Redesigning a Large Lecture Course for Student Engagement: Process and Outcomes

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Abstract
Using an action-research approach, a large-lecture science course (240 students) was redesigned to improve student engagement in the areas of active and collaborative learning, faculty-student interaction and level of academic challenge. This was mainly achieved through the addition of a half-semester long group project, which replaced half of the lectures and the final exam. The course redesign did not result in more hours spent on teaching and teaching-related activities (grading, assessment preparation, lecturing, lecture preparation) for the instructor – although the redesigned course requires the support of teaching assistants for the project component. Data on students’ perceptions of the modified course and the frequency to which they participated in the engagement activities were collected using the Classroom Survey of Student Engagement (CLASSE). The majority of students reported high levels of engagement in most of the intended areas and were comfortable with the new class design. The CLASSE data also helped identify areas where intended engagement levels were not met. These areas are the focus for future course development and action research questions.

Utilisant une approche de type recherche-action, un cours de science offert dans un grand auditorium (240 étudiants) a été reconfiguré afin d’amener les étudiants à s’engager davantage dans un apprentissage actif et collaboratif ainsi que dans leur interaction professeur-étudiants et à relever un défi de nature académique. Pour ce faire, la moitié des cours magistraux ainsi que l’examen final ont été remplacés par un projet de groupe. La reconfiguration du cours ne s’est pas traduite par une augmentation des heures d’enseignement ou des activités liées à l’enseignement (notation, préparation des évaluations, exposé magistral, préparation de l’exposé magistral) – bien qu’elle ait nécessité le soutien des assistants à l’enseignement pour la composante projet de groupe. Les chercheurs ont effectué un sondage en classe afin de recueillir des données sur la perception des étudiants à propos du cours modifié et sur la fréquence à laquelle ils ont participé aux activités favorisant leur engagement. La majorité des étudiants a rapporté un niveau élevé d’engagement dans la plupart des domaines souhaités et a déclaré se sentir à l’aise avec le cours reconfiguré. Les données du sondage ont également permis d’identifier les domaines dans lesquels le niveau d’engagement souhaité n’était pas atteint. Une nouvelle version du cours de même que les questions posées dans le cadre d’une autre recherche-action tiendront principalement compte de ces domaines.

Keywords
student engagement, course redesign, understanding by design, classroom survey of student engagement

Cover Page Footnote
I would like to thank the students from the Mountains Course in who took part in this redesign and shared their experiences. I would also like to thank Patti Dyjur from the Teaching and Learning Centre at the University of Calgary, who assisted me during the redesign process. Thanks also to Susan Cannon for her peer review of my data analysis and for helpful comments editing this manuscript. Finally, I would like to thank the two anonymous reviewers who provided thoughtful comments and suggestions that helped improve the final version of the manuscript. This study was funded by the Tamaratt Teaching Professorship at the University of Calgary.

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At universities across Canada, many non-science undergraduate students take science option courses to complete their program requirements. At the institution where this study took place, these courses are often large (120-400 students) and taught in lecture format. The class that is the subject of this paper (herein referred to as the Mountains Course) is one of these courses. Its focus is on the geologic history, resources and hazards of the mountains of western Canada. It is a large enrollment science course (240-280 students), taught every winter semester in a lecture theatre with fixed, tiered seating. Students in the course come from a variety of programs from Faculties across campus (including Arts, Business and Science) and are at various points in their program of study (5% of students are in first year, 40% in second year, 30% in third year and 25% in their fourth and final year of their program).

After teaching the Mountains Course for several years using a lecture-intensive format, and becoming familiar with the research on the impact of engagement on student learning, motivation and development, I became interested in redesigning the course to incorporate engagement practices. For example, course activities that provide an appropriate level of challenge, allow students to have flexibility and control, and provide opportunities for feedback and reflection can increase students’ motivation to learn (Ambrose, Bridges, DiPietro, Lovett, & Norman, 2010). Collaborative learning activities—such as working with other students on course assignments and completing group projects—have also been found to increase student learning (Armstrong, Chang, & Brickman, 2007; Cortright, Collins, & DiCarlo, 2005; Terenzini, Cabrera, Colbeck, Parente, & Bjorklund, 2001). Research such as that of Knight & Wood (2005) have also found that students in a lecture-only classes do not perform as well as students in a mixed lecture and active learning classes on concept tests administered before and after instruction. Such research has prompted the call for more engaged undergraduate classrooms and a reduction of time spent lecturing (Handelsman, Ebert-May, Beichner, Bruns, Chang, DeHaan, Gentile, Lauffer, Stewart, Tilghman, & Wood, 2004).

In the lecture-intensive format of the Mountains Course, there were no formal opportunities for collaborative learning and no opportunities for students to exercise some flexibility and control over their learning. At this time it became apparent to me that there was an inconsistency between my teaching philosophy (which had student-centered practices and engagement at the core) and my teaching practice (which was predominantly teacher-centered). For example, in my teaching philosophy statement I espoused that it was important students have opportunities to engage with each other, the instructor, and the material they were learning. However, I was teaching the Mountains Course in a predominantly lecture-style format with no meaningful opportunities for this kind of engagement. (A detailed description of the traditional class structure is described in “Before the Redesign – The Traditional Course” section of this paper.) I also espoused the importance of students having opportunities to direct the course of their own learning – difficult to accomplish with the lecture-style format. From this place of dissatisfaction, I decided to redesign the Mountains Course using student engagement as a focus. I decided to document the process and outcomes for the pilot year of the redesign so I could compare the two course models, and use this comparison to make informed decisions about further course modifications. The results of this redesign are the focus of this paper. Ethics approval was obtained by the institution’s Conjoined Faculties Research Ethics Board to conduct a study of the redesign and its outcomes.
Why Student Engagement?

Research on the impact of higher education on student development over the past 30 years has demonstrated links between certain educational practices and increased student learning and development (Astin, 1993; Carini, Kuh, & Klein, 2006; Chickering & Gamson, 1987; Kuh, 2001a; Pascarella & Terenzini, 2005). The National Survey of Student Engagement (NSSE) is a survey instrument developed to measure the time and effort students put into educational practices that are linked to learning and development (collectively referred to as engagement activities) over the course of a school year (Kuh, 2001a, 2001b). Questions on the NSSE survey focus on five areas or benchmarks of student engagement. Of these five benchmarks, three – Active and Collaborative Learning, Faculty-Student Interaction and Level of Academic Challenge – are directly influenced by what students do in their classes. These activities are summarized in Kuh (2009) and outlined in Table 1 below.

<table>
<thead>
<tr>
<th>Benchmark</th>
<th>Engagement Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active and Collaborative Learning</td>
<td>Asked questions in class.</td>
</tr>
<tr>
<td></td>
<td>Contributed to a class discussion.</td>
</tr>
<tr>
<td></td>
<td>Made a class presentation.</td>
</tr>
<tr>
<td></td>
<td>Worked with other students on projects during class time.</td>
</tr>
<tr>
<td></td>
<td>Worked with classmates outside of class to prepare class assignments.</td>
</tr>
<tr>
<td></td>
<td>Tutored or taught other students.</td>
</tr>
<tr>
<td></td>
<td>Participated in a community-based project.</td>
</tr>
<tr>
<td></td>
<td>Discussed ideas from your readings or classes with others outside of class (students, family members, coworkers or others).</td>
</tr>
<tr>
<td>Faculty-Student Interaction</td>
<td>Discussed grades or assignments with an instructor.</td>
</tr>
<tr>
<td></td>
<td>Discussed ideas from your readings or classes with faculty members outside of class.</td>
</tr>
<tr>
<td></td>
<td>Received prompt feedback from faculty on your academic performance (written or oral).</td>
</tr>
<tr>
<td>Level of Academic Challenge</td>
<td>Preparing for class (studying, reading, writing).</td>
</tr>
<tr>
<td></td>
<td>Number of assigned readings.</td>
</tr>
<tr>
<td></td>
<td>Number of written assignments.</td>
</tr>
<tr>
<td></td>
<td>Coursework emphasizing mental activities including analyzing, synthesizing, organizing ideas, making judgments, application of theories.</td>
</tr>
<tr>
<td></td>
<td>Working hard to meet instructors’ standards or expectations.</td>
</tr>
</tbody>
</table>

Since 2004, Canadian post-secondary institutions have begun to regularly administer NSSE to their students across to better understand levels of student engagement on their campus (“NSSE: National Survey of Student Engagement”, 2012). NSSE data has been used to help
institutions identify levels of student engagement (and lack thereof) and develop strategies to improve students’ experiences (Conway, Zhao, & Montgomery, 2011). NSSE data is also used as a metric to rank Canadian post-secondary institutions for prospective students (“How students rate their experiences”, 2012). However, NSSE data is limited in that it focuses on a student’s experience in all of their classes over an entire year – what is happening at the course level cannot be determined. To get at this information, an instructor can administer the Classroom Survey of Student Engagement (CLASSE) at the end of a semester to obtain information on student perceptions of engagement activities (Smallwood & Ouimet, 2009 as cited in Banta, Jones, & Black, 2009, p. 175). There is also a faculty component to the survey (Faculty CLASSE) to be completed by the instructor before the semester begins in which faculty rate the importance of the engagement activities in their class.

The links between classroom engagement practices and student learning, motivation, and satisfaction have been the focus of research in higher education. In particular, research on the use of active learning techniques in classroom instruction—incorporation of problem-based learning, collaborative and cooperative activities—has been found to increase student motivation to learn, student engagement and improved learning (Ahlfeldt, Mehta, & Sellnow, 2005; Cavanagh, 2011; Cherney, 2008; Hake, 1998; Kuh, 2009; Prince, 2004; Terenzini et al., 2001; Yoder & Hochevar, 2005). Research has also shown that instructors who communicate high expectations for student learning and engagement and develop courses that reflect and support those expectations can promote deep approaches to learning (Baeten, Kyndt, Struyven, & Dochy, 2010; Entwistle & McClune, 2004; Fyrenius, Wirell, & Silen, 2007). For a summary of research on the impact of engagement practices on student learning and development, see Kinzie (2010).

Methodological Framework

Action research, as defined by Stringer (2007), is a systematic approach to investigating and finding effective solutions to problems people encounter in their professional settings. Action research is widely used in educational settings as a framework by which educators can systematically investigate an aspect of their situation (i.e. student learning, student engagement, curriculum, teaching practices) with the goal of gathering information, gaining insight, and improving practice (Altrichter, Feldman, Posch, & Somekh, 2008; Mills, 2006). While there are numerous action research models, they have common components including identifying and/or posing questions, collecting data, analysis and interpretation, and reflection/planning for future action. This process is often carried out in an iterative manner, allowing for constant analysis and improvement of the aspect under study. I elected to follow the action research model of Kuhne and Quigley (1997) to provide a scholarly structure to the course redesign process. This model involves three stages: (a) planning, (b) action, and (c) analysis and reflection.

The planning stage involved identifying specific action research questions and selecting the measures I would use to evaluate the impact of the redesign.
Previous experiences teaching the Mountains Course had given me the insight necessary to generate numerous action research questions, which were eventually honed down to the following three:

1. How can a large enrollment course be designed to better align with the principles of student engagement?
2. How can data provide insight in understanding the impact of the redesign?
3. What are the resource implications for redesigning and teaching a course with increased student engagement?

In this stage I decided what data was required in order to understand the impact of the redesign. Certain course artifacts (course outline, course schedule, recorded time spent on developing class activities and classroom observations) could be used to compare the redesigned course to the traditional course. To collect data on the students' perspective of the course redesign, I used the Classroom Survey of Student Engagement (CLASSE) (Smallwood & Ouimet, 2009). I selected this instrument because it measures student engagement – a primary issue to be addressed in the redesign. CLASSE also includes a faculty component, allowing me to rate and compare the importance I placed on certain engagement activities introduced through the course redesign with what students actually report doing. The survey is intended to be administered to students at or near the end of a course and can easily be administered and analyzed using an online survey platform. I chose to formally survey students once throughout the course as I was mindful of not over-surveying, which can compromise survey response rates (Porter, Whitcomb, & Weitzer, 2004). With the CLASSE survey being administered only once, immediately after students finished the course, they could reflect on their entire course experience and the risk of survey fatigue would be minimized.

The second stage in the action research model is action. This involved developing the redesigned course, which included revising the learning goals, assessment strategies, and learning activities that would be part of the course. A detailed description of the development of the modified course model can be found in the Redesign Process section of this paper. This stage also involved teaching the course using the newly redesigned course model and collecting data for the final stage.

The final stage involved compiling and analyzing the data collected, and identifying areas for improvement and further investigation. Students’ engagement experiences in the redesigned course were collected through the Classroom Survey of Student Engagement (CLASSE) survey at the end of the semester. I also compared the two course designs in the categories of engagement defined by Kuh (2009) (see Table 1) and the impact on the time and resources needed to teach the redesigned course.

**Before the Redesign – The Traditional Course**

The traditional class structure consisted of three face-to-face lectures per week. Teaching assistants were not assigned to the course. During scheduled class time students mainly listened to a live lecture and took notes. Approximately 10% of the time in each class was spent on engagement activities such as small-group work, informal class discussions and answering
questions from the students. The remaining 90% of class time was dedicated to direct instruction (lecturing) with students passively listening and taking notes. These times were calculated using classroom observation data collected by a research assistant, who recorded the time spent on different types of learning activities throughout the semester.

Learning Objectives

The learning objectives for the traditional course model focused on content knowledge in three main thematic areas related to the mountains of western Canada (e.g., geologic history and processes, natural hazards and geologic resources). Table 2 outlines the learning objectives. I used the objectives primarily as a guide to determine the topics to be covered during the lectures and the topics on which students would be tested.

Table 2. Learning Objectives for the Traditional Course Model

<table>
<thead>
<tr>
<th>Theme</th>
<th>Objective (Students will learn....)</th>
<th>Topics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geologic History and Processes</td>
<td>About the geologic history of the Canadian Cordillera (or how the mountains west of Calgary became the mountains we see today).</td>
<td>plate tectonics, rock formation, erosion and glaciations, geologic time</td>
</tr>
<tr>
<td>Hazards</td>
<td>About the ongoing geologic processes happening in the present Canadian Cordillera and the geologic hazards that exist.</td>
<td>volcanoes, earthquakes and landslides of the past and present</td>
</tr>
<tr>
<td>Resources</td>
<td>About the different geologic resources found in the Canadian Cordillera and how they form.</td>
<td>metals and fossil fuel resources (coal, oil and gas), mining processes and environmental issues</td>
</tr>
</tbody>
</table>

Assessment of Student Learning

The formal assessment of student learning consisted of multiple-choice tests – two 50-item tests during the semester (worth 25% each) and one 100-item final exam (worth 50%). The test questions focused on content covered in the lectures. Approximately half of the questions on each test required students to recall facts; the other half required students to apply concepts covered in class to a novel situation or problem. An example of each type of multiple-choice question is shown in Table 3.
Table 3. Examples of the Two Main Types (Factual Recall and Apply) of Multiple-Choice Questions Asked on the Traditional Assessments

<table>
<thead>
<tr>
<th>Question Type</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factual Recall</td>
<td>What geologic event caused the westward movement of the North American continent to initiate mountain building?</td>
</tr>
<tr>
<td></td>
<td>a) orogenic collapse of the Cordillera</td>
</tr>
<tr>
<td></td>
<td>b) accretion of the terrane rocks</td>
</tr>
<tr>
<td></td>
<td>c) formation of the Coast Belt</td>
</tr>
<tr>
<td></td>
<td>d) break-up of Pangea</td>
</tr>
<tr>
<td>Apply</td>
<td>If you were to travel back in time to Vancouver Island 1 Ma (1 million years ago), what geologic activity would you likely observe?</td>
</tr>
<tr>
<td></td>
<td>a) Volcanic eruptions from the island arc volcanoes of the Insular Belt.</td>
</tr>
<tr>
<td></td>
<td>b) Geologists mapping out the location of coal and gold deposits.</td>
</tr>
<tr>
<td></td>
<td>c) The formation of thrust faults caused by tectonic accretion and mountain building.</td>
</tr>
<tr>
<td></td>
<td>d) Cordilleran glaciers flowing from areas of high elevations, filling mountain valleys with ice.</td>
</tr>
</tbody>
</table>

Learning Activities

The main activity students did in classes in the traditional course was note taking. I made the lecture notes (in the form of PowerPoint slides) available to students before each class through the course website. I also used a tablet laptop computer to annotate the notes during the lecture and highlight features in figures and diagrams.

Engagement activities were typically questions I posed to the class, intended to have the students first think about a problem or concept and then form small groups and share their ideas with classmates. While students were working, I would circulate through the room and interact with them, answering questions and informally assessing their understanding of the problem or concept by listening to the discussions. After students were given some time to work through the question, I would lead a class discussion focusing on the question and the students’ ideas. These think-pair-share activities took students 5 to 15 minutes to complete. There was no formal assessment of student learning on these activities.

The Redesign Process

For the course redesign process, I followed the Understanding by Design (UbD) model of Wiggins and McTighe (2005). This model was chosen because of its strong alignment with the research findings on learning and the implications for instruction (Bransford, Brown & Cocking, (Eds.), 1999). The UbD model follows three stages. In Stage one, the conceptual framework and intended learning outcomes for the course are developed. Wiggins and McTighe (2005) refer to the learning outcomes developed in this stage as the “Big Ideas” and “Enduring Understandings.” Stage two involves identifying assessment strategies needed to evaluate students’ understanding as related to the learning objectives. Stage three of the UbD model is planning instructional activities that help students achieve learning objectives.
Using this model helped ensure that the classroom engagement activities developed would be informed by the learning objectives and assessment strategies, avoiding one of the common errors of instructional design identified by Wiggens and McTighe (2005) of planning activities first without well-developed learning objectives and assessment plan.

The redesign process took place over a five-month time frame. During this period, each UbD stage was guided by the action research questions. While the overall redesign process appears to be linear, on a finer scale, the process was iterative as the development of materials for one stage would influence and necessitate change in another. The next section describes the details of the redesigned course model.

**Redesign Outcomes**

There were fundamental changes to the intended course learning outcomes, assessment strategies and learning activities in the redesigned (modified) course. The learning objectives moved beyond learning scientific facts, concepts and knowledge to include understanding the nature of scientific research and the scientific method as well as the relationship between the geosciences and society as related to the mountainous regions of western Canada. In order to ensure that the newly developed learning outcomes were emphasized in the coursework and could be achieved by students, the addition of a student research project (made possible by the reduction of lecture time and removal of the final exam) highlight the major changes to the course design. A project was chosen because it allowed for students to explore topics of their own interest and through that exploration achieve the desired outcomes around the “Big Ideas” of Geosciences and Society and about Geoscientific Research. A project also emphasized higher order thinking skills such as synthesize, analyze and make judgments. The project was designed to be a group project. There were two main reasons for this decision. First, this allowed for an increase in student engagement in the domain of Active and Collaborative Learning and second, it reduced the number of projects (and project components) to be graded. It is also important to note that for the modified course I had access to financial resources to allow for the hiring of up to four half time teaching assistants (half time is equivalent to an average of three hours of work per week) to support student engagement activities in this class. This also played a role in deciding to develop a project component for the course. These changes are explained in more detail in the following three sections.

**Learning Objectives**

In the UbD model, learning objectives are expressed in the big ideas and enduring understandings. The big ideas are the major themes that provide a conceptual framework for the course; the enduring understandings are statements that describe the level of understanding students are intended to achieve and are linked to the big ideas. The essential questions frame the big ideas and serve as entryways into exploring the content. In total, six big ideas were developed for the course: mountain building, glaciers and mountain landscapes, geologic hazards and human risk, geologic resources and exploration, geoscientific research, and geosciences and society. Table 4 is an example of two of the course’s six big ideas and their corresponding enduring understandings and essential questions.
<table>
<thead>
<tr>
<th>Big Idea</th>
<th>Enduring Understandings (Students will understand that….)</th>
<th>Essential Questions (Students can answer and discuss the following questions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mountain Building</td>
<td>The mountains of western Canada have formed from a complex interaction of tectonic plates in the geologic past.</td>
<td>How did plate tectonic processes cause the mountains to form in Western Canada?</td>
</tr>
<tr>
<td></td>
<td>Tectonic activity is still ongoing in Western Canada.</td>
<td>When did the mountains start forming? What are the key stages of mountain development?</td>
</tr>
<tr>
<td></td>
<td>This history of mountain building is recorded in the rock types found throughout the mountains of Western Canada.</td>
<td>What parts of the mountains are still tectonically active? Which aren’t?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>How did tectonic processes of the past affect the formation and distribution of the different rock types found throughout the mountains?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>How does understanding the tectonic history help society?</td>
</tr>
<tr>
<td>Geosciences and Society</td>
<td>The geology and geologic processes of the mountains affects the distribution and livelihoods of human populations in the mountains.</td>
<td>How do the geologic processes in the mountains of Western Canada affect humans?</td>
</tr>
<tr>
<td></td>
<td>The mountains are special to humans. Their resources have affected the history and development of Western Canada, have driven human exploration and have inspired (and continue to inspire) human endeavors that include art, literature, recreation and science.</td>
<td>How are the mountains of western Canada unique? How did they influence early exploration and development of western Canada?</td>
</tr>
<tr>
<td></td>
<td>A geoscience-literate society, informed by current and accurate scientific understanding of the mountain processes, hazards and resources is critical to the promotion of sound policy, hazard mitigation, environmental stewardship and preservation of the natural beauty for enjoyment and recreation.</td>
<td>What should citizens know about geologic processes in the mountains? What should they know about hazards, risk and hazard mitigation?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>What current environmental issues are unique to the mountains?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Why do the mountains draw humans there to recreate? What is beautiful about the mountains?</td>
</tr>
</tbody>
</table>
Assessment of Student Learning

Students’ understanding of the concepts covered in lectures was assessed in two multiple-choice tests during the lecture component (first half) of the modified course. Much of the content in the lecture component focused on the big ideas of mountain building, glaciers and mountain landscapes, geologic hazards and human risk, and geologic resources and exploration. Students’ understanding of the geoscientific research and geosciences and society big ideas was incorporated into the project component of the course. Assessment of the project was broken down into a number of smaller elements so both the final project and the process of completing the project were part of the overall assessment. A breakdown of the assessment strategies and their worth is summarized in Table 5.

Table 5
Breakdown of Assessment Strategies and their Worth for Modified Course

<table>
<thead>
<tr>
<th>Assessment Strategy</th>
<th>Worth (% of student grade)</th>
<th>Timing of Assessment</th>
<th>Class Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple Choice Test #1</td>
<td>20%</td>
<td>End of the 3rd week of classes</td>
<td>Primarily lectures with informal problem-solving group activities throughout</td>
</tr>
<tr>
<td>Multiple Choice Test #2</td>
<td>20%</td>
<td>End of the 7th week of classes</td>
<td></td>
</tr>
<tr>
<td>Project Proposal</td>
<td>5%</td>
<td>Due before end of the lecture portion of the class</td>
<td>Group work – meeting times for students to work on project research and get feedback from instructor and teaching assistants</td>
</tr>
<tr>
<td>Team Contract</td>
<td>5%</td>
<td>Due at the end of the first team meeting</td>
<td></td>
</tr>
<tr>
<td>Project Progress Reports</td>
<td>5%</td>
<td>Weekly reports throughout the project component of the course</td>
<td></td>
</tr>
<tr>
<td>Team and Self Assessment</td>
<td>5%</td>
<td>Due the last day of classes</td>
<td></td>
</tr>
<tr>
<td>Project Presentation</td>
<td>10%</td>
<td>During the last week of class</td>
<td>Project presentation</td>
</tr>
<tr>
<td>Final Project</td>
<td>30%</td>
<td>Due the last day of classes</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Learning Activities

The lecture component of the course used the same learning activities as in the traditional course (lectures with the tablet computer, small group activities and discussions, whole class discussions and question and answer sessions). These activities also served as a means by which students could meet each other and start forming their project groups and developing areas of interest for the focus of their project, which was strongly encouraged during these activities. During the second half of the semester – in the project component of the course – the learning activities during scheduled class time consisted of students working on their projects within their teams. During these times, student groups would conduct research, report on their weekly achievements, ask questions and get feedback, write and/or edit their work and plan out weekly tasks to complete. Students were also required to give a verbal weekly progress report, before the end of the scheduled class time, on their project.
Analysis

Data to assess the impact of the course redesign on student engagement, compare the traditional and modified course designs, and reflect on my teaching practice, were collected from multiple sources. These included course documents (course outlines, course schedule, records on time spent developing classroom activities), the CLASSE student and faculty surveys and classroom observations.

Comparison of Course Designs

In the first stage of analysis, a systematic comparison of the traditional and modified course designs in three areas of student engagement defined by Kuh (2009) – Active and Collaborative Learning, Faculty-Student Interaction and Level of Academic Challenge – was completed to identify how, and to what extent, the modified course design creates more opportunities for student engagement. The data used to complete the comparison of course designs were the course outlines, course schedule (to compare the time dedicated to class activities), assessment documents, and assessment rubrics (for the modified design). This comparison is summarized in Table 6.
## Table 6. *Comparison of the Traditional and Modified Course Designs Between Benchmarks of Student Engagement*

<table>
<thead>
<tr>
<th>Engagement Area</th>
<th>Engagement Activity</th>
<th>Traditional Course</th>
<th>Modified Course</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Asked questions in class</td>
<td>Lecture activities encouraged questions in class</td>
<td>Lecture activities encouraged questions in class Project meeting classes encouraged questions</td>
</tr>
<tr>
<td>Active and Collaborative Learning (ACL)</td>
<td>Made a class presentation</td>
<td>No presentations in traditional model</td>
<td>End of semester final project presentation</td>
</tr>
<tr>
<td></td>
<td>Worked with other students on projects</td>
<td>No project in traditional model</td>
<td>45% of classes are dedicated entirely to group work (Active and Collaborative learning)</td>
</tr>
<tr>
<td></td>
<td>Worked with classmates to prepare an assignment</td>
<td>No assignments in traditional model</td>
<td>Project is designed to be completed within a group</td>
</tr>
<tr>
<td></td>
<td>Tutored or taught other students</td>
<td>Lecture activities encouraged teaching other students</td>
<td>Lecture activities encouraged teaching other students Project encourages peer teaching within groups</td>
</tr>
<tr>
<td></td>
<td>Discussed ideas from readings or classes with others outside of class</td>
<td>Lectures cover topics of student interest identified in pre-course survey. Potential for out-of-class discussion.</td>
<td>Lectures cover topics of student interest identified in pre-course survey. Potential for out-of-class discussion. Project allows in-depth exploration of areas of student interest. Potential for out-of-class discussion.</td>
</tr>
</tbody>
</table>
Table 6 (continued)

<table>
<thead>
<tr>
<th>Engagement Area</th>
<th>Engagement Activity</th>
<th>Manifestation of Engagement Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faculty</td>
<td>Discussed grades or assignments with instructor</td>
<td>Students can discuss test results with instructor</td>
</tr>
<tr>
<td>Student</td>
<td></td>
<td>Students discuss project assignment weekly with instructor and/or teaching assistant as it is a project requirement</td>
</tr>
<tr>
<td>Interaction (FSI)</td>
<td>Received prompt feedback on academic performance</td>
<td>Test results provide students with feedback on their performance</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Test results provide students with feedback on their performance – feedback is summative Weekly project progress reports ensure student groups receive frequent formative feedback</td>
</tr>
<tr>
<td>Level of</td>
<td>Number of assigned readings</td>
<td>Lecture readings: ~8 assigned</td>
</tr>
<tr>
<td>Academic</td>
<td></td>
<td>Lecture readings: ~8 assigned</td>
</tr>
<tr>
<td>Challenge (LAC)</td>
<td>Number of written assignments</td>
<td>Project components: proposal, progress reports and final project, peer and self reflection report</td>
</tr>
<tr>
<td></td>
<td>Coursework emphasizing mental activities</td>
<td>Tests: emphasize memorize and apply</td>
</tr>
<tr>
<td></td>
<td>including analyzing, synthesizing, organizing ideas</td>
<td>Readings: emphasize synthesize and organize</td>
</tr>
<tr>
<td></td>
<td>Working hard to meet instructors standards or expectations</td>
<td>Tests challenge students to apply knowledge</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tests challenge students to apply knowledge Project challenges students to synthesize, organize &amp; make judgments of information</td>
</tr>
</tbody>
</table>
Active and Collaborative Learning (ACL)

As shown in Table 6, the addition of the student research project increased opportunities for engagement in the area of ACL. The scheduling of classes dedicated to project work ensured that students worked together. The project also increased the likelihood of students meeting outside of class time to do the course work, although this was not a requirement. The traditional model had no student presentations, whereas in the modified course, the project component included a conference-style poster presentation where student groups presented their work to a poster ‘adjudicator’ and then answered questions.

A comparison of the time dedicated to active and collaborative learning was done by tracking the amount of class time dedicated to direct instruction (DI) versus active and collaborative learning (ACL). A research assistant in both the traditional and modified course completed classroom observations over the two semesters and tracked the time spent on each activity. DI activities included all the time when I was lecturing and students were passively listening or taking notes. ACL activities included students working on a problems or questions individually or in small groups during the lectures, participating in small group or class discussions or asking questions during class.

As shown in Figure 1, the amount of time dedicated to DI in the modified course decreased from 90% to 45% with a subsequent increase in ACL activities. This is a result of incorporating six weeks of class time dedicated exclusively to students working in small groups on their team project.

![Figure 1](image.png)

*Figure 1.* Comparison of traditional and modified courses showing amount of class time dedicated to DI and ACL activities.

Faculty-Student Interaction (FSI)

The modified course design created opportunities for faculty-student interaction throughout the semester, also as a result of the addition of the project component. In the class time dedicated to project work, the teams would check in with a teaching assistant or myself.
They would provide a short verbal report on their progress and receive feedback. This process would take about 10 minutes per group. The remainder of the class time was spent with students working on the next steps of their project with the opportunity to ask questions and talk to the instruction team.

Compared to the traditional model, the redesigned course model increased the opportunities, and requirements, for faculty-student interaction (Table 6). In the traditional course, I estimate I gave feedback to approximately 10-15% of my students (This estimate is based on records kept on the number of students who attended my office hours to review their tests and/or ask questions about their learning or asked questions during class.). In the modified course, every student group received feedback on their work at least once a week during the project component. The limitation to giving the group feedback is that individual students did not necessarily receive one-on-one feedback on their performance or work within the team.

**Level of Academic Challenge (LAC)**

Both course models emphasized the mental activities of memorize and apply on the multiple-choice tests. The inclusion of the group project created the opportunity for students to engage in other mental activities including synthesize, analyze and make judgments, increasing the opportunity to engage in a higher level of academic challenge in the course (Table 6). In terms of academic skills, the only shared skill in both course designs was reading research papers. Additional skills the modified course emphasized as a result of the project are:

- defining a project topic and scope
- finding research publications, reports and resources about project topic
- assessing the quality of information
- summarizing / synthesizing the findings from multiple research papers
- team work (communication, negotiation, division of tasks)
- project management (developing goals and timeline, assigning tasks, reporting to team, reporting to instructional team)
- self-assessment and peer-assessment
- presentation skills (preparing succinct summary of project, answering questions about project findings)

**CLASSE Student and Faculty Survey Results**

The CLASSE survey was completed by all students in the class (n=240) at the end of the semester. The response rate reported here represents the students who consented to their survey data being used for research (n=127), which is a 52% response rate.

Students completed the CLASSE survey the week after the course had finished and after they handed in their final projects. A copy of the student and faculty CLASSE instruments are in the Appendix. The survey was administered online through Survey Monkey. I completed the Faculty component of the CLASSE survey just before teaching the modified course and after the course redesign was completed. In order to compare engagement levels during the lecture component of the course with the project component of the course, some of the questions on the CLASSE survey were asked twice – once for each component. For example: students were asked how difficult they found the lecture portion of the course as well as how difficult they found the
project portion of the course, rather than being asked the original question, “How difficult is the course material.”

I first compared the data from the faculty and student CLASSE surveys by doing a quadrant analysis recommended by Smallwood (2011). I completed this analysis by correlating the faculty and student responses from the respective surveys into the four quadrants (see Table 7). First, the Faculty CLASSE responses were put into two categories: those engagement items I rated as “very important” or “important” and those I rated as “somewhat important” or “not important”. Next, student responses were put into two categories: “low frequency” and “high frequency”. An item was assigned to the low frequency category if the combined total of students who chose the two less positive options (i.e. lower frequency) was 50% or more. The “high frequency” category was assigned if the combined total of students who chose the two more positive options was 50% or more. From there the data could be divided into four quadrants based on the alignment of student frequency and instructor importance for each engagement activity. This perspective allowed me to see the relationship between my ratings of importance of engagement elements and their frequency of occurrence reported by students. The analysis highlights areas where my rating of importance and more than 50% of the students response rated that item were consistent (quadrants 2 and 3) and, more importantly, the areas where instructional importance were not consistent with what students reported (quadrants 1 and 4). Of the 36 engagement activities students were asked to report on, 26 of them were aligned with the level of importance I had placed on them (quadrants 2 and 3); 10 engagement activities were not aligned (items in quadrants 1 and 4). Of particular interest to me were the engagement items that had misalignment between my rating of importance and students frequency reports. These items provided a starting place to focus my reflections of the redesigned course and identify areas for improvement.
Table 7
Relationship between Instructor Rating of Importance on an Engagement Activity and Frequency of Occurrence Reported by Students

<table>
<thead>
<tr>
<th>Quadrant 1</th>
<th>Quadrant 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instructor Rating:</td>
<td>Instructor Rating:</td>
</tr>
<tr>
<td>Very Important or Important</td>
<td>Very Important / Important</td>
</tr>
<tr>
<td>Student Reporting:</td>
<td>Student Reporting:</td>
</tr>
<tr>
<td>Low Frequency</td>
<td>High Frequency</td>
</tr>
</tbody>
</table>

- Asked questions during class
- Included diverse perspectives in discussions or assignments
- Discussed grades or assignments with the instructor
- Worked harder than you thought to meet course expectations
- Coursework emphasizes synthesizing
- Contributed to a group discussion during project meeting
- Worked on an assignment / project that required integrating ideas or information from various sources
- Worked with other students on activities during class
- Discussed ideas from this class with others outside of class
- Received prompt oral or written feedback on your academic performance
- Coursework emphasizes analyzing
- Students interested in learning the course material
- Project challenges students to do their best work
- Attend classes
- Take notes during lectures
- Comfortable with the class atmosphere
- Comfortable talking with the instructor
- Enjoy group work with classmates
- Easy to follow the lectures
- Worked with classmates outside of class to prepare the project
Table 7 (continued)

<table>
<thead>
<tr>
<th>Quadrant 3</th>
<th>Quadrant 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instructor Rating:</td>
<td>Instructor Rating:</td>
</tr>
<tr>
<td>Somewhat Important or Not Important</td>
<td>Somewhat Important or Not Important</td>
</tr>
<tr>
<td>Student Reporting:</td>
<td>Student Reporting:</td>
</tr>
<tr>
<td>Low Frequency</td>
<td>High Frequency</td>
</tr>
</tbody>
</table>

- Contributed to a class discussion during lectures
- Prepared two or more drafts of an assignment in class before turning it in
- Studied with a classmate to prepare for a test
- Tutored or taught other students in the class
- Used email to communicate with the instructor
- Coursework emphasizes making judgments
- Coursework emphasizes applying theories
- Put together ideas or concepts from different courses when completing the project
- Spend more than 3 hours per week preparing for class
- Review notes prior to class
- Course material in lectures is difficult

- Used an electronic medium to discuss or complete an assignment in class
- Tests challenge students to do their best work
- Coursework emphasizes memorizing
- Project is difficult
- Worked with classmates outside of class to prepare an assignment

*Note: Low frequency indicates less than 50% of students reported a low frequency or no frequency of participation in the particular engagement activity; high frequency – more than 50% of students reported doing the activity more frequently.*)
Specific CLASSE Questions

In this section I highlight some of the specific CLASSE questions that were directly related to the engagement activities developed for the redesigned course model. These questions provided insight into the effects of the modified course design on student engagement. I have grouped these questions into their respective areas of engagement.

Active and Collaborative Learning (ACL)

The responses to three ACL questions that pertain to the course model were selected from CLASSE are summarized in Table 8. Question 1 in Table 8 shows that during the project component, students frequently participated in discussions (89% reported participating in group discussions more than 5 times during the project component). This is compared to the lecture component of the course where 55% of survey respondents reported never taking part in a discussion and 35% reported taking part in a discussion 1-2 times. Students also reported how often they met with classmates outside of class time to work on coursework, with 33% of students reporting they met with classmates three to five times and 26% reporting meeting more than 5 times (Question 2 in Table 8). Question 3 gives a sense of students’ enjoyment of the ACL activities (i.e., group work) in the modified course with 81% of respondents indicating they enjoyed the project component.

Table 8.
Results from three selected CLASSE questions focusing on Active and Collaborative Learning

<table>
<thead>
<tr>
<th>Question 1: How many times have you contributed to a discussion during the project and lecture components of the course?</th>
<th>Project</th>
<th>3-5</th>
<th>1-2</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project component</td>
<td>89</td>
<td>9</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Lecture component</td>
<td>3</td>
<td>7</td>
<td>35</td>
<td>55</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Question 2: How often did you work with students outside of class time on coursework?</th>
<th>Very Much</th>
<th>Quite a Bit</th>
<th>Someewhat</th>
<th>Very Little</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project component</td>
<td>26</td>
<td>33</td>
<td>31</td>
<td>9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Question 3: How much did you enjoy the group work component of this course?</th>
<th>Very Much</th>
<th>Quite a Bit</th>
<th>Someewhat</th>
<th>Very Little</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project component</td>
<td>43</td>
<td>38</td>
<td>17</td>
<td>2</td>
</tr>
</tbody>
</table>
Faculty-Student Interaction (FSI)

The student responses to CLASSE questions in Table 9 report on the frequency and comfort with their experiences concerning faculty-student interaction throughout the course. The majority of students (84%) reported receiving some level of feedback on their academic performance the course, and 16% reported never receiving feedback (Question 4, Table 9). The vast majority (99%) of students reported they were comfortable or very comfortable interacting with the instructor and a very small number of students (1%) reported they were only somewhat comfortable (Question 5, Table 9). No students reported being uncomfortable interacting with the instructor.

Table 9

Results from two selected CLASSE questions on Faculty-Student Interaction

<table>
<thead>
<tr>
<th>% Students Responses (n=127)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Response Options</td>
</tr>
<tr>
<td>Question 4: How often have you received prompt oral or written feedback on your performance?</td>
</tr>
<tr>
<td>Response Options</td>
</tr>
<tr>
<td>Question 5: How comfortable are you talking to the instructor of the class?</td>
</tr>
</tbody>
</table>

Level of Academic Challenge (LAC)

Overall the majority of students reported that the coursework emphasized a range of mental activities. The extent to which the coursework emphasized these activities varied with memorizing having the greatest percentage (67%) of student responding “quite a bit” and “very much” relative to the other categories (55% for analyzing, 46% for synthesizing, 38% for applying and 42% for making judgments) (Figure 2).
Figure 2. Results from the CLASSE question: How much has the course work emphasized the following mental tasks? The majority of students perceive memorizing as the most emphasized mental task.

The CLASSE data also show that more students reported finding the project component “difficult” compared to the lecture component (Question 6, Table 10). In the CLASSE question on which component of the course challenged students to do their best work (Question 7, Table 10), 80% reported the project challenged them either “very much” or “quite a bit,” 20% reported “some” and no students reported “very little”. With the lecture component, fewer students (52%) reported being challenged “very much” or “quite a bit.” These results suggest that students perceived the project to be more academically challenging than the lecture assessments and were more challenged to do their best work on the project, than in the lecture tests.
Table 10
*Results from two selected CLASSE questions on Level of Academic Challenge*

<table>
<thead>
<tr>
<th>Response Options</th>
<th>% Students Responses (n=127)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Very difficult</td>
</tr>
<tr>
<td>Question 6: How difficult is the course material in the project component? In the lecture component?</td>
<td>Project</td>
</tr>
<tr>
<td></td>
<td>Lecture</td>
</tr>
<tr>
<td>Question 7: To what extent did the project challenge you to do your best work? The tests?</td>
<td>Project</td>
</tr>
<tr>
<td></td>
<td>Tests</td>
</tr>
</tbody>
</table>

**Class Environment**

The results of the CLASSE question that asks students to report on their overall comfort level in the class found that an overwhelming majority (98%) of students reported being comfortable or very comfortable, with a small cohort of students reporting being somewhat comfortable (2%), no students reported being uncomfortable. Thus, despite the non-traditional format of the redesigned course, students seemed generally comfortable with the environment. It is possible that students who felt very uncomfortable in the class and/or interacting with the instructor were also too uncomfortable to report that in the survey.

**Comparison of Time and Resources**

I kept a log of the time spent on the design and implementation of the modified course. In the log, I recorded the hours I spent preparing for and teaching the course with its new learning activities. In order to do a comparison, I conducted a retrospective estimation of my time spent on teaching preparation and teaching activities for the traditional course. When the times were totaled (Figure 3), I found the time spent preparing and teaching the modified course was slightly less than the estimated time spent in the traditional course.
Figure 3. A comparison of the time spent on teaching activities in the traditional and modified course design.

^Includes the time spent developing the course outline, class activities, learning objectives, rubrics for class assignments

*Indicates an activity that was supported by four undergraduate teaching assistants who attended team project meetings and assisted with the grading of the final projects.

The main additional resources I required to effectively implement the modified course design with its project component were the teaching assistants who attended all project classes in the second half of the semester and helped grade the final projects. The four teaching assistants were hired for 8 weeks on a part-time basis (3 hours/week). This time covered their attending the 6 weeks of project classes, attending meetings and their project grading hours.

Reflections

This section will focus on my reflections on the three overarching action research questions I identified at the beginning of the redesign process.

Research Question 1

The first action research question was: How can a large enrollment course be designed to better align with the principles of student engagement? In the case of the Mountains Course, the reduction of lecture time and replacement of that time with engagement activities (i.e. the addition of the project) was the key change that helped better align the course activities with the principles of student engagement. Embedding the project component work into class time ensured that a significant proportion of class time was dedicated to engagement activities. The project component also enabled students to engage in a more diverse range of mental activities
and complete an authentic performance task on a topic that was meaningful to them. Utilizing senior undergraduate students (program majors in the field) as team project teaching assistants provided the necessary resources to manage the project component effectively. Without these teaching assistants, the project component would not have been feasible.

Reflecting on the project itself, I questioned whether the project was the only means by which student engagement can be improved in a large class. I do not believe that it is. What seems most crucial to improving student engagement was the reduction of lectures and replacing that lecture time with engagement activities that are strongly tied to an assessment component of the course. This created a learning environment where deep and sustained student engagement was inevitable and an environment that supported students completing a major component of the course.

Research Question 2

The second action research question was: How can data provide insight for understanding the impact of the redesign? The CLASSE data provided a window into the student experience in the class and helped me assess the frequency to which they took part in the intended engagement activities. Without this data I would not have understood students’ perceptions and engagement experience in the modified course design. In some instances, the CLASSE data gave me insight into engagement activities I did not know were occurring (such as students meeting outside of class time to work on course activities) providing useful insight into the student experience. I focus my reflections on the three areas of student engagement the course design emphasized – Active and Collaborative Learning, Faculty-Student Interaction and Level of Academic Challenge.

Active and collaborative learning (ACL)

Compared to the traditional course, the modified course has approximately 3 times more class time dedicated to students engaging in active and collaborative learning. As expected, the CLASSE data showed that most students reported frequently engaging in the activities. What the CLASSE data also revealed, was that the majority of students enjoyed the group work activities and found the class atmosphere comfortable. Although I had a sense that students were enjoying the group work during their weekly meetings as they would express this enjoyment to me, I did not know if this observation would appear in the survey data, where students may be more willing to express negative feelings. What the CLASSE data showed me that I was not expecting was how often students reported working with classmates outside of class time. This was an engagement activity that was not emphasized and one I had rated as “somewhat important”. What aspect of the course encouraged this out-of-class engagement – studying together for a test or working on their project or both – cannot be determined from the survey data. Did these students meet outside of class because they were not able to complete all of their work during class time or did the class work generate create a motivation to go beyond class meetings and meet more frequently? Also, what about the 9% of students who reported never meeting with students outside of class time? Did they “meet” outside of class by email or another electronic form? (In the quadrant analysis shown in Table 6, the activities of discussing course work with classmates using an electronic medium received a higher rating than I had expected.) Or was there something that affected these students in a negative way, causing them to not engage with
their classmates? These are questions that were prompted by my analysis of the CLASSE data and revealed areas for future action research.

While most students reported enjoying the group work, there was a cohort of students who reported only somewhat or not enjoying the group work (see Figure 4). It is difficult to know why some students did not enjoy their group work but this is an important aspect to understand in terms of future modifications to the project component. During the project component there is no formal means to assess how students are enjoying the process, hence, there is currently no way to intervene. This result has identified an area in the group work that needs more data to understand the aspects that can affect student enjoyment. As a start, a simple online survey administered half way through the project component could help identify students in need more support or groups in need of an intervention, and allow students to give feedback that can be acted upon during the semester.

Faculty-student interaction

While teaching the modified course, I interacted with more students than in the traditional course. The nature of these interactions was different as well. In the traditional model, I felt that most of my interactions with students were answering questions about test content, either before a test as they prepared for it or after, when they wanted to know why they got certain questions wrong. In the modified class, the interactions I had with students during the project component were far more dynamic, challenging and diverse. The students’ interests and project needs drove their questions. In some cases, students would present me with research findings or studies I wasn’t familiar with, and the role of teacher-student reversed.

The CLASSE data suggests that the majority of students felt comfortable with the overall class atmosphere and interacting with me. However there were a small percentage of students (2%), who reported not feeling comfortable with the class atmosphere, and were only “somewhat comfortable” talking to the instructor. A deeper investigation of the data found that the students who reported being uncomfortable in the class environment, and only somewhat comfortable talking to me were the same students who reported not enjoying group work. This connection highlights an aspect of student engagement I would like to better understand, which is the inter-relationship between group work, class atmosphere, and student comfort in the class. More information is needed to fully understand why some students did not enjoy the group work, and felt uncomfortable in the class. This would help identify areas where the course design can be improved, or additional options for completing the project component for students who are strongly adverse to group work. It also shows that there may be a need to create a system where students who do not feel comfortable taking to me could communicate their concerns about the course, allowing for me the opportunity to address (and ideally help manage) the aspects of the course that may. This insight was only gained by having the CLASSE data available to analyze after the course was over.

The purpose of dedicating class time to group work was, in part, to be able to provide student groups with oral feedback on their progress on a weekly basis. The CLASSE data showed that the majority of students reported receiving prompt feedback on their performance “often” or “very often”, with the rest reporting sometimes or never receiving feedback (see Figure 5). These results reveal another area for future exploration regarding how students perceive feedback. From my perspective, all student groups received weekly feedback at least on their performance during the project component, and would consider that “very often”. I
therefore expected then that an overwhelming majority of students would report “very often” receiving feedback. This had identified a number of areas where there may be a discrepancy between student and instructor perceptions of feedback. It may be that the students defined “very often” differently then I did, in which case an adjustment in the survey questions to ask students to report the frequency upon which they received feedback instead of the more subjective scale provided in the CLASSE instrument. There may also be a discrepancy between how I define “feedback” and how some of my students do. Students may perceive feedback to mean receiving a letter grade that contributes to their final course grade and not see the informal formative feedback received during their meetings as giving them information on their academic performance. Spending some class time explaining to students the various forms of feedback might help students see the class times as opportunities to receive information on their academic performance.

**Level of academic challenge (LAC)**

The learning outcomes and assessment strategies for the modified course emphasized a more diverse range of higher-level mental activities as compared to the traditional course. This is mainly due to the addition of the project. The lecture component for each course design focused on the same outcomes (basic knowledge and understanding of the course concepts) and emphasized the same mental activities. The most interesting responses in the LAC area were the ones where students reported coursework emphasis on different mental activities (see figure 7). Memorizing was considered by students to be the most emphasized mental task. Higher-level mental tasks (e.g., analyzing, synthesizing, applying, making judgments) were reported by students to be emphasized to a lesser degree. This is an area where the CLASSE quadrant analysis showed disconnects between what I had rated as important and what students reported doing. For example, I rated memorizing as not important and students reported a strong emphasis on this mental activity. Conversely, I rated synthesizing as important, yet students reported interpreting these results is challenging because of the general nature of the question, which did not separate the lecture and project component of the course. This makes it difficult to know how students approached answering these questions. The project was designed to emphasize synthesis of information from different sources, however less than half of students reported synthesizing as a mental activity that was emphasized “very much” or “quite a bit”. (I would have expected that to be higher.) It is also possible that although their project work emphasized synthesizing, because it was done in groups with shared work, the students might not have the same impression as they did of memorizing and applying – activities emphasized in the lecture component tests that students complete individually. A deeper examination into how students perceive the different mental activities and how they interpret this question along with separating out the two components in the CLASSE survey could provide more insight into students’ perception of mental activities.

The other data collected including classroom observations recording time spent on engagement activities, instructor records on time spent developing instructional activities, was helpful for comparing the course models and assessing the impact of the redesign on the instructor experience. These data helped me quantify the change in class time dedicated to student engagement as well as how this kind of course design impacts teaching practice, in particular the time spent teaching this type of course.
Research Question 3

The third action research question was: What are the resource implications for redesigning and teaching a course with increased student engagement? By comparing the time it took me to teach the course using both models as well as keeping track of the teaching assistant resources used to teach the modified course design I found that the course was not more labor intensive to teach, however it does require additional resources. I focus my reflections in this section on the impact teaching the modified course had on my time and my teaching practice.

Instructor time

Overall the modified course design required slightly less planning and instructional time than the traditional course. However, the way that time is spent in the modified course was markedly different. The main time saver in the modified course design was in lecture preparation. In the traditional course, I spend an average of three hours preparing for each lecture. This would vary with a minimum of two hours (reviewing, modifying and posting lecture notes) to 8 hours (preparing a new case study, lecture notes on a new topic, or class activity). Lecture preparation time was essentially cut in half with the addition of the team project component. The team meeting classes did not require pre-class preparation as the classes were based on the student groups giving short progress reports and seeking help with their projects. Because student questions could usually be answered during class time, this reduced the amount of time spent outside of class time assisting students in their project work. I did not have to increase my office hours during the project component of the course. In the traditional course it would take me approximately three days work (approximately 24 hours) to prepare the final multiple-choice exam. Time that would have spent preparing the final exam was replaced with grading the final projects.

Teaching assistant support

Teaching assistant support for the modified course design is imperative. The teaching assistants played a key role in making the project component of the modified course manageable. The teaching assistants attended the project classes, and assumed the same role I had – providing mentorship and direction to the student groups. The teaching assistants also helped grade the projects at the end of the semester. To ensure the grading was fair and reliable, we initially practiced using the project rubric together. We accomplished this by all grading the same two final projects (which I sent out to the teaching assistants) and then met to compare our scores. Where there were discrepancies in the scoring we would discuss how the score was derived and arrive at a group consensus on how to interpret scoring within the rubric categories. Once we were using the rubric consistently, we each took about 15 projects to grade. It took approximately 30-45 minutes to grade one project and enter the score into the grading system. The total amount of grading hours for the final projects, split between the teaching assistants and myself, was approximately 60 hours, approximately 12 hours each. The 25 hours of grading I reported in Figure 11 (which included grading the lecture tests, final projects and compiling final grades) would have been significantly higher without the teaching assistants. Using senior undergraduate students as my teaching assistants also gave them a meaningful work experience in their senior year.
Impact on teaching practice

From a professional perspective, the modified course was more challenging and satisfying to teach, though surprisingly, not more time consuming. Interacting with the student groups and guiding them through their projects gave me a feeling of connectedness with students. Mentoring student groups also demanded more of me intellectually. Some of the student groups choose project topics I was not familiar with, meaning we explored new material together. There were times when roles were reversed and students were teaching me about what they were learning on their topic. Together we were interpreting scientific papers, looking for additional resources and deciding how to best present data. It was satisfying to have students be responsible for learning about their topic and for my role to be more of a mentor, which is better aligned with my teaching philosophy.

Before teaching the modified course, I anticipated difficulties – more than I actually encountered. I thought deciding what lecture content to cut was going to be problematic. However once I worked through UbD Stages 1 and 2, it was clear to me what should be cut and what needed to stay. Developing the project component was time consuming in the pre-course planning phase but ran relatively smoothly during the semester. When planning the project, I sought help from staff at the Teaching and Learning Centre, and relied heavily on the research literature on group projects / group work (Birmingham & McCord, 2002; Fink, 2002; Michaelsen, 2002a, 2002b). This was extremely helpful in helping avoid common problems with student group work. I learned that while detailed planning the project assignment itself is very important, other components – group contracts, peer and self-evaluations and securing class time for teams to meet and receive feedback – are essential elements that lead to successful team projects.

Conclusions

The process of redesigning and teaching a large undergraduate science course to improve student engagement was professionally rewarding. Using an action research approach helped guide this process and showed me how to make informed decisions about collecting and using data to evaluate the effects of the course redesign. Using the model of Understanding by Design (Wiggins & McTighe, 2005) during the planning phase allowed me to identify the most important areas to focus on for the first iteration of the redesign. This ensured that the redesign elements were connected to the intended learning outcomes and that the activities served to support students achieving these outcomes, avoiding the trap of ‘activity for the sake of activity’ in instructional design.

The modified course promoted deeper engagement in three main areas: (a) active and collaborative learning, (b) faculty-student interaction, and (c) level of academic challenge. The CLASSE data suggest that students participated in most of the engagement activities the design intended to promote. Engagement activities that I deemed important/very important and students reported not doing frequently provide areas for reflection and analysis and potential course modifications in the future.

My teaching practice is more strongly aligned with my teaching philosophy as a result of this redesign. The redesigned course is more student-centered and the project component allows students to take responsibility for their learning. This experience proved to me that large classes
can be engaging – with the appropriate design and support. Using senior undergraduate students as teaching assistants was essential to the success of the group projects.

This experience has helped me develop a scholarly and more reflective teaching practice (Trigwell, Martin, Benjamin, & Prosser, 2000). I will continue to turn to education research for data that can inform my teaching. I will continue to teach the Mountains Course with the project component. I will also continue to develop and modify the course each year based on student data following a similar action research model. For me, this course redesign process and implementation has generated as many new action research questions as it attempted to answer. Areas for future action research in the Mountains Course include: understanding the factors that affect students’ enjoyment of group work and understanding how students perceive feedback in a group setting.

References


Appendix

CLASSE STUDENT (Classroom Survey of Student Engagement)

This survey includes items that ask about your experience in the Mountains Class and about educational practices that occur in this class. Your honest and straightforward responses to these questions will help us identify targets for improvements.

PART I: ENGAGEMENT ACTIVITIES

So far this semester, how often have you done each of the following in the Mountains Course?

1. Asked questions during lecture
   □ Never  □ 1 or 2 times □ 3 to 5 times □ More than 5 times

2. Contributed to a class discussion that occurred during lecture
   □ Never  □ 1 or 2 times □ 3 to 5 times □ More than 5 times

3. Contributed to a class discussion that occurred during your project meetings
   □ Never  □ 1 or 2 times □ 3 to 5 times □ More than 5 times

4. Worked on a paper or a project that required integrating ideas or information from various sources
   □ Never  □ 1 or 2 times □ 3 to 5 times □ More than 5 times

5. Included diverse perspectives (different races, religions, genders, political beliefs, etc.) in class discussions or assignments
   □ Never  □ 1 or 2 times □ 3 to 5 times □ More than 5 times

6. Worked with classmates outside of class to prepare an assignment
   □ Never  □ 1 or 2 times □ 3 to 5 times □ More than 5 times

7. Put together ideas or concepts from different courses when completing assignments
   □ Never  □ 1 or 2 times □ 3 to 5 times □ More than 5 times

8. Tutored or taught other students in class
   □ Never  □ 1 or 2 times □ 3 to 5 times □ More than 5 times

9. Used an electronic medium (list-serv, chat group, Internet, instant messaging, etc.) to discuss or complete an assignment
   □ Never  □ 1 or 2 times □ 3 to 5 times □ More than 5 times

10. Used email to communicate with the instructor
    □ Never  □ 1 or 2 times □ 3 to 5 times □ More than 5 times

11. Discussed grades or assignments with the instructor
    □ Never  □ 1 or 2 times □ 3 to 5 times □ More than 5 times
12. Discussed ideas from the Mountains Class with others outside of class (students, family members, coworkers, etc.)
   □ Never □ 1 or 2 times □ 3 to 5 times □ More than 5 times

13. Made a class presentation
   □ Never □ Once □ 2 times □ More than 2 times

14. Discussed ideas from your readings or classes with the instructor outside of class
   □ Never □ Once □ 2 times □ More than 2 times

15. Received prompt written or oral feedback on your academic performance from the instructor
   □ Never/Rarely □ Sometimes □ Often □ Very Often

16. Worked harder than you thought you could to meet the course standards or expectations
   □ Never/Rarely □ Sometimes □ Often □ Very Often

**PART II: COGNITIVE SKILLS**
So far this semester, how much of your coursework emphasized the following mental activities?

17. Memorizing facts, ideas, or methods from your courses and readings so you can repeat them in pretty much the same form
   □ Very Little □ Some □ Quite a Bit □ Very Much

18. Analyzing the basic elements of an idea, experience, or theory, such as examining a particular case or situation in depth and considering its components
   □ Very Little □ Some □ Quite a Bit □ Very Much

19. Synthesizing and organizing ideas, information, or experiences into new, more complex interpretations and relationships
   □ Very Little □ Some □ Quite a Bit □ Very Much

20. Making Judgments about the value of information, arguments, or methods, such as examining how others gathered and interpreted data and assessing the soundness of their conclusions
   □ Very Little □ Some □ Quite a Bit □ Very Much

21. Applying theories or concepts to practical problems or in new situations
   □ Very Little □ Some □ Quite a Bit □ Very Much

**PART III: OTHER EDUCATIONAL PRACTICES**
So far this semester

22. How often have you been required to prepare written papers or reports of more than 5 pages in length?
23. To what extent did the tests challenge you to do your best work?
□ Very little □ Some □ Quite a bit □ Very much

24. To what extent did the project challenge you to do your best work?
□ Very little □ Some □ Quite a bit □ Very much

25. In a typical week, how much of the coursework takes you more than one hour to complete?
□ None □ 1 or 2 □ 3 or 4 □ 5 or more

26. In a typical week, how often do you spend more than 3 hours preparing for class (studying, reading, doing homework or lab work, analyzing data, rehearsing, and other academic matters)?
□ Never □ Sometimes □ Often □ Very Often

27. How many times have you been absent so far this semester?
□ None □ 1 - 2 absences □ 3 – 4 absences □ 5 or more absences

28. How frequently do you take notes in class?
□ Never □ Sometimes □ Often □ Very Often

29. How often do you review your notes prior to the next scheduled class?
□ Never □ Sometimes □ Often □ Very Often

30. How often have you participated in a study partnership with a classmate to prepare for a quiz or a test?
□ Never □ Once □ 2 times □ 3 or more times

31. How interested are you in learning the course material?
□ Very uninterested □ Uninterested □ Interested □ Very Interested

PART IV: CLASS ATMOSPHERE
So far this semester, what are your general impressions of the GLGY201 class atmosphere?

32. How comfortable are you talking with the instructor?
□ Uncomfortable □ Somewhat Comfortable □ Comfortable □ Very Comfortable

33. How much did you enjoy the group work with your classmates?
□ Very Little □ Some □ Quite a Bit □ Very Much

34. How difficult is the lecture component?
□ Easy □ Somewhat Difficult □ Difficult □ Very Difficult

35. How difficult is the project component?
□ Easy □ Somewhat Difficult □ Difficult □ Very Difficult
36. How easy is it to follow the lectures?
□ Difficult □ Somewhat Easy □ Easy □ Very Easy

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## CLASSE FACULTY (Classroom Survey of Student Engagement)

This survey asks you to indicate the level of importance of various activities and practices planned for your class. Your honest and straightforward responses to these questions will help us to identify targets for improvements within the course.

**For students to be successful in your class, how important is it that they**

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<tr>
<td>1. Ask questions during your class</td>
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<td>2. Contribute to class discussions that occur during your class</td>
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<td>3. Prepare two or more drafts of a paper or assignment in your class before turning it in</td>
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<td>4. Work on a paper or a project in your class that requires integrating ideas or information from various sources</td>
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<td>5. Include diverse perspectives (different races, religions, genders, political beliefs, etc.) in class discussions or writing assignments in your class</td>
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<td>6. Come to your class having completed readings or assignments</td>
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<td>7. Work with other students on projects/assignments during your class</td>
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<td>8. Work with classmates outside of your class to prepare class assignments</td>
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<td>9. Put together ideas or concepts from different courses when completing assignments or during class discussions in your class</td>
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<td>10. Tutor or teach other students in your class</td>
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<td>13. Discuss grades or assignments with you as the instructor of your class</td>
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<td>14. Discuss ideas from your class with others outside of class (students, family members, coworkers, etc.)</td>
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<td>15. Make a class presentation in your class</td>
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<td>16. Participate in a community-based project (e.g., service learning) as part of your class</td>
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<td>17. Discuss ideas from your readings or classes with you outside of class</td>
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<td>18. Receive prompt written or oral feedback from you on their academic performance in your class</td>
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19. Work harder than they think they can to meet your standards or expectations in your class

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**PART II: COGNITIVE SKILLS**

**How important is it to you that the coursework in your class emphasizes the following mental activities?**

20. Memorizing facts, ideas, or methods from your courses and readings so you can repeat them in pretty much the same form

21. Analyzing the basic elements of an idea, experience, or theory, such as examining a particular case or situation in depth and considering its components

22. Synthesizing and organizing ideas, information, or experiences into new, more complex interpretations and relationships

23. Making Judgments about the value of information, arguments, or methods, such as examining how others gathered and interpreted data and assessing the soundness of their conclusions

24. Applying theories or concepts to practical problems or in new situations

**PART III: OTHER EDUCATIONAL PRACTICES**

**For students to be successful in your class, how important is it that they**

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25. Prepare written papers or reports of more than 5 pages in length in your class?

26. Are challenged to do their best work on the examinations they have in your class

27. Have homework assignments during a typical week in your class that take more than one hour each to complete?

28. Spend more than 3 hours during a typical week preparing for your class (studying, reading, doing homework or lab work, analyzing data, rehearsing, and other academic matters)?

29. Attend your class?

30. Take notes in your class?
31. Review notes prior to the next scheduled meeting of your class?

32. Participate in a study partnership with a classmate in your class to prepare for a quiz or a test?

33. Attend a review session or help session to enhance their understanding of the content of your class?

34. Are interested in learning the course material?

PART IV: CLASS ATMOSPHERE
How important are the following class atmosphere variables to the success of students in your class?

35. Being comfortable talking with you as the instructor of the class

36. Enjoying group work with their classmates in your class

37. Finding the course material in your class to be difficult?

38. Finding the lectures easy to follow in your class?

PART V: DEMOGRAPHICS
39. Over the past 3 years, how many times have you taught this class?

40. How many years of teaching experience do you have in higher education?

41. Approximately how many students are enrolled in this class?

PART VI: OTHER
Use the space provided below to comment on any aspects of the course that are important for student success

Thank you for taking the time to complete this survey

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