/content/edu+overview

[14] Ravid, G., Kalman, Y.M., Rafaeli, S. (2008). Wikibooks in higher education: Empowerment through online distributed collaboration. *Computers in Human Behavior, 24,* 1912-1928.

[15] Shih, W-C., Tseng, S-S & Yang, T-C (2008). Wiki-based Rapid Prototyping for Teaching-Material Design in e-Learning Grids. *Science Direct, 51*, 1037-1067.

[16] Sigala, M. (2007). Integrating Web 2.0 in e-learning environments: A socio-technical approach. International Journal of Knowledge and Learning, 3(6), 628-648.

[17] Tashkkori, A. & Teddlie, C. (2003). The Past and the Future of Mixed Methods Research: From Data Triangulation to Mixed Model Designs. In A. Tashakkori & C. Teddlie (Eds.), *Handbook of Mixed Methods in Social & Behavioral Research (pp. 671-702)*. Thousand Oaks, CA: Sage Publications, Inc.

[18] Trentin, G. (2009). Using a wiki to evaluate individual contribution to a collaborative learning project. *Journal of Computer Assisted Learning, 25(1)*, 43-55.

[19] Walsh, L. (2010). Constructive Inference: Wikis and Service Learning in the Technical Communication Classroom. *Technical Communication Quarterly, 19(2)*, 1840211.

[20] Wheeler, S. & Wheeler, D. (2009). Using Wikis to Promote Quality Learning in Teacher Training. *Learning, Media and Technology, 34(1),* 1-10.

[21] Woelk, K. 2008. Optimizing the use of personal response devices (clickers) in large enrollment introductory courses. *Journal of Chemical Education, 85(10),* 1400-1405.

[22] Wiki Spaces for educators (2011). Available at: http://www.wikispaces.com/content/for/teachers

[23] Learning Objects (http://www.learningobjects.com/)

Appendix 1
Product (Wiki) and Process (Gallery Walk) Involvement Tools

If "1", the middle of the scale, represents the lecture in this course the Wikis were:

beneficial	5	4	3	2	1	2	3	4	5	**not beneficial**
unappealing	5	4	3	2	1	2	3	4	5	**appealing**
vital	5	4	3	2	1	2	3	4	5	**superfluous**
boring	5	4	3	2	1	2	3	4	5	**interesting**
wanted	5	4	3	2	1	2	3	4	5	**unwanted**
not needed	5	4	3	2	1	2	3	4	5	**needed**
valuable	5	4	3	2	1	2	3	4	5	**worthless**
unimportant	5	4	3	2	1	2	3	4	5	**important**
relevant	5	4	3	2	1	2	3	4	5	**irrelevant**
mundane	5	4	3	2	1	2	3	4	5	**fascinating**
essential	5	4	3	2	1	2	3	4	5	**nonessential**
undesirable	5	4	3	2	1	2	3	4	5	**desirable**

If "1", the middle of the scale, represents the lecture in this course the Gallery Walks were:

important	5	4	3	2	1	2	3	4	5	**unimportant**
irrelevant	5	4	3	2	1	2	3	4	5	**relevant**
means a lot	5	4	3	2	1	2	3	4	5	**means nothing**
useless	5	4	3	2	1	2	3	4	5	**useful**
valuable	5	4	3	2	1	2	3	4	5	**worthless**
trivial	5	4	3	2	1	2	3	4	5	**fundamental**
beneficial	5	4	3	2	1	2	3	4	5	**not beneficial**
insignificant	5	4	3	2	1	2	3	4	5	**significant**
vital	5	4	3	2	1	2	3	4	5	**superfluous**
nonessential	5	4	3	2	1	2	3	4	5	**essential**
wanted	5	4	3	2	1	2	3	4	5	**unwanted**
not needed	5	4	3	2	1	2	3	4	5	**needed**

Adapted from Kappelman [8].