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Using Geoscience Education Graduate Students to Help Faculty Transform Teaching Practice

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USING GEOSCIENCE EDUCATION GRADUATE STUDENTS TO HELP TRANSFORM TEACHING PRACTICE

by

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ABSTRACT

USING GEOSCIENCE EDUCATION GRADUATE STUDENTS TO HELP FACULTY TRANSFORM THEIR TEACHING IN PRACTICE

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Master of Science

Universities make claims about student learning that graduates don't often achieve and are under pressure to show improvement in teaching and learning in their undergraduate programs. This has been the constant focus of university-level professional development programs, but most teachers are still not using the most effective teaching methods. Individual departments need to find ways to help their instructors overcome three main challenges associated with adopting more effective student-centered teaching methods. No matter what strategy is adopted, instructors need considerable support to 1) change their beliefs about what constitutes effective teaching and learning, 2) learn to effectively implement new strategies, and 3) help their students change their beliefs about teaching and learning.

We investigated whether M.S. Geoscience Education graduate students could offer the support instructors need to overcome the challenges listed above. We successfully piloted this approach during 2006 to 2008. Receiving consistent and individualized support from a Geoscience Education graduate student, the instructor changed his beliefs about teaching and learning and learned to effectively implement active learning strategies. His teaching satisfaction and student ratings also increased.

Advantages of our approach include 1) the time the graduate student devoted to making course changes, 2) the consistent support the instructor received which allowed him to transfer research supported educational theory into his teaching practice, and 3) the instructor is now a departmental resource that other instructors can go to for guidance. Disadvantages include 1) the graduate student's lack of experience as a teaching consultant and 2) the difficulty of transforming a professor/student relationship into a client/consultant relationship.

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I am grateful for Doc—my teacher and exemplar. I admire his willingness to change, his desire to become better, and his willingness to take advice from a graduate student! He is the epitome of academic humility. Working with him has been a joy and I'd do it again in a heartbeat.

I am grateful for Charles and his council. He was always willing to hear my ideas and concerns and offer much needed advice. He has also helped me to correct my own misconceptions and stay focused on trying to understand something instead of trying to prove it.

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If, after all this support, any errors remain in this thesis they are my own.

TABLE OF CONTENTS

INTRODUCTION

While universities invariably make impressive claims about what students are supposed to get out of their degree programs, the fact is that these claims are often greatly inflated (Amiran, 1989; 2003). Most employers agree (AAC&U, 2007) that too often graduates are inadequately prepared for employment and need to be trained to do what they should have learned in their degree programs (cf., Peddle, 2000). Is the problem that individual teachers don't share the same goals as their universities? Fink (2003) argues that, based on his experience, the problem is not misalignment between the goals of teachers and their universities, but misalignment between the teachers' goals and their teaching methods.

Universities, employers, and teachers all agree that students should graduate being able to apply their knowledge in new situations, think critically and analytically, communicate well, work in teams, etc. But the dominant teaching method in college classrooms is still passive lecture (Allen et al., 1996; Guskin, 1994), which has repeatedly been shown not to effectively promote such active learning goals. What passive lecture promotes instead is rote memorization of information that is often disconnected and soon forgotten (Barr and Tagg, 1995). If instructors are serious about helping their students achieve their active learning goals then they must replace their passive lectures with active learning methods (Angelo and Cross, 1993; Bonwell, 1991; McConnell et al., 2003; Michael and Modell, 2003). These provide students with opportunities to actually practice skills while they integrate what they learn with what they already know, reflect on their learning process, and interact with their instructor and fellow students (Allen et al., 1996). When students actively engage in constructing their understanding and performing learned skills they learn more (Tagg, 2006) and retain what they learn. For instructors, an important advantage of using active learning is being able to monitor student learning and adjust their instruction accordingly (McConnell et al., 2003; Savion and Middendorf, 1994).

Active learning has been heavily promoted over several decades in professional development settings, yet, passive lecture remains the dominant teaching method in universities. What is going wrong? Adopting active learning techniques is difficult because teachers need to 1) change their ideas about what constitutes effective teaching (Guskin, 1994), 2) learn to effectively implement active learning techniques in their own classrooms (Putnam and Borko, 1997), and 3) motivate their students to accept their role as active learners (Michael and Modell, 2003). If this is to happen, instructors need considerable support (Ball, 1996).

We decided to try providing this support using a graduate student in our Geoscience Education M.S. program. This is not an ideal solution, but we believed it had some advantages over our alternatives. Ideally, this support would have come from a geoscience teaching expert but there were none among our university's six educational consultants. Any of these consultants could have been a good source of support, but with so few of them and so many faculty (~1,500) their efforts were spread thin. Faculty peers could provide instructors with content-specific support, but they generally can't offer the pedagogical support instructors need because they, too, have limited training in pedagogy. A graduate student in Geoscience Education, on the other hand, could provide support in both areas, and offer time and invested interest to help the instructor change, because the project would be the basis of a thesis. Finally, we periodically have students enter this program, anyway, so in a sense they are an existing departmental resource.

Here we report what we learned from using a Geoscience Education graduate student to help an instructor adopt active learning strategies in an upper-division Sedimentology and Stratigraphy class for Geology majors. This case study represents the thesis work of Geoscience Education graduate student and first author of this contribution (T. Tomlin). Over a three year period, she used the methods described below to guide and monitor the instructor's progress as he adopted active learning techniques, changed his beliefs about learning, improved his skill using active techniques, and convincing his students to adopt their role as active learners. The rest of this paper is written from T. Tomlin's perspective.

INSTRUCTIONAL SETTING

Geology 370 (Sedimentology and Stratigraphy) is a sixteen-week, upper-division, undergraduate course taught annually in winter semester. The course is required for Geology B.S. students, and approximately 20-30 students enroll per semester. Students attend class three times per week—twice for 75 minute lectures and once for a 2 hour laboratory session. They also go on a two-day field trip to Green River, Utah. Class assignments include assigned reading, lab reports, and a term project—a term paper and oral presentation. Students are expected to read assignments prior to lecture and participate in class. Pop quizzes, three unit tests, and a comprehensive final exam are used to assess student learning. These exams, and most assignments, are graded by a Geology 370 graduate TA.

METHODS

I employed the following general procedure as I worked with the instructor to redesign Geology 370. I 1) performed an initial course evaluation, 2) helped the instructor plan the redesign based on the initial evaluation results and ideas taken from educational literature, and 3) helped the instructor implement the redesigned course, while 4) making ongoing field evaluations of the changes. I then 5) helped the instructor formulate responses to issues that emerged, and 6) evaluated the instructor's progress in making and sustaining change.

It proved useful to adopt a case study approach with elements of action research for understanding the redesign process and evaluating the course redesign impact on the teacher and students. I collected both qualitative and quantitative data from semi-structured interviews, direct observations, surveys, student ratings of instruction, and student assessments.

An Institutional Review Board (IRB) consent form (see Appendix B) was used to legally gather information from human subjects. All students were required to take surveys, even if they declined to give their consent, to prevent students from not signing consent forms to get out of having to take surveys. Information gathered from students who did not give their consent, however, was not used.

Initial Course Evaluation and Redesign Planning

Most courses have a number of issues that could be individually addressed in a course redesign. Most, however, are generally offshoots of the larger issue of alignment. In fact, Cohen (1987) calls course alignment the "magic bullet" because it is the most potent variable when it comes to implementing effective learning strategies. Course alignment refers to the extent to which a course's learning goals, instructional techniques, and evaluation methods align with each other. I focused my initial evaluation on the state of alignment in the winter 2006 (W06) course by 1) having the instructor define course learning outcomes, 2) observing instructional techniques by making classroom observations, 3) comparing assessment methods with learning goals and instruction, and finally 4) examining student opinions expressed in the instructor's past teaching evaluations.

My main finding from the initial evaluation was that, although the learning goals seemed to align with the assessments, the instructional methods didn't appear to match either the learning goals or assessment. The instructor wanted students to learn to apply course content, but his instructional methods didn't provide students with the opportunities they needed for learning this skill. (See the Results and Discussion section for more detail.) We addressed this by designing each class after the enhanced lecture model, described by Bonwell (1996) as short mini-lectures punctuated by active learning experiences. These experiences included interactive demonstrations (Sokoloff and Thornton, 1997), class discussions (King, 1992), role play (Davis, 1993), class debates, pair work (D'Avanzo, 2003), and small-group work (Allen et al., 1996; Apedoe et al., 2006; Kolars et al., 1997; Smith et al., 1995). We also designed reading guides to help students prepare to participate effectively in the class activities.

Implementation

The best-designed active learning experiences can be unsuccessful if they are implemented ineffectively. However, instructors can learn, with sufficient time, practice, and feedback, the skills they need to effectively incorporate active learning experiences in their classrooms. I spent two semesters, winter 2007 (W06) and winter 2008 (W08), coaching the instructor to help him learn and refine these skills. This coaching process involved observing and providing feedback on how he practiced them in class. I gave him this feedback first through our discussions and second in a written summary. We regularly discussed how well he used these skills during our meetings before and after each lecture. During our discussions I asked the instructor to reflect on the following four questions. 1) *"What went well today?"* 2) *"What didn't go well?"* 3) *"What can be improved for next year?"* 4) *"Do you have any concerns?"* Following each lecture, I collated his responses to these questions along with my feedback into a written summary or "lecture debrief." My objective was to gather information about the instructor's use of active learning strategies, summarize it, and give it back to the instructor as a lecture debrief (Brinko, 1993). W07 Lecture debriefs can be found in Appendix C of this report. The instructor felt that the coaching and feedback that he received was instrumental in helping him to improve his teaching. He also considers the lecture debriefs a valuable resource that he can continue to use in the future.

Evaluation of Changes

A program evaluation is an essential part of any professional development effort. It should be trustworthy, align with the overarching program goals, and use several sources of data to support its findings (Heck, 2006). My evaluation of the course redesign focused on what impact changes had on student learning and on the instructor's classroom practice.

I evaluated the impact on student learning using exam scores, interviews, surveys, and student ratings of instruction. I compared exam scores from different semesters (W06, W07) using the t-test statistic ($\alpha = 0.05$) to detect differences in student content knowledge and problem solving skills. I conducted interviews with selected students from the redesigned course (W07) to discuss their perspectives on their learning experiences. I also interviewed the instructor concerning his impression of what students were learning relative to previous semesters.

Surveys were used to gather information about students' attitudes towards the course, the instructor, and what they were learning. Surveys were also used to gather students' suggestions for making future course improvements. I tried to administer surveys when the maximum number of students could take them—generally the best time was directly after exams. Each survey (see Appendix A) consisted of open-ended questions, forced-choice response items (i.e., Likert scale), or a combination of both.

I analyzed open-ended survey responses using a qualitative data analysis technique described by Seidel (1998) as the Noticing, Collecting, and Thinking model. I followed this iterative process by noticing and categorizing interesting survey responses, grouping what I noticed into categories or themes, and exploring these responses from different viewpoints (i.e., in terms of the individual who made the comment, in terms of the responses as a whole, etc.).

Six years of student ratings reports—from 2003 to 2008—were used to explore student perspectives towards the instructor and the course. Both student comments and numerical ratings were used to suggest the kind of impact course changes may have had on student attitudes. Student comments were analyzed and general trends compared using Seidel's (1998) qualitative approach described above. Mean ratings and standard deviation data were compared using frequency plots.

Responding to Emerging Issues

While ongoing evaluations may not show big improvements in teaching and learning, they can provide an excellent opportunity for reflection and continuous improvement (Loucks-Horsley et al., 2003). As soon as I analyzed the results of exams or surveys, I would discuss them with the instructor to determine whether the issues that emerged were related to aspects of the course over which we had control. When that was the case, we would make changes and evaluate those changes using surveys and interviews. If we decided that the issues represented something over which we didn't have control (e.g., number of hours students spent effectively studying), then we would discuss how to encourage students to make changes.

Instructor Progress

The main barrier to change is risk. Instructors who attempt changing their courses must risk negative student responses to the new teaching and learning strategies. An instructor's concern about these risks will change as they continue using and adapting their new teaching strategies. When these concerns, however, are not addressed throughout the change process, they can prevent the instructor from successfully using new strategies and, consequently, from making lasting improvements.

I used the Concerns-Based Adoption Model (CBAM) to track the instructor's use of active-learning methods and monitor his concerns throughout the change process. CBAM grew out of research focused on the concerns of individuals who are involved in change (Hall, 1979). I used two CBAM evaluation tools— Levels of Use (Table 1) and he Stages of Concern (Table 2).

Table 1. CBAM Levels of Use scale with descriptions of behavior characteristics and typical interview responses used to diagnose Levels 0 to 4B Levels of Use (adapted from Hall et al., 2006; Loucks-Horsley et al., 2003).

Level of Use	**Type of Use**	**Behavioral Characteristics**	**Typical Interview Responses**
0	Nonuse	The teacher is not using the innovation. ▪ They don't know about it, ▪ They know about it but not much, or ▪ They are not doing anything to start using it.	▪ "I have no plans to use the innovation." ▪ "I've heard of it but I am not really interested in using it."
1	Orientation	The teacher is learning about the innovation and considering the value of using it and what it will take to use the innovation.	▪ "I am looking at what the innovation is and am considering using it someday." ▪ "I understand the innovation but need more information about how I can use it."
2	Preparation	The teacher is preparing for their first use of the innovation.	▪ "I am planning on using the innovation next semester." ▪ "I don't want to use the innovation but the department is requiring that I use it next semester."
3	Mechanical Use	The teacher is using the innovation but their effort is focused on figuring out how to use it and changing how they use it to accommodating their own needs. Use is commonly disjointed and superficial.	▪ "I spend most of my time just trying to stay organized and make the innovation work during class." ▪ "I am using it and plan to keep using it but there seem to be a lot of problems with the innovation." ▪ "I plan one day at a time. I know what I am doing next month but not past that."
4A	Routine	The teacher has found a way to use the innovation and is making few if any changes to their use. The teacher isn't improving the innovation or addressing consequences.	▪ "The innovation is working great. I will probably make some changes to it but not many." ▪ "The students liked what we did and I am not going to change it." ▪ "This is the second time I have done this and it still works great." ▪ "I don't see what we need to change to make it work better."
4B	Refinement	The teacher varies their use of the innovation to increase its impact on the students. Changes are based on the teacher's knowledge of both immediate and long-term consequences on students.	▪ "I discovered a problem with the innovation and am researching how to fix it. I still want to use the innovation." ▪ "I just changed the way I was testing the students so I think the innovation is going to work even better." ▪ "I got some ideas from the students that I can use to improve my use of the innovation."

Table 2. CBAM Stages of Concern descriptions Stages of Concern Questionnaire Profile interpretations for peak scores of each stage (adapted from George et al., 2006).

Stage of Concern	Type of Concern	Stage Description	SoCQ Profile: Peak Score Interpretation
0	Awareness	Relative degree of interest in and engagement with an innovation.	The individual is concerned about many things—not just the innovation.
1	Informational	Relative interest in learning more about the innovation.	The individual wants information about what the innovation is, what it does, how to use it, and what using it involves.
2	Personal	Self concerns—degree of concern about the status, rewards, and what impact the innovation could have on them.	Individual is most concerned about the impact on themselves that they are less focused on substantial concerns about the innovation.
3	Management	Intensity of concern about time, management, and logistics of using an innovation.	The higher the score, the more intense the individual is concerned with managing the innovation.
4	Consequence	Concern about improving impact on students and interest in making innovation more relevant for students and the course in general.	Most concerned about impact on students and their learning.
5	Collaboration	Interest in coordinating and cooperating with others in regards to using the innovation.	Higher scores indicate higher interest in working with others to improve the impact of the innovation.
6	Refocusing	Interest in changing use of an innovation, searching for a new innovation, or replacing innovation with a better alternative.	Higher scores indicate higher interest in finding more benefits from the innovation or replacing with a more powerful innovation.

I did not find out about the CBAM until midway through the pilot, so while I was then able to use these tools concurrently with the change process, I didn't have them for the initial stages of the pilot. Instead, I had to retrospectively apply the CBAM tools to the data I had gathered to uniformly track how the instructor progressed through the entire project.

The Levels of Use (LoU) dimension of CBAM allowed me to track and describe how the instructor was using new methods in the classroom. Table 1 shows the ranges of behavior matching each level in the model. This tracking process allowed me to continue helping the instructor until he reached a point of successful implementation (Hord et al., 2006).

The instructor's progression in the LoU dimension was directly related to his concerns about using new methods. The Stages of Concern (SoC) tool helped me to diagnose which of the seven major concerns the instructor faced during the course redesign process. The main part of this tool is a Stages of Concern Questionnaire that I gave the instructor twice. I used a CBAM grading instrument to interpret the instructor's responses (George et al., 2006). These results helped me to make important decisions about how to continue providing the instructor the kind of assistance he needed. Comparing these questionnaires also provided information about how his concerns had changed with use of the redesigned course.

RESULTS AND DISCUSSION

My results have several dimensions—Instructor progress, changes in student learning, changes in student perceptions of the course and instructor, and so on. Therefore, there could be any number of legitimate ways to organize this report. But since I intend this work to be used as a resource for Geoscience departments, I decided to organize my results chronologically, according to my estimate of the instructor's LoU score. At each point, I report on the various types of data I had collected, discuss what the instructor and I learned from our experiences, and how we adjusted our strategies in response.

Level 0 Nonuse

When I first met with the instructor, he told me that he was unsatisfied with his undergraduate course—Geology 370—and anxious to make improvements to address two issues. First, he expected his students to learn quite a few vocabulary words and basic concepts, but he noticed that his students had trouble connecting these details to a few overarching course concepts. Therefore, they struggled to stay oriented in the course. In 2004, one student commented that:

> *"I felt like we jumped from topic to topic. I did not always know where I was going or how it is all connected."*

The instructor thought he could improve his students' focus and orientation in the course by providing students with reading guides.

Second, with so much information to disseminate, he constantly struggled to cover everything in class. He wanted to shift his lectures from overhead film to PowerPoint to use class time more efficiently and to cover more material and improve the organization of the class.

He hadn't been able to make these changes because he felt he lacked the time. Thus, he was excited to have my help, because he thought I could ease the burden of making these time-consuming changes. Clearly, he was not thinking in terms of a truly student-centered learning environment.

My other advisors and I insisted, however, that more substantive changes would also have to be made if I were going to make this my thesis project. The instructor agreed to make additional changes that I might suggest after my initial evaluation of his course, after it was pointed out that he could always revert to his old methods the next year. At the time, he probably wasn't expecting that the additional changes I would suggest involved changing his own beliefs about teaching and learning.

Initial Course Evaluation

I conducted the initial course evaluation in W06 and found evidence suggesting there was an alignment problem. That is, the intended learning outcomes, instruction, and assessment did not reinforce one another the way they should.

Although the intended learning outcomes and assessments were fairly aligned, they were not reinforced by the instructor's instructional methods. The learning outcomes the instructor expressed in his syllabi and interviews with me were active. That is, he wanted students to understand terms and concepts and confidently apply their knowledge to make observations, solve realistic problems, and communicate their ideas. His active learning outcomes were, on the other hand, reinforced by course assessments. Exams consisted of recall and application questions that tested students' knowledge of basic concepts and terms, and their ability to make interpretations and solve problems in realistic contexts, thus reinforcing the instructor's intended learning outcomes.

The instructor's learning outcomes and assessments, on the other hand, did not align with his lecture-based instruction. Passive lectures—even good ones—do not promote active learning, because they 1) place sole responsibility for information gathering on the instructor, and 2) do not give students enough practice at achieving active goals.

Most students enjoyed lecture and felt the instructor was an excellent teacher. In 2006, a student commented that the instructor *"did a wonderful job explaining"* difficult concepts. Another felt the instructor did a great job relating *"all the things [they] were* *learning to the real world"* and answering the question *"who cares?"* A student in 2005 said the instructor's stories *"helped to demonstrate the applicability of the subject matter."* In 2004, a student who also liked his stories said *"they helped to make the course fun"* and to make the course material memorable.

The instructor did perhaps too good of a job explaining course concepts in class since students often viewed him as their sole source of information. One student said:

> *"I did well in the class without using the book much, but it did help a bit when I did use it. If I had to, I think reading the book could have taught me the necessary info of the class, but because the professor teaches it, why focus all my energy on the book?"*

It was easier for the students to sit passively and let the instructor tell them what they should know.

The problem was that the instructor expected students to be able to think critically and use their knowledge in new ways, but he gave them little practice and guidance in this area. Thus, when students took exams, they were often frustrated because they struggled to know how to apply concepts in unfamiliar situations. One student explicitly voiced the criticism that the instructor needed to provide practice opportunities if he expected students to know what to do on exams:

> *"If you expect us to be able to solve 'real life' problems then we need to practice 'real life' geology problems in lab and in class so that they do not spring up on us in the exam."*

I decided, therefore, that my goal for the course redesign should be to help the instructor shift his instructional methods from passive lecture to active learning. As a result, I expected student learning and performance, along with the instructor's satisfaction in teaching, to increase.

I also expected that getting the instructor to make this shift would be challenging. During our first meeting and the initial course evaluation, I found that he wasn't using, and expressed no interest in, active learning strategies (Level 0). In order to convince him to make this shift, I needed to help him understand three things. First, his course was misaligned, and his passive instruction was the culprit. Second, he needed to implement active learning strategies to facilitate higher-level learning. Third, implementing time-consuming active learning strategies would require him to either cut content or to hold students accountable for reading before class and properly preparing for exams.

Level 1 Orientation

When I presented the instructor with my suggestions from the initial evaluation, my objective was to redirect his course redesign focus away from upgrading lectures and toward implementing active learning strategies. Active learning, I explained to the instructor, would align his course since his passive instruction did not align with his intended learning outcomes and assessments. I described several general active learning strategies the instructor could use to promote higher-level learning. These included interactive demonstrations (Sokoloff and Thornton, 1997), class discussions (King, 1992), pair work and class debates (D'Avanzo, 2003), and team work exercises (e.g. Allen et al., 1996). The plan was to enhance lectures by engaging students in activities or exercises approximately every fifteen minutes (Bonwell, 1996).

The instructor initially thought the idea of implementing time-consuming active learning strategies was counter-productive. His original intent, after all, was to cover more content, not less. How could he do this while implementing active learning techniques? His reluctance to let go of course content was an indicator of his belief that students learn effectively from passive listening. Changing his beliefs would take time and the experience of recognizing the benefits of using active learning in his own classroom. Fortunately, despite his skepticism, the instructor agreed to try out my plan in W07.

Since the instructor's main concern about implementing active learning was the necessity of cutting content, I suggested a way to dodge this problem. What he needed to do, instead, was to make his students accountable for preparing for class. He could use reading guides to focus students on terms and concepts they would need to actively participate in class. Frequent reading quizzes could be used to hold students accountable for their preparation.

He was receptive to the idea of using reading guides but he told me he couldn't visualize how the in-class active learning techniques I described could be applied in a sedimentology and stratigraphy class. Fortunately, a few months after the instructor agreed to the plan, he and I attended a workshop where he saw several specific examples he was looking for.

It is important to note that although the instructor progressed from having no interest in using active learning strategies (Level 0) to learning about, considering, and eventually agreeing to use active learning strategies (Level 1), his skepticism and reluctance indicated that his beliefs about how students learn and about his role as an instructor remained instruction-centered, rather than student-centered (Barr and Tagg, 1995).

Level 2 Preparation

The instructor couldn't visualize how to apply active learning techniques because the examples I gave were not specific to teaching sedimentology and stratigraphy. He explained that he needed specific examples when he said:

> *"It is clear you understand but my question is do you have specific examples to implement in my class so I don't revert back to lectures. We need to line them up for each class period."*

He not only wanted to see strategies specific to teaching his course content but he also wanted the ones he would be using to be planned and prepared for each lecture.

One thing that really helped us start preparing for W07 was attending the SERC professional development workshop titled "Teaching Sedimentary Geology in the 21st Century" (http://serc.carleton.edu/NAGTWorkshops/sedimentary/workshop06/index.html). Approximately fifty geoscience instructors came to the workshop to spend a week attending sessions and discussing effective ways to help students learn sedimentology. Several of these sessions focused on teaching with active learning strategies.

While attending one of these active learning sessions, the instructor saw two specific examples that he thought were fantastic ways to teach a few concepts in his course. Both examples used a physical model to teach an abstract sedimentary process.

Workshop participant Jim Trexler presented a physical model for teaching about density modified flows (http://serc.carleton.edu/NAGTWorkshops/sedimentary/activities/13952.html). Using a tank of water, students predict and model flow behavior using fluids with different densities. An adjustable ramp in the tank also allows students to change the gradient of the flow path.

The instructor told me that he knew exactly how he could use the density tanks in Geology 370. He thought they would be great to teach students to classify flow types based on density and began making plans to construct two tanks to use during W07.

The second physical model was *NCED's Delta Box* presented by Tom Hickson (http://www.nced.umn.edu/SERC.html). Like the first model, the Delta Box was also a tank but instead of flow it modeled factors influencing large-scale sedimentation. The tank modeled how changes in factors like sea level impact deposition and erosion of sedimentary layers.. The tank essentially looks like a large ant farm; tall and narrow with two clear plastic walls. A constant supply of water and sediment—a mixture of sand and coal—is added to the tank, depositing alternating light and dark layers of sand and coal. Factors like the rate that sediment enters or how much water exits the tank can be manipulated allowing students to predict and observe how changes influence sedimentary layers.

The instructor was determined to build a delta tank of his own. He told me that he could use this tank to help students visualize a process that takes place at spatial and temporal scales that are difficult to observe directly.

When we returned from the workshop, the instructor immediately started construction of both tanks. He hired two students to spend Fall semester building the delta box. He also hired another student to experiment with two flow tanks that he commissioned a plastics company to build. After months of preparation, both tanks were ready for use in W07.

Preparing these demonstrations for W07 seemed to help him change his attitude toward active learning. His initial skepticism towards active learning strategies seemed to disappear after he saw specific examples for using them to teach sedimentology. As he prepared two of these examples for his own class he was excited to use them to teach.

Attending the workshop and constructing demonstrations to use in W07 helped the instructor visualize and prepare to implement active learning strategies (Level 2). But only a few days before the first day of class, we only had two weeks fully planned and prepared. The instructor expressed his concern that we were not prepared. He was right, in that we were not as prepared as he had expected and didn't have time to finish making the rest of the course changes before the beginning of the semester. I knew, however, that it wouldn't be a problem. I explained that we didn't want to have everything done before we saw what worked and what didn't. We would be making ongoing changes, instead, which would allow us to make ongoing improvements. He decided to trust me and go forward as planned. With only two weeks planned, he began implementing active learning strategies on the first day of W07 (Level 3).

Level 3 Mechanical Use

When the instructor began implementing active learning strategies in W07, it was only natural that his initial attempts were often disjointed and partially effective since he was trying a new approach for the first time (Level 3). But when he introduced his first activity, I realized there was another issue preventing him from using these strategies effectively: he was still skeptical.

I had assumed his attitude changed after we went to the SERC workshop since he seemed enthusiastic about implementing some of the examples he had seen there. But when he introduced his first activity in W07, it was clear that he was still skeptical about active learning. He said:

> *"We are going to do one of these groupie things. My son doesn't like 'em but we are going to see if this works."*

I felt like he was using his son's doubt to say *"Don't blame me if it doesn't work; I never expected it to."*

When I told him what he said he was surprised. He didn't realize he said it like that. Fortunately, the potential damage was not realized because he did an excellent job leading the activity. Reflecting on the activity after lecture, he said:

> *"The exercise went great. It was a good warm up for the students and they got a chance to get to know each other. They were engaged and thinking and they were forced to communicate."*

The more he reflected on the benefits he saw when he used active learning strategies in class, the less skeptical he felt toward them and the more he mastered the mechanics of implementing them.

With time and experience, the instructor felt less awkward and more confident about guiding activities and discussions. By W08 his change was dramatic. Think back on the instructor's first introduction where he used the term "groupie things," and then read his introduction given approximately one year later.

> *"I focus on student-centered learning…It means I do less lecturing and you do more learning. You have to buy off on this. If you don't buy off on this, this class won't work. The buy off is that you have to read the book. You have to do your part."*

His introduction sends a powerful message. Clearly, he now valued active learning and expected students to take responsibility for their learning. This was an important shift, because teachers must encourage student participation and see themselves as active learning teachers (Dubois, 1993) to effectively implement active learning strategies. In order to make this change, he had to first change his beliefs about teaching and learning. He did this incrementally, beginning with mastering the mechanics of active learning.

One mechanical issue he continued to struggle with, however, was time management. Good practice, according to Chickering and Gamson (1987), emphasizes time on task. The instructor tried, but often rushed his activities because he had lecture material to get through. Rushing frustrated him and he often told me that *"timing is an issue."*

Another issue soon emerged: redundancy. By redundancy I mean covering the same things that students were covering on their own. This can be good if the instructor takes it to a new level or shows it in a new context. But it can also be counterproductive if it is just the same presentation as in the text. Busy with other courses, students are quick to cut down unnecessary labor, and if an instructor covers what is in their text, they stop reading the text. One student noticed this redundancy and commented:

> *"I felt like a lot of yesterday's class was reviewing what we were required to write on the study guide. And so for me, I already wrote it, I read it, I understand that talking about it makes you internalize it even more, but I feel like I absolutely didn't learn anything new through most of the class because I had already done it."*

She was frustrated and probably close to give up on reading.

One reason the instructor may have been teaching redundant information was his reluctance to cut content from lecture. Students generally didn't give up on reading the textbook because of frequent quizzes. But some, like the student quoted above, began to feel aggravated.

Part of my role as a "consultant" was to help the instructor understand why students were frustrated and to help him make the daily progress he needed to make to resolve issues like redundancy. We would frequently discuss these issues during out meetings and I would point out the progress he was making in class. Typically the changes that made the biggest impact were small and easy to forget about. The instructor made tremendous improvements by staying on top of these small changes. He said that frequently talking about the issues he wanted to focus on and having me there to encourage and support him really helped him change.

He spent most of W07 working on making the changes we would discuss in our meetings. At first he was focused on mastering the mechanics of using active learning strategies (Level 4A). I suggested ways he could improve using these strategies and reminded him to focus on certain things while teaching. I would then follow up on his progress and include specific examples of his progress on the lecture debriefs I gave him (see Appendix C). With my constant support, the instructor made tremendous progress by making small changes during each lecture and reflecting on his progress. In summary, an instructor trying to implement a new method usually must pass through the awkward experience of getting used to the mechanics. The instructor did this and made step-wise improvements as he focused on his day-to-day use of active learning strategies. His time management issues stemmed from his traditional beliefs about teaching and learning and prevented him from letting go of content in lecture creating an issue with redundancy; an issue that could encourage students to stop preparing for class. These issues persisted over W07 and even into W08 but as he received constant support, he was able to address these issues and progressively improve the way he implemented active learning strategies. As his skills improved, his concerns changed and his willingness to let go of content increased.

Level 4A Routine

A month into the W07 semester, the instructor settled into a comfortable routine of regularly implementing active learning strategies (Level 4A). Students were also used to this routine and came prepared to participate in class. It seemed like active learning was working like we had hoped, or at least that was what we thought after Exam 1.

The W07 students did about the same as the W06 students on Exam 1 (Fig. 1 and Table 3). We were happy to see this since the instructor was concerned that using time for activities might detract from the amount of content W07 students would learn. But their performance on Exam 1 was comparable, and although the average score in W07 (0.86) was slightly higher than the average in W06 (0.79), according to a t-test (Table 3) the difference was not statistically significant ($\alpha=0.05$). This suggested that using lecture time for active learning activities did not hurt their ability to acquire content knowledge.

Relative to Exam 1, Exam 2 had more application-oriented problems. I anticipated W07 students would perform better than W06 students, considering the problem solving practice they were getting in class. But when the results came in, I was stunned. On average, they did worse than the 2006 students (Fig. 1 and Table 3) and this time the difference was statistically significant ($\alpha=0.05$). What went wrong?

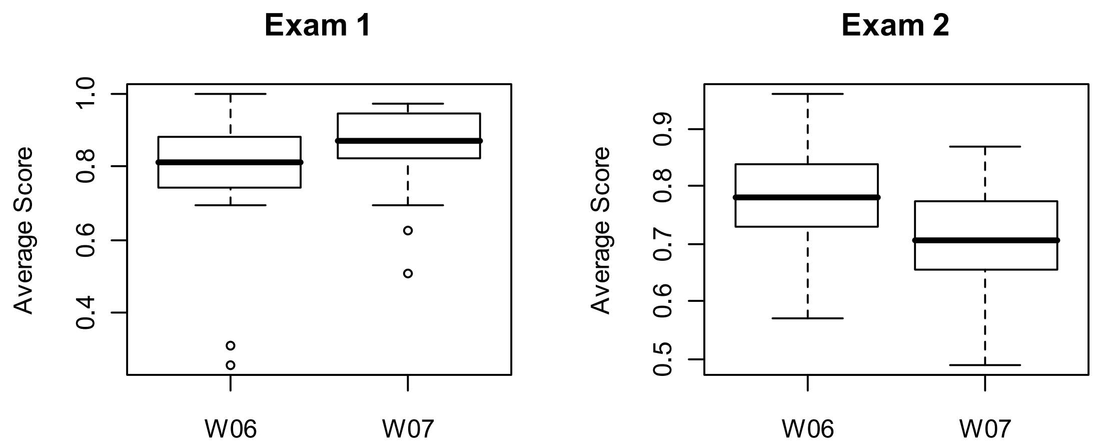

Figure 1. Boxplots of student scores on Exam 1 and Exam 2 in W06 (n=25) and W07 (n=18). For each boxplot, the central box is drawn between the hinges and the median is marked with a bold line in the box. The average scores (standard deviation in parentheses) for Exam 1 were 0.79(0.18) in W06 and 0.86(0.13) in W07. For Exam 2 the average scores were 0.78(0.09) in W06 and 0.71(0.09) in W07. Outlying scores are displayed as empty circles.

Table 3. Table of numerical summaries and t-test results for scores on the four course exams given in W06 and in W07. Statistically significant values (α=0.05) are indicated by an asterisks symbol '*'.

	W06			W07			t-test		
	Sample Size	Mean (μ)	Std. dev. (s)	Sample Size	Mean (μ)	Std. dev. (s)	df	t- Stat.	p-value
Exam 1	25	0.79	0.18	18	0.86	0.13	41	1.31	0.0984
Exam 2	21	0.79	0.087	19	0.74	0.092	37	-1.96	0.0285*
Exam 3	26	0.79	0.11	19	0.82	0.12	37	0.72	0.2378
Final	26	0.69	0.14	19	0.72	0.10	41	0.86	0.1972

Many of the students felt the exam was the problem. According to one of these students, the exam was unfair:

"The stuff on the exam was not at all what I expected. Instead of asking what we know, which is doable, it asked us to take a concrete knowledge of the subject and apply it. Very difficult."

The instructor was perplexed when he saw this comment. Wasn't this the point of doing activities in class? The instructor felt like the problem was the fact that students were being lazy by not reading or using the reading guides.

Another student who claimed to do the reading and use the reading guides insisted the problem was the exam.

> *"I like the reading guides, they help me learn, but the test was ambiguous and encourages me not to waste my time on reading guides if it is going to hurt my grade."*

I took this student's comment into consideration and examined the test and the reading guides. I found the questions on the reading guides were aligned with the same general concepts the instructor wanted them to use on the exam. I met with the student to discuss exactly what he meant when he said the reading guides didn't match the exam. He showed me a few of the questions he felt were not covered on the reading guides. I then showed him that they were, in fact, covered on the reading guides. He admitted that they were better aligned than he thought, and explained that he was probably just venting his frustration when he made that comment. He insisted, however, that even though the reading guides covered the content on the exam, he couldn't memorize everything they covered.

Hearing this, I realized immediately that the problem was that some students did not understand how to use the reading guides properly. They were treating reading guides as one more thing to memorize and treating the class like a traditional lecture class. By doing this, they were missing the point of what they were expected to do. By treating the course material as a list of things to memorize, they were not learning how to transfer what they learned to new situations.

The instructor wanted to prevent this from happening again, so we decided to clarify his expectations and improve the remaining two exams. We put the intended learning outcomes on reading guides and the instructor explained to the students that he wanted them to read and study with the goal of being able to *do* the tasks mentioned there. We also improved questions that seemed confusing or ambiguous in the subsequent exams.

When the students took Exam 3, most felt the changes were an improvement. One student felt the learning outcomes on the reading guides were *"great."* Several others said Exam 3 was much better than Exam 2. But other comments suggested they still felt they had to memorize everything. One student said:

> *"The instructor said we should know everything in the book, class notes, reading guides, activities and labs. I guess that covers everything. How we are supposed to synthesize and remember it all, I don't know."*

The feeling that they needed to memorize everything carried over to the final and frustrated many students.

The student ratings reports reflected the fact that many students were still unhappy with the course. An angry student commented that "the course is still disorganized." Another student acknowledged the fact that the course was being "overhauled" but was frustrated that "course materials…were not ready" and that he had to spend a lot of time "simply figuring out what" he was being asked to do on exams and assignments.

On the other hand, several students raved about how much they enjoyed the class. Several commented that they "learned a lot in the class" and that even though it was "one of the more challenging courses" they had taken, it was still "one of the more enjoyable" ones. Another student was impressed that the instructor "had a passion for geology and cared an abnormal amount" about his students' learning.

The division in student opinions about the course was also reflected in the overall instructor ratings (Fig. 2).

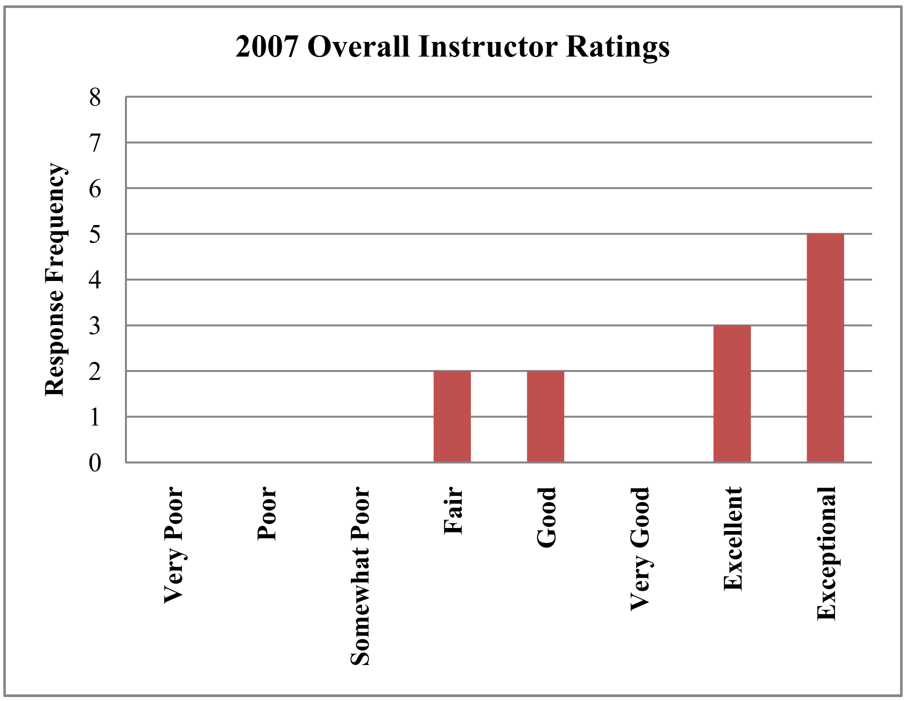

Figure 2. Histogram showing the distribution of the 2007 student ratings of the Geology 370 instructor's overall performance.

I was disappointed with the students' evaluations of the course. I initially expected the course ratings and the students' performance to improve, but neither happened, and I felt like the changes we made had failed. The instructor agreed that "we didn't have any hard data" to suggest that the changes improved student learning and that the course needed to be improved. But, he did not feel like we failed. He felt that the

W07 students were more "willing to ask questions and engage him in conversation" and that that improvement was "not a trivial thing." He also was impressed with how students performed on the field trip. Never had he seen a class work so efficiently and effectively in groups. He could only explain what he saw as a clear benefit of using active learning strategies in class. He wanted to continue improving the course for 2008.

The instructor spent W07 learning the mechanics of using active learning strategies (Level 3) and establishing a comfortable routine for implementing them during lecture (Level 4A). Yet, even though his instruction improved, it seemed like student learning did not. Student attitudes towards the course were split and their overall performance did not improve relative to the W06 course. The instructor, however, felt the students' performance on the field trip was impressive and attributed it to the changes made in W07. He wanted to continue making improvements to the course and met with me in September 2007 to begin planning changes for W08 (Level 4B). His attitude toward active learning and willingness to continue to make improvements in the face of setbacks showed that his beliefs about teaching and learning had begun to permanently change.

Level 4B Refinement

When we began planning the changes for W08, the instructor told me that he wanted to improve the exams and class activities. He also thought we should put a course packet together to help students stay oriented. We discussed the fact that students were confused about his learning expectations and decided to focus on making those more explicit.

We worked on making these changes for W08 and prepared a new activity that we hoped would help students understand what they would be expected to do. The instructor implemented this activity on the first day of W08. The activity was designed to get students to interact and reveal their own expectations of the class and the instructor (Michael and Modell, 2003), and involved surveying students using 3 x 5 cards to quickly gather student opinions on the following two questions:

1. What can be expected of you (the student) in this class?
2. What do you expect of me (the instructor) in this class?

After students wrote their responses on these 3 x 5 cards, the instructor quickly skimmed through their answers (see Tables 4 and 5) and selected a few to read aloud. After he read a comment, he asked the class to discuss what they thought about it. The students were hesitant at first but the instructor was persistent. He clearly wanted students to participate. When no one would respond he made a joke and the tension in class began to lighten. Students began making comments and eventually he was leading a discussion with the entire class.

Table 4. 3 x 5 Card Activity – Student Expectations of the Instructor. The student answers to the stated question were categorized by themes and distilled into this table, comment frequency (number of students making a comment aligned with each theme) and percentages are shown for each category.

Question 1: What do you expect from the professor in this class?	**Comment Frequency**	**Percent of Students**
Teach things that are relevant, have purpose, or are of value	10	28.6
Be available for students to get help	8	22.9
Be clear, teach clearly	8	22.9
Teach how to apply and use what is taught	6	17.1
Make class exciting and fun	5	14.3
Be prepared to teach	3	8.6
Explain everything that students need to know	3	8.6
Prepare students for tests	2	5.7
Teach for understanding	1	2.9
Teach what students are expected to learn	1	2.9
Use and add to what students already know	1	2.9
Grade and be fair	1	2.9

Table 5. 3 x 5 Card Activity – Student Perceptions of Expectations of Students
The student answers to the stated question were categorized by themes and distilled into this table, Comment frequency (number of students making a comment aligned with each theme) and percentages are shown for each category.

Question 2: What can be expected of you in this class?	Comment Frequency	Percent of Students
Do work and put in effort	22	62.9
Class attendance	10	28.6
Specifically to do my best work	7	20.0
To prepare for class	5	14.3
To participate in class	5	14.3
To be punctual	4	11.4
To read	4	11.4
To seek help when I need it	3	8.6
To study	2	5.7
Do work on time	1	2.9

In this simple activity, the instructor let the students know what he expected of them. He expected them to come to class prepared and ready to participate. He also let them know that he valued their opinions and wanted them to feel comfortable interacting in class.

Along with making his expectations clear, the instructor increased his focus on how well activities were being implemented. Instead of waiting until our after-class meeting to reflect on how to improve activities, he began reflecting on the activities while he was implementing them and improving his implementation on the fly. This was a good sign that he needed me less and was willing to make ongoing changes to improve student learning.

During the rest of W08, the instructor continued to focus on making his expectations explicit and adjusting the way he implemented active learning strategies to improve student learning. His priorities also changed. For instance, he made a comment that showed cutting content to make activities more effective was no longer a struggle for him.

"The lecture went well…because I had the time to probe the students. I just don't have time like this in every lecture. This goes back to having to cut information out to get good discussions like we got today. I don't want to feel like we are rushed. If we have to cut out a bit more let's do it so students have a chance to think."

He was even willing to completely restructure his final exam. Traditionally the final was a comprehensive exam consisting of both recall and short, problem-based questions. The instructor decided he would try something completely different. We had designed a comprehensive problem in W07 that we gave the students as a post-field trip assignment. He wanted to change it a little and use it as the final exam.

When he informed the students that their final would consist of one, comprehensive problem, they were not happy. They didn't like the idea of their entire grade resting on their performance on one question. To alleviate the students' concern, he let them come up with and submit comprehensive multiple choice questions. He then selected some of the questions for a section of the exam. The students liked the idea of making the questions and being able to know which questions might show up on the exam.

On the day of the final, the students were nervous and uncertain about what to expect. We gave them the exam and most immediately turned to page with the comprehensive problem. Their facial expressions didn't show relief, but they also didn't show despair. Everyone was able to attempt the problem. After they finished the exam, the students expressed their feelings about it on the final exam survey.

The students were unanimous in saying they felt the exam focused on what the instructor said he expected them to learn. One student commented that the instructor *"was all about application and that this test did a great job"* getting students to apply what they learned. Another agreed and commented that:

> *"the instructor wanted us to be good at what we do and to think and interpret and that was what we were asked to do on the exam."*

The students also agreed that the comprehensive problem was challenging. Half of the students didn't enjoy the challenge and felt the comprehensive problem was "scary," "overwhelming," and "difficult to prepare for." Those who liked the problem said that it made them think and allowed them to be creative, since there was no set answer. One student explained why he liked the problem by saying:

> *"I felt like I was solving a problem that was real. It was way better than memorizing a bunch of terms and spewing them onto paper in sentence form."*

I also noticed that, regardless of whether the students liked the problem or not, they all were uncertain about how well they did on the exam. They commented that they had never taken an exam like this one and were nervous that they did it wrong. And yet, their scores on the exam (Fig. 3 and 4) show that they performed well (average score = 86.5, standard deviation = 8.75)—with the exception of a few students who were already struggling in the class.

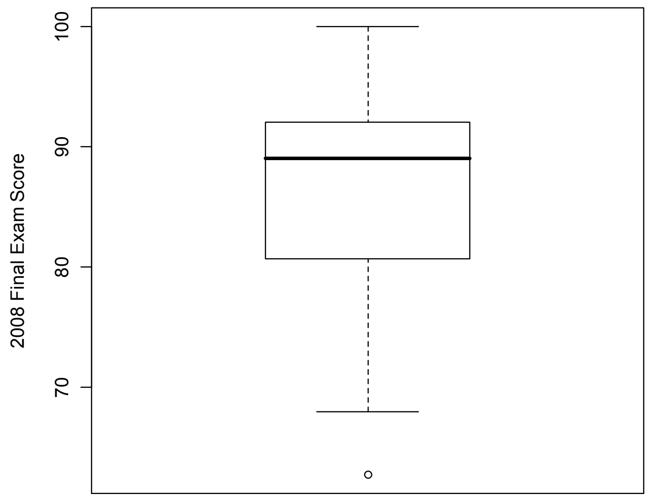

Figure 3. Boxplot of 2008 student scores on the final exam. Bold line indicates an average exam score of 86.5. Open circle below the lower fence of the boxplot suggests this data point representing the lowest exam score is an outlier.

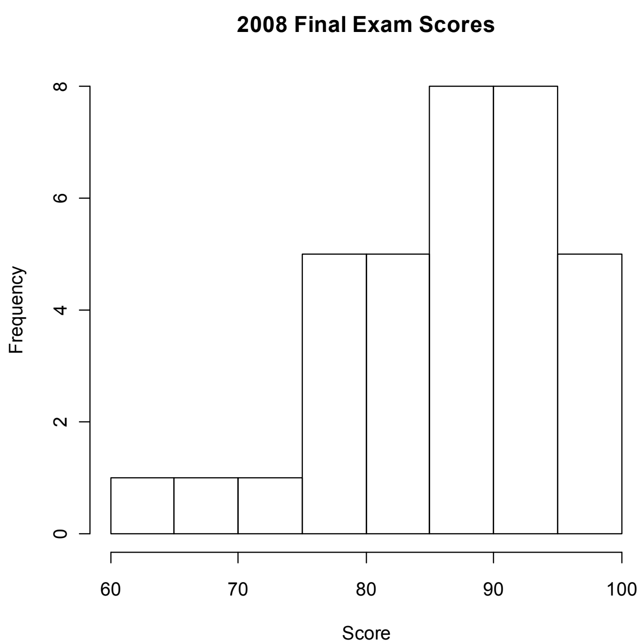

Figure 4. Histogram of 2008 student scores on the final exam scores. The distribution of scores is left skewed, centered on the mean score of 86.5 and dispersed about the mean by a standard deviation value of 8.8.

It is interesting that the students seemed confident applying problem-solving skills in class, but when it came to the exam they became doubtful. One reason may be that they were treating this exam like they treat their lecture-based exams and you can't expect to study a few hours and feel prepared to use that knowledge in different ways to solve a comprehensive problem. Those students who participated in class and focused on the learning outcomes all successfully attacked the problem. It is clear that the students were able to apply their knowledge, but they lacked confidence. This is something the instructor can improve for W09 by adding more synthesis problems to exams and quizzes. The more students realize that they are capable of solving these "scary" questions in testing situations, the more confident they will become.

A few weeks after the final exam, the instructor was thrilled to tell me about his 2008 student ratings report. His ratings had improved, and were some of the highest ratings he had ever received (Fig. 5 and 6).

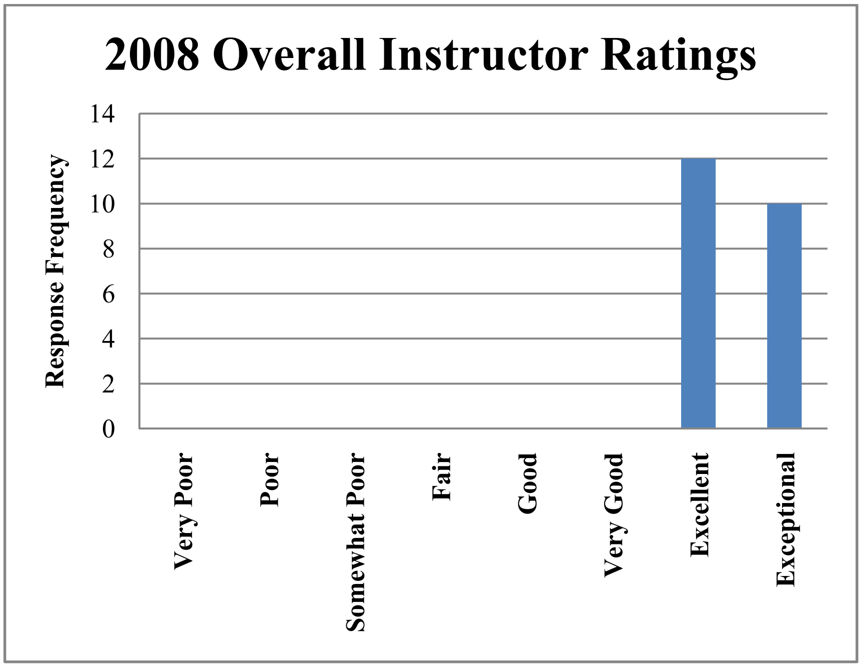

Figure 5. Graph showing the distribution of the 2008 student ratings of the Geology 370 instructor's overall performance. Compare to Fig. 2.

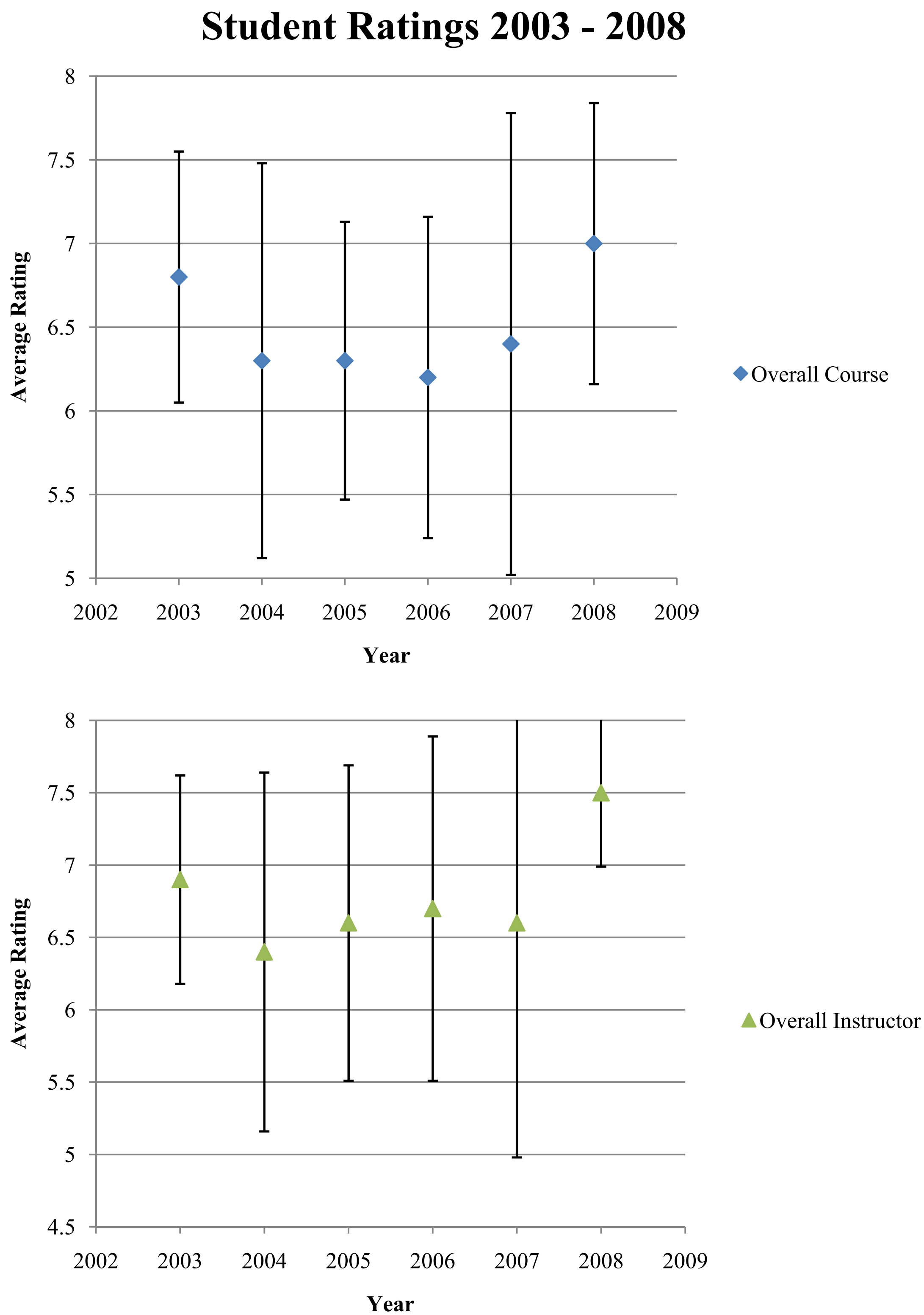

Figure 6. Average student ratings of the Geology 370 course and instructor from the years 2003 to 2008. Error bars represent ± one standard deviation.

Students felt they learned a lot in the class. One student felt that they learned more in Geology 370 compared to lecture classes:

"The way the material was presented really helped me to remember more. Other classes that are purely lecture are forgettable."

Even a student who knew he didn't do very well in the class felt he had learned more than he had in lecture courses:

"Though my grades may not reflect the amount I learned. I feel I learned more in this class than in most of the other classes I have taken."

And another student felt the instructor did a great job helping everyone in the class learn:

"I have never seen an instructor who showed so much interest in the learning of their students. You are always available to visit in your office, which cannot be said of most professors. You made the quiet and shy kids in the class participate, which helped their confidence. You made the lectures very interesting. I never doubted for a moment that you do indeed care about the learning and progress of every student in the class."

One thing W08 students felt needed to be improved was the course workload. One student, most frustrated by the workload, felt like the instructor *"put a lot on"* them. Another student felt it was too much work:

"This class is a lot of work for 3 credit hours. It seems comparable in workload of a 4 credit class."

This made me wonder how many hours of work are appropriate for the course and how many hours the students were actually working. The 2007-2008 BYU undergraduate catalog explains:

"The expectation for undergraduate courses is three hours of work per week per credit hour for the average student who is appropriately prepared; much more time may be required to achieve excellence. These three hours may include one hour of lecture plus two hours of work outside class, three hours in a laboratory with little outside work, or any other combination appropriate to a particular course."

The course is 3 credit hours so students who expect to be *"appropriately prepared"* should expect 9 hours of work per week. Lecture and lab make up 4 ½ hours, so students should expect to spend another 4 ½ hours working on the course. Even more time should be spent if students expect to *"achieve excellence."* On average, students reported spending less (3.8 hours) than the minimum number of hours suggested for being *"appropriately prepared"* and yet, several felt what the number of hours they were spending on the course was unreasonable (Fig. 7).

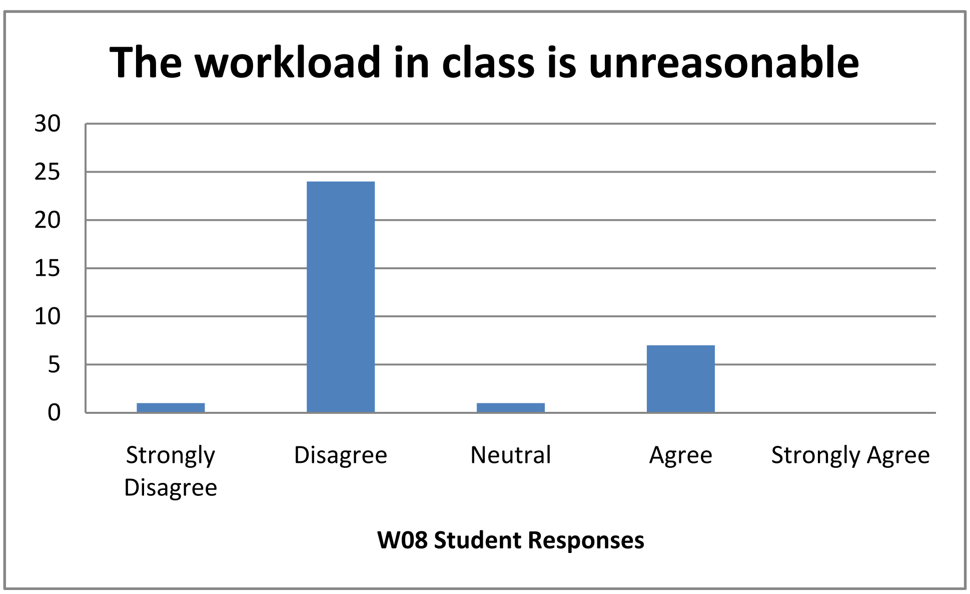

Figure 5. 2008 student responses to the question "Is the workload in class unreasonable?".

We concluded that if the instructor was going to help students take responsibility for their learning, then he needed to help them realize exactly how much work they would need to put into the class to be successful. Thus, he would need to change their expectations about what it takes to get *"achieve excellence"* in a university course.

After working with the instructor for three years, I had collected considerable evidence to suggest he had changed his attitude toward active learning strategies and his beliefs about learning. Part of his change is reflected in how his concerns changed over time. I used the SoCQ instrument to construct the instructor's concern profile—once in August 2007 and once in August 2008). An individual's concern profile indicates which of the six stages of concern best describes what the individual is most concerned about. In the instructor's 2007 profile (Fig. 8), the peak in concerns corresponds with stage 3 and 4—indicating that the instructor was most concerned with the management and consequences of using active learning strategies.

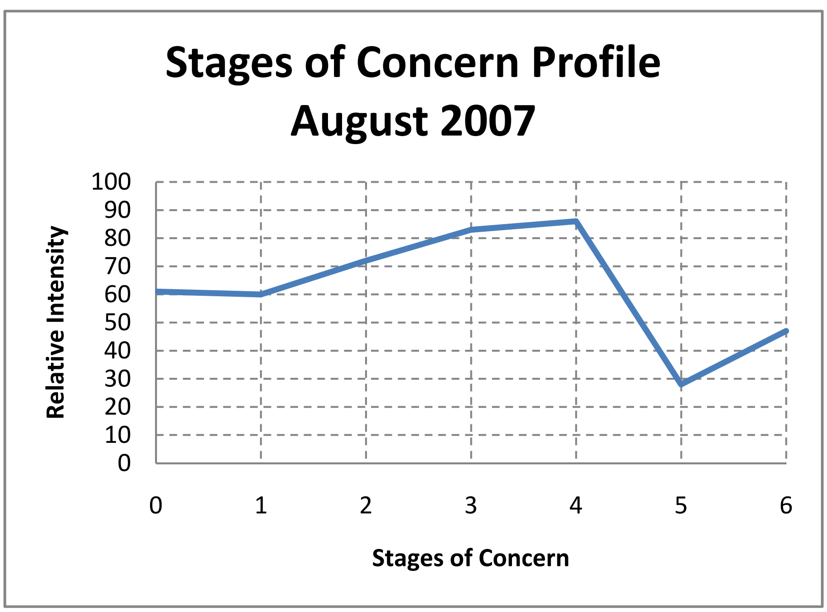

Figure 6. The instructor's stages of concern profile constructed from his August 2007 responses to the SoCQ regarding his concerns about implementing active learning strategies. The resulting profile indicates the relative intensity of concern he felt in terms of the six stages of concern.

Ideally, an individual's concern profile moves like a wave to the right as they receive effective support from the change facilitator who is helping them to improve their use of an innovation. The expectation is that, as a person who adopts a new innovation has concerns about the innovation and becomes more comfortable implementing it, their concerns will shift progressively from low to high Stages of Concern (see Table 2). The early stages (0-2) relate to an individual's knowledge of the innovation, and their personal concerns about implementing the innovation. As they learn about the innovation and how it will actually impact them their concerns will shift to how they will actually use the innovation (Stage 3). Again, as they receive support and encouragement, they are likely to learn to use the innovation, and management will no longer be their main concern. The next stage a person would then move to is Stage 4, where their main concerns are about how using the innovation impacts their students' learning. When they make steps to address this they may want to work with other people to make their use of the innovation even more impactful and, thus, move to Stage 5 (Collaboration). Finally, after a person successfully learns about, implements, and improves their use of an innovation, they may feel like they need a new innovation that works even better, or to make further changes to improve their use of the existing innovation. Their highest intensity concern would be in Stage 6 (Refocusing). This wave-like movement from left to right on a concerns profile is a general model of how an individual's concerns change as they receive support to address their concerns. An individual's concerns profile may not follow this pattern over time, however, because of concerns specific to their situation, or perhaps because they are not receiving the support they need to address their concerns (George et al., 2006). If a person is stuck on a certain concern, they are likely not going to progress much.

The instructor's 2008 profile (Fig. 9) indicates his concerns were shifting to the right, but not according to the general pattern.

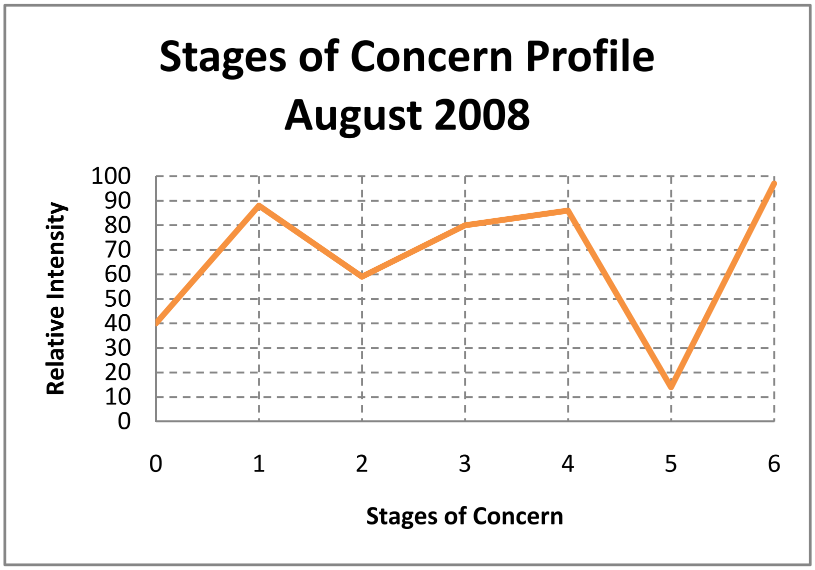

Figure 7. The instructor's stages of concern profile constructed from his August 2008 responses to the SoCQ regarding his concerns about implementing active learning strategies. The resulting profile indicates the relative intensity of concern he felt in terms of the six stages of concern. Compare to Fig. 8.

A new peak emerged at Stage 1 indicating he was concerned about obtaining information about active learning strategies. When I discussed this trend with one of my committee members, we agreed that he had made substantial progress, but perhaps I should have focused more on showing him how he can find such information on his own. His desire to learn more information, I believe, is a positive sign that he wants to learn more about using active learning so he can continue to use it.

He later reflected on this course redesign experience, and his comments further convinced me that the benefits he saw from changing his teaching style would help him sustain those changes and continue to improve on them. He wrote:

"I knew I needed to upgrade and change. I also anticipated that it would be painful with a lot of work. Changes did take some work but it was not so painful, partly because of Teagan's hard work and personality. [Now, teaching] is exciting! I am starting to see the benefits in my students' learning as well as in their involvement and relative excitement about the concepts and materials. First, this change effort has rewards, both for the students and myself. Second, as I have changed and organized the class I see the benefits of how much material I cover, in student learning and involvement of the students, and how it is more fun to teach and hopefully the student's learning improves. I have also gotten more satisfaction this year than for many years previous."

The instructor felt the years of work spent redesigning Geology 370 were well rewarded. He enjoyed teaching more and was more satisfied with teaching than he had been for years.

It was the instructor's feelings of dissatisfaction that motivated him to volunteer for this redesign project in the first place. He initially wanted to change from projector slide shows to PowerPoint presentations, but he ended up changing much more. After the initial course evaluation he agreed to change his teaching methods and implement active learning strategies. As he implemented these strategies his attitude towards them changed dramatically and he replaced his doubt with conviction that active learning strategies were effective. He also changed his mode of instruction. He mastered the mechanics of using active learning methods and continued improving by making planned and impromptu changes that he felt would improve student learning. Finally, he changed how he presented his expectations to make sure students clearly understood what they needed to do to achieve course learning outcomes. Now, as he prepares for W09, he is making more changes with the goal of helping the students to change their own beliefs and attitudes about learning and how much work is reasonable to achieve his expectations for them.

CONCLUSION

The BYU Geological Sciences Department is trying to find a ways to improve teaching and learning in their undergraduate courses using their own resources. We investigated whether this could be done using a M.S. Geoscience Education graduate student to help a professor design, implement, and evaluate active learning strategies in one of his courses.

We found that our method was successful after we addressed three major issues. First, he had to change his beliefs about teaching and learning. Specifically, he had to realize that students learn when they are actively engaged instead of when they are passively listening. Second, the instructor had to learn how to implement active learning strategies effectively, and to adjust them as he went along to improve student learning. Third, he had to align student expectations with his own. He is still actively working on this last goal, but feels he has a clear direction.

We found there were several advantages to our approach. First, redesigning a class was very time consuming, and the M.S. Geoscience Education graduate student was able to reduce the amount of time the instructor had to devote to making course changes. Second, by having the long-term, consistent support of the graduate student, the instructor was able to successfully transfer pedagogical theory into his teaching practice. Third, by helping the instructor change his beliefs about teaching and learning, and helping him learn to implement active learning methods, we have created a new resource for the Geoscience Department. We are confident that the instructor would be willing to help other instructors in the department if they seek his advice on implementing similar strategies.

We also found that our approach had some disadvantages. First, the graduate student was not an expert and, had she had more experience she may have been able to avoid some of the issues she and the instructor faced. Second, the success of our project is largely due to the fact that we were able to transform the teacher/student relationship between the instructor and the graduate student into a client/consultant relationship. This could occur, in this case, because the personalities of both individuals worked well together. Had this not been the case, it is unlikely that the instructor would have trusted the opinion or taken the suggestions of an inexperienced graduate student. This problem was mitigated somewhat, because before this relationship of trust was established, the graduate student had her committee members to support her when she made the initial suggestions for redesigning the course. Their support bolstered her own confidence and brought credibility to the suggestions she made. Again, without achieving this client/consultant relationship, we don't believe others will find the success that we were able to achieve.

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APPENDIX A: Surveys

2006 Textbook Survey

Why a Textbook Survey?

An important way that students can prepare for class is to do their reading assignments. At the end of 2006 I had a feeling that students were not reading their textbooks prior to coming to class. I sent the class this survey to get an idea for how and when students were using their textbooks.

Response Summary

Half of the class responded to the textbook survey (Responses/Students Enrolled: 14/28). Of those who responded, the majority seldom used it. Over 75% of the respondents didn't read the assigned chapters before class and less than 25% read the text to study for exams. Most students said they started reading the text in the beginning of the semester but stopped after realizing they could just study their notes and handouts to prepare for tests. When they did use the text it was more for diagrams or formulas and not for content information. The students, overall, didn't feel like the book was very useful.

W06 Textbook Survey Questions

Did you read the assigned chapters before the corresponding lectures?

Did reading before class help you to understand the lecture better?
If YES, explain how reading helped.
If NO, explain how reading didn't help.

How well did you understand the concepts from reading the text?

Did you read the textbook to study for exams?
If YES, how did reading the textbook help you to prepare for exams?
If NO, did you feel prepared for exams?

How did you prepare for exams?

As a tool that helped you to succeed in Geology 370, how would you rate the textbook?

	Useless
	Not Very Useful
	Somewhat Useful
	Very Useful

Explain your reasoning for the rating you gave the textbook in the previous question.

W06 Textbook Survey Responses

Question	Response Frequency	Percent
Did you read the assigned chapters before the corresponding lectures?		
Yes	3	21.4
No	11	78.6
Did reading before class help you to understand lecture better?		
Yes	8	57.1
No	5	35.7
How well did you understand the concepts from reading the text?		
Well to Very Well	7	50.0
Average	2	14.3
Not Well to Not Very Well	4	28.6
As a tool that helped you to succeed in Geology 370, how would you rate the textbook?		
Useless	2	14.3
Not very Useful	3	21.4
Somewhat Useful	7	50.0
Very Useful	1	7. 1

Representative Comments:

Useless

- I just didn't use it. I didn't need to. Oh, I used it to decide what my paper would be about.

Not very Useful

- The class seems based mostly on notes—the textbook is more a side thought
- For most tests I used notes. I hardly ever used my book.

Somewhat Useful

- The textbook was somewhat useful in the sense that it had the information that I needed to know, but many of that information was given through the notes in class so I didn't need to use the textbook.
- I did well in the class without using the book much, but it did help a bit when I did use it.
- If I had to, I think reading the book could have taught me the necessary info of the class, but because the professor teaches it, why focus all my energy on the book?

Very Useful

- In general, I learn better from textbooks than from lectures, and this class was no exception (although I learned more from lectures in this class than from many others).

2007 Exam 1 Survey

Purpose: The purpose of this survey is to find out your opinion about exam 1. Your responses will be extremely valuable to us as we plan future exams. Your responses are confidential and will not affect your grade in this class.

Section 1: Your Impressions of Exam 1

Instructions: Answer questions 1 and 2 by circling the word or phrase that best describes your opinion. Use the space provided to explain why you selected that word or phrase.

1. How prepared do you feel you were for Exam 1? Explain your response.
   - Very prepared
   - Somewhat prepared
   - Not prepared at all

2. How difficult was Exam 1? Explain your response.
   - Extremely easy
   - Moderately easy
   - Challenging
   - Extremely challenging

Section 2: Exam Content

3. Do you feel the items on the exam represent what Dr. Morris stressed in class?

4. a. Were there any exam questions that caught you off guard? What were they?

   b. If yes, why do you think you were caught off guard?

Section 3: Your Preparation

5. What did you use to study for the exam? (Check all that apply)

The textbook
Reading questions
Vocabulary lists
Notes from class
Handouts from class
Other: ______________________

6. How did you prepare for each lecture period? (Check all that apply)

Read the assigned chapters
Answered reading questions
Defined vocabulary words
Reviewed notes from previous classes
Reviewed handouts from previous classes
Other: _____________________

7. a. Circle the percentage that best represents how much of the reading guides you completed:

   0%   25%   50%   75%   100%

   b. Do you feel the reading guides helped you focus your reading? Explain.

   c. Do you feel the reading guides were useful? Explain.

8. Do you feel Dr. Morris helped prepare you for what he expected you to do on the exam? Explain.

2007 Exam 2 Survey

Purpose: The purpose of this survey is to find out your opinion about Exam 2. Your responses will be extremely valuable to us as we plan future exams. Your responses are confidential and will not affect your grade in this class.

Section 1:Your Impressions of Exam 2

Instructions: Answer questions 1-3 by circling the word or phrase that best describes your opinion about Exam 2. Use the space provided to explain why your response.

1. How prepared do you feel you were for Exam 2? Explain your response.
    Very prepared
    Somewhat prepared
    Not prepared at all

2. How difficult was Exam 2? Explain your response.
    Extremely easy
    Moderately easy
    Challenging
    Extremely challenging

3. How representative of the course material was Exam 2? Explain your response.
    Extremely representative
    Mostly representative
    Mostly unrepresentative
    Extremely unrepresentative

Section 2: Your Preparation

4. Did you attend the review session for Exam 2?

5. What did you mainly use to study (i.e. reading guides, past tests, the book etc…)?

6. Do you feel the items on the exam represent what Dr. Morris stressed in class, handouts, and reading? Explain.

7. Do you have any suggestions/comments to help improve Exam 2?

2007 Exam 3 Survey

Purpose: The purpose of this survey is to find out your opinion about Exam 3. Your responses will be extremely valuable to us as we plan future exams. Your responses are confidential and will not affect your grade in this class.

Section 1: Your Impressions of Exam 3

Instructions: Answer questions 1-3 by circling the word or phrase that best describes your opinion about exam 2. Use the space provided to explain why your response.

1. How prepared do you feel you were for Exam 3? Explain your response.
   Very prepared
   Somewhat prepared
   Not prepared at all
2. How difficult was Exam 3? Explain your response.
   Extremely easy
   Moderately easy
   Challenging
   Extremely challenging
3. How fair was Exam 3? Explain your response.
   Extremely Unfair
Mostly Unfair
Mostly Fair
Extremely Fair

Section 2: Your Preparation
4. What did you use to study for the exam? (Check all that apply)
The textbook
Reading questions
Vocabulary lists
Notes from class
Handouts from class
Other: ______________________
5. How did you prepare for each lecture period? (Check all that apply)
Read the assigned chapters
Answered reading questions
Defined vocabulary words
Reviewed notes from previous classes
Reviewed handouts from previous classes
Other: _____________________
6a. Circle the percentage that best represents how much of the reading guides you completed:
   0%   25%   50%   75%   100%

6b. Do you feel the reading guides helped you focus your reading? Explain.

6c. Do you feel the reading guides were useful? Explain.

7. Do you feel Dr. Morris helped prepare you for what he expected you to do on the exam? Explain.

8. Do you feel the items on the exam represent what Dr. Morris stressed in class, handouts, and reading? Explain.

9. Do you have any suggestions/comments to help improve the test?

2007 Final Exam Survey

Purpose: The purpose of this survey is to find out your opinion about the final. Your responses will be extremely valuable to us as we plan future exams. Your responses are confidential and will not affect your grade in this class.

Section 1:Your Impressions of the final Exam

Instructions: Answer questions 1-3 by circling the word or phrase that best describes your opinion about the final. Use the space provided to explain why your response.

1. How prepared do you feel you were for the final? Explain your response.
   - Very prepared
   - Somewhat prepared
   - Not prepared at all
2. How difficult was the final? Explain your response.
   - Extremely easy
   - Moderately easy
   - Challenging
   - Extremely challenging
3. How representative of the course was the final? Explain your response.
   - Extremely representative
   - Mostly representative
   - Mostly unrepresentative
   - Extremely unrepresentative

Section 2: Your Preparation

4. Did you attend the review session for the final?
5. What did you mainly use to study (i.e. reading guides, past tests, the book etc…)
6. Do you feel the items on the exam represent what Dr. Morris stressed in class, handouts, and reading? Explain.
7. Do you have any suggestions/comments to help improve the final?

General Course Evaluation Questions

8. Put an 'x' in the box in the column under the phrase/statement that best represents the degree you agree with the following statements:

Statement	Strongly Disagree	Disagree	Agree	Strongly Agree
The concepts covered in this course were too simplistic. I expected to be challenged more.				
When asked questions in class, I felt comfortable to give my best answer, even if it was wrong.				
I feel like my assignments were graded fairly and if there was a problem that Dr. Morris or Teagan were always willing to discuss it.				
The class asked too much of me. I couldn't keep up with all the material and assignments.				
Dr. Morris and Teagan seemed to be doing two different things with the class so the class felt disjointed.				
I really liked how Dr. Morris taught. I really learned a lot.				
Changing from lecture to activity and back to lecture was annoying. I wished he would have just stuck to one thing.				
You could really tell that Dr. Morris and Teagan were working to accomplish the same goals with the class.				
I had a tough semester so this class was a low priority to me.				
The activities were great and helped me learn better than normal lecture.				

If you feel strongly about any of the above comments please explain below:

Exercise/Demonstration Survey

Purpose: The purpose of this survey is to find out your opinion about the demonstrations and exercises that have been used in the Geology 370 lecture.

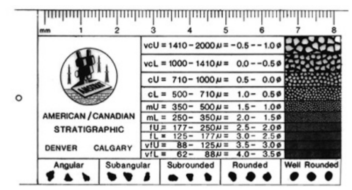
Directions: The images below are meant to trigger your memory of the different exercises and demonstrations we have done in lecture. Use them to answer the questions on the next sheet.

A.) Grain Observation

B.) Bagnold Wand

C.) Grain Size Analysis

D.) Making a Grain Size Card

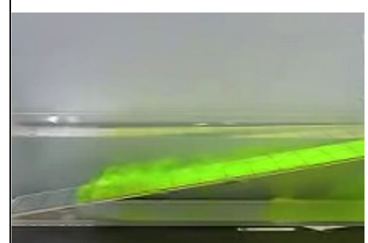


E.) Observing Bedforms with the Flume

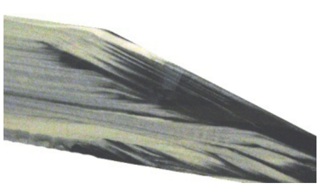
F.) Turbidite Bottle – graded bedding

G.) Soft Sediment Deformation Bottle

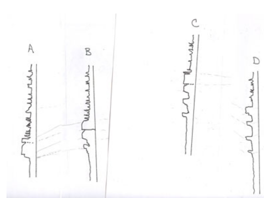
H.) Density Flow Tank



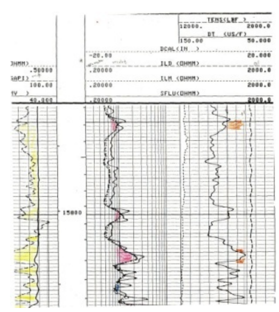
I.) Sequence Stratigraphy Tank



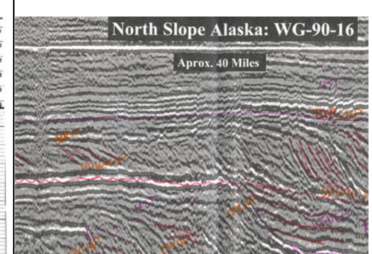
J.) Lithostratigraphic Correlation



K.) Borehole Lab



L.) Seismic Interpretation



Questions:

1. List the letters that correspond to your TOP 2 favorite demos/activities.
2. What about these activities makes them your favorite?
3. List the letter that corresponds to your 2 LEAST favorite demos/activities:
4. What about these activities makes them your LEAST favorite?
5. Which demo/activity do you feel you learned the most from? Why?
6. Of the demos/activities which do you feel you learned the LEAST from? Why?

2008 Exam 1 Student Opinion Survey

Purpose: The purpose of this survey is to find out your opinion about Exam 1 and the class in general. Your responses will be extremely valuable to us as we plan future exams and continue making improvements to the class. Your responses are confidential and will not affect your grade in this class.

Directions: After you complete Exam 1, take a few minutes to respond to the following questions. Turn this survey in with Exam 1.

1. What one thing can Dr. Morris do to make this class a better learning experience?

2. What one thing can you do to make this class a better learning experience?

3. What one thing would you tell students taking this course next year that you would have liked someone to have told you about how to prepare for Exam 1? (Other than the answers to the exam, of course).

4. Feel free to share any additional co0mments you have about Exam 1 or the class in general.

2008 Course Evaluation Survey

Purpose: The purpose of this survey is to find out your opinion about the class. Your responses will be extremely valuable to us as we plan future changes. Your responses are confidential and will NOT affect your grade in this class.

General Course Evaluation Questions

Put an 'x' in the box in the column under the phrase/statement that best represents the degree you agree with the following statements:

Statement	Strongly Disagree	Disagree	Agree	Strongly Agree
The concepts covered in this course were too simplistic. I expected to be challenged more.				
When asked questions in class, I felt comfortable to give my best answer, even if it was wrong.				
I feel like my assignments were graded fairly and if there was a problem that Dr. Morris or one of the TAs was always willing to discuss it.				
There is too much material in this class!!				
The class felt disjointed.				
The workload (assignments, reading, exams, etc.) is unreasonable.				
I really learned from Dr. Morris.				
Changing from lecture to activity and back to lecture was annoying. I wished he would have just stuck to one thing.				
I had a tough semester so this class was a low priority to me.				
In-class exercises are a great way to use class-time.				
Doing group work in class helps me learn.				
So far, I feel like I have learned a lot in this class.				

If you feel strongly about any of the above comments please explain below:

Answer the following questions. Be direct and clear in your responses but don't spare the details! This will help me understand what you are thinking.

What about Dr. Morris' teaching style makes class a good learning experience for you?
How can Dr. Morris improve his teaching in order to improve your learning experience?
What more can you do to improve your learning experience in this class?
Explain one thing about this class that you like most.
Explain one thing about this class that frustrates you most.

2008 Final Exam Survey

Purpose: The purpose of this survey is to find out your opinion about Exam 1 and the class in general. Your responses will be extremely valuable to us as we plan future exams and continue making improvements to the class. Your responses are confidential and will not affect your grade in this class.

Directions: After you complete Exam 1, take a few minutes to respond to the following questions. Turn this survey in with Exam 1.

1. What one thing can Dr. Morris do to make this class a better learning experience?

2. What one thing can you do to make the class a better learning experience?

3. What one thing would you tell students taking this course next year that you would have liked someone to have told you about how to prepare for Exam 1? (Other than the answers to the exam, of course.)

4. Feel free to share any additional comments you have about Exam 1 or the class in general.

APPENDIX B: IRB Consent Form

Consent to be a Research Subject – Geology Course Enhancement

Dear Geology/Physical Science student,

Your class has been selected to participate in a study of the effects of various course enhancements that are in the process of being implemented. We will be trying to determine whether your attitudes toward science, conceptions of science, and grasp of the material to be learned is improved due to these course enhancements.

Those who participate in this study will be asked to complete short surveys given at the beginning and end of the course. In addition, assignments and exams given to the class may also be used to evaluate the effect of the course enhancements. Finally, a few students may be asked to participate in one or more short (30 minutes or less) interviews.

There are no known disadvantages or benefits to those who participate in this study. The purpose of this study is to determine whether such disadvantages or benefits are present.

Participation in all aspects of this research is voluntary. You have the right to refuse to participate and the right to withdraw later without any jeopardy to your class grade. Strict confidentiality will be maintained. No individual identifying information will be disclosed. All identifying references will be removed and replaced by control numbers. All data collected in this research study will be stored in a secure area and access will only be given to personnel associated with the study.

If you have any questions regarding this research project, you may contact Barry Bickmore, S-321 ESC, Brigham Young University, Provo, UT 84602-4606; phone, (801) 422-4680.

If you have questions regarding your rights as a participant in a research project, you may contact Renea Beckstrand, Chair of the Institutional Review Board, 422 SWKT, Brigham Young University, Provo, Utah 84602; phone, (801) 422-3873, renea_beckstrand@byu.edu.

Affirmation of Informed Consent

I have read, understood, and received a copy of the above consent, and desire of my own free will and volition, to participate in this study.

Check one of the following:

____I am willing to participate in this research by taking a survey at the beginning and end of this semester or term, and possibly by participating in one or more short interviews.

____I am willing to participate in this research by taking a survey at the beginning and end of this semester or term.

____I do not wish to participate in this research.

Research subject ________________________________ Date ______________

Witness ________________________________ Date ______________

Page 1 of 9

APPROVED EXPIRES
AUG 2 5 2006 - AUG 2 4 2007

APPENDIX C: Winter 2007 Lecture Debriefs

Lecture Debrief
Lecture 1
January 9, 2007

Q1: What went well?
The exercise went great. It was a good warm up for the students. They got a chance to get to know each other. They were engaged and thinking and they were forced to communicate.
Q2: What didn't work?
I did too much talking at the end of class.
Q3: Do you have any concerns?
We ran out of time, timing is an issue.
<Teagan's notes> He did say that this happens every year. You are really excited for the first day of class and you always plan too much. We didn't get to the historical lecture which means we will need to change the quiz to next time, which I think is a plus considering now we can quiz more on the reading instead of the lecture.
Q4: Do you have any ideas for how to change things or ideas for future lectures?
I want to have more spontaneity in lecture, give more opportunities to teach based upon student interaction. Have students state more of their assumptions.
<Teagan's notes> This is awesome!!! I am so excited the instructor is doing this. He did it on his own. He took part of the activity where students were defending their answers and worked in the law of superposition. This is where I want him to go, to be able to work around a problem and lecture based on what students are asking about. AWESOME.

Positive Observations:
Great introduction and transition into activity. (Make sure to sell them on these activities. It is obvious when you are excited about it. Your enthusiasm will get them excited!)
Well stated question for the Occam's razor problem: *"Here is the exercise. Take 10 minutes to give me two hypotheses as to how this sand body formed. Rank them and be prepared to defend them."*
During the activity your **questions were leading**…**very good** method to help them figure things out on there own and to see why they are thinking the way they are: *"What do you think?", "Why do you think it is a river channel?", "Let me stop you, you are saying this system built from point A' to A? Why do you say that?"*
Walked around, used a variety of things to teach with: white board, overhead, power point, discussion, handouts.
Mix of humor is GREAT. The students looked like they were at ease, laughing but also able to get back on topic.
Already **using students' names.**

Suggestions for The instructor:
Activity intro: less background explanation for the problem. Just let them have at it. Make them explain their assumptions and how their hypothesis may change if their assumptions are wrong.

Transition from activity to lecture: Wrap up the activity by having them vote on what they think is the answer or by telling them what the actual answer was. Use this quick summary or wrap up to transition into the lecture.
Tie activity to later discussion: When discussing the scientific method, have them reflect on the activity they just did and show the steps used in doing the activity. Help them realize that what they are doing is the application of the concepts they learn in class; the application of the scientific method.

Timing – Lecture 1

Activity	**Estimated Time**	**Actual Time**
Class Introduction	5 min	12 min
Occam's Razor activity	25 min	27 min
Syllabus Outline Term-paper topics Reading guide	20 min	16 min (Syllabus) 13 min
3 handouts: FYI – objectives FYI – Why this matters History – Historical development	25 min	7 min (FYI handouts) Didn't get to Historical developments handout
Total Time	75 min	75 min

Lecture Debrief
Lecture 2
January 11, 2007
(11:53 am) **General Thoughts:** Today went well. He didn't get to explain the handout but we did get to both activities. The students were into the activities but I felt like we were losing some of them during the grain exercise. Maybe they didn't have enough motivation to do it. Maybe they need a problem to attack?
Debrief: I asked The instructor four questions about what he thought worked and didn't work.
Q1: What went well?
The weathering rate activity: The discussion let the student the interplay between climate and weathering like precipitation and insolation.
Having the students rank their responses is a good way to make them think.
The grain activity gave them an opportunity to observe and look. I think looking has a benefit.

<Teagan's note> Make sure that the students realize the benefit in looking. You know the benefit but do they?

Q2: What didn't work?
Again, like the first lecture, we didn't have enough time. Maybe spent too much time talking in the beginning.

There were some students standing around but perhaps if there was more space for them to see the samples and stand by the microscope they wouldn't just stand there.

<Teagan's note> It is expected to have students not 100% involved 100% of the time. The trick is to minimize it and not give them the opportunity to get off of topic.

Q3: Do you have any concerns?
Not enough time
Q4: Do you have any ideas for how to change things or ideas for future lectures?
The stations for the microscopes were too close together. Next time probably would be better to put the scopes farther apart. There is a small file cabinet in the corner of the room that a microscope could go.

I Would like to develop student responses more to get them to have more precise responses.

<Teagan's note> At the beginning of class you told me that you were concerned that, during the weathering rate group activity, students might wonder "why are we doing this?" I am glad you had this concern because you realize that the students probably won't want to do something if they don't know why they are doing it. Letting them know the purpose for doing something or the main benefit will help students understand the activities relevance. You can tell them before or after an activity. You should let hem know what you expect them to be able to do after they complete the activity.

Positive Observations:
Feedback – you had the students grade their own quiz so they have immediate feedback. This worked well. This also cuts grading time for you or the TA.
Developed Student Responses – While a student (Student B) was reporting his list of factors for weathering rate you helped develop one of his answers. He said slope and you stopped him and asked him about how slope would effect weathering rate. You further questioned him and asked what kind of slope, does the degree of slope make a difference.
<Teagan's note> This is a good example of how your questions can help the students clarify their answers and give more precise responses. This will get them to think more about what they are saying and gives you an opportunity to see if they really understand what they are saying.

Reminded them of their responsibility to read – Before talking about weathering "Not going to spend a lot of time on this because you have already read it."
Good Positive Reinforcement – These are some comments you made that helped reinforce correct things students said:

You restated what a student said and then said "good example"
"Good, you get the idea"
"I liked Student K's definition of sand because…"

Good Questions - Here are some well phrased questions you asked that make students think and defend their responses.

"Is it always true, when is it not true? Give me an example of when it is not true."- talking about the Law of Superposition
"The laws of nature change with time. Do you agree with that?"
"What is going to happen when the sea rises? What color is going to be above the red?" – talking about Walther's law

Comment on Integrity – You said the following comment after they switched quizzes:

"Don't lose your integrity on one point of your flippin' 370 geology class."
This was a great comment to let them know that lying about if they read or not isn't worth it.

Suggestions for The instructor:
Before you restate a student's answer in a statement that makes it more correct, ask questions that help the student restate what they said.
Grain Activity :

Possible questions that could help conclude the activity:
What did you observe?
Did you have any questions about the things I wanted you to observe?
What kind of variety did you observe?

*****You can refer back to this experience when you explaining grain types*****

Key Things to Work on:
Helping students develop their answers or responses
Use questions to break up lecture
Making concluding statements about activities or exercises
Good opportunity to tell them why what they did was important
Ask them what the purpose of the activity was, what they got out of it
Have them summarize the key point of the activity

Timing

Activity	**Estimated Time**	**Actual Time**
Quiz (take and grade)	10 min	11 min
Historical Lecture	20 min	32 min
Groups: Factors of weathering rate	25 min	14 min

Grain activity	15 min	15 min (with a one minute quick write on what sand is)
Grain/weathering Handout	15 min	--- (lectured on this in Lab)
Other: discuss lab meeting time		3 min
Total Time	85 min	75 min

Lecture Debrief
Lecture 3
January 16, 2007

Q1: What went well?

I thought the marble demonstration was good, even though it didn't work out the way I thought it would. I think the problem is related to the difference in packing of the marbles and having the container constraining the bigger marbles.

The PowerPoint seemed like it went well because the students had a lot of questions. I only had a slide or two left at the end.

Q2: What didn't work?

When we were going over the answers to the homework questions, I left them hanging with the statistics. I feel like I gave them the answer without seeing if they really got it.

Q3: Do you have any concerns?

My major concern is what I have been dealing with for years…what to cut out and the amount of information I need to cover. I could spend the whole class discussing one thing in detail but then that would sacrifice the majority of information I wanted to cover.

<Teagan's notes> Just ask yourself the following questions when deciding what to spend class time on:

- Can the students get this definition/concept on their own?
- If the students are left on their own, are there major misconceptions they may end up with?
- Does the book cover this? Does it make sense?
- What can I add to the lecture that they wouldn't get on their own? (i.e. experiences, tricks to ID things)

Q4: Do you have any ideas for how to change things or ideas for future lectures?

Marble demo: next time focus on the difference between the experiment data and what is expected and its relation to packing.

<Teagan's notes> You could also save time having a note written above where you draw this chart on the white board that says "copy this down." As students come into class the first thing they will see is that note and can use the time before class even begins to copy the chart down:

	Large	Medium	Small	Mixed
Spherical grains				
Flattened grains				

- Call on a student or two to tell what they predict and rank for the porosity before they break up into groups. Then, after the experiment is done, **wrap-up** by comparing what was predicted and what was actually observed.
- Have groups do the demo for one cup, save the mixed grains cup for you to do after students do theirs. Have them describe the grains they have in proper terms when presenting their data.

<Teagan's notes> Here is a list of instructions you can use as a power point or have written on the board:

In your group, do the following:

1. Describe the grain you are working with (shape/form, size, roundness etc.)

2. Determine how much water is used to fill the beaker to the 300 mL mark
3. You have 30 seconds to tell the class what your grain looked like and how much water you used.

This should take 5 minutes for the groups to break up and do the experiment. Reporting should take no more than 3 minutes. Keep it short. You want to save your time for discussion.

- Have several graduated cylinders ready to go so you don't have to refill each time
- Have groups report their numbers to fill out the chart on the board
- Before you wrap-up the exercise, ask students what could be done to minimize error or flaws in the experiment?

Positive Observations:

- **Using visuals –** When you explained about the grains in the sieve you quickly grabbed a whiteboard eraser. This works great because it doesn't take time to set it up, and it is easy to see the three dimensions (width, height, thickness).
- **Incorporating in-class demonstrations** – To show permeability you had the students in the front row squish up to the table and make a straight path that you used to run through. Then you had some students pull there chairs back and then tried to run through, dodging students and chairs.

<Teagan's notes> You can tell the class really liked this demonstration and it really makes a point, too!

- **Setting up scenarios to apply concepts –** Your experience in working in the field gives you a good idea of what problems these students will face. When you set up your scenario to show how the particle size analyzer didn't follow stokes law, the students could see an application for what they are learning. This is good! The more they can see the use for what they are learning, the more importance they will put towards remembering it.

<Teagan's notes> After you explain the scenario like the one for the PSA, ask the students if there are any problems with the set up or what assumptions they need to make.

- **Voting activity:** This is a great way to make the whole class participate and help students make decisions that they can defend. A good variety of students were able to quickly defend their vote in the water vs. wind vote:

When asked to vote almost half of the class said water
The instructor: *"Why did you say water?"*
Student J: *"Chemicals in solution that can eat away the rock"*
Student I: *"Water has more power, denser, ram things into other things"*
Student G: *"water can carry larger particles, mass plays a major role"*
Student C: *"I voted for wind"*
The instructor: *"Anyone else for water first"*
Student K: *"Because you have to go through water, it is different, Wind particles look more chipped"*
The instructor: *"Student C"* (Moving on to those who voted for wind)
Student C: *"If you are comparing water vs. wind, if grains are in the wind, in the water they fall slower, wind they move faster"*
Student H: *"the book said so"*
Now you lead the students to figure out the correct answer for themselves:
The instructor: *"Think of this, think of your deepest darkest enemy. The roommate that stole your chick. If I had one shot to really knock this guy out, would I want him in an air filled room… Stand up Student C…Would I want to stand in an airfield room, or lets go down to the deep end of swimming pool and then I will hit you. Which am I going to do more damage in? Air."*

<Teagan’s notes> Remember to call on people that you haven’t heard from a lot to defend their position. In this activity most of the people volunteered. Don’t let the shy students get out of defending what they think. This will help them develop necessary communication skills.

Suggestions for The instructor:

- Instead of a slide with definitions, is there an image/picture that you can use to talk about several terms?

<Teagan’s notes> Think of a good image/picture kind of like a good diagram for a depositional system that can summarize several concepts while showing relationships.

- With the PSA exercise showing how Stoke’s Law doesn’t work in that scenario, explain the scenario and then have the students tell you major problems with the set up. You did a good job leading them to different problems but see if they can pick those out on their own before you lead them to specific ones:

The instructor: *“Do we have laminar flow when we do this?”*
Student A: “*Big grains make turbulence”*
The instructor: *“Does stokes law really work?”*
The instructor: *“Are all the sand grains going to be spherical”*
The instructor: *“What are they really measuring?”*

<Teagan’s notes> You could briefly point out what are the requirements for Stoke’s Law to be valid, then ask the students if there are any problems that they see in the set up.

Things to Focus on:

- **Leading Students to answers** rather than telling the answer and then going through experiments or reasoning.

<Teagan’s notes> Keep in mind the water vs. wind exercise/vote. This is a classic example of where you lead students to think about a question and face their own misconceptions. In the end, you don’t tell them the answer but paint them a picture where they can easily figure out the answer by themselves. They will never forget that experience…”the UhhHa moment”!

- **Wrap-up**. Remember to ask students see if they got the point of a lecture/exercise/demo. Help them realize how things connect together, tie up loose ends.

Minor things to **Correct** or **Change** for next year
1. On the PSA overhead change the word size to “equal density of grains”

Timing

Activity	**Estimated Time**	**Actual Time**
Collect and Review homework problems #3 & #4	5-10 min	6 min
Go over textures handout with PowerPoint	15 min	39 min
Class Demonstration	20 min	23 min
Finish PowerPoint	10 min	7 min
Maturity flow chart HO	2 min	---
Check understanding of terms	15 min	---
Stair well – look at geopetal structures and stylolites	15 min	---
Total Time	77 min	75 min

Lecture Debrief
Lecture 4
January 18, 2007,

Q1: What went well?

- **Quiz:** There was a good transition from the quiz to terms I wanted to discuss. This was because of the great design of the quiz.
- **Field Trip:** The field trip to the hall was good. Field trips always are. I feel like the students were able to relate things to the real world and we engaged.

Q2: What didn't work?

- **Quiz instructions:** The students circled multiple grain sizes instead of giving one general size that described the slide. This happened because the instructions said to circle all the terms that applied.
- **Statistics:** I think the statistics presentation confused people more than anything else. Why did this happen? Maybe it didn't work because I didn't go to the power point. But maybe I would have gotten the same problem.
- **Not using the statistics PowerPoint:** I think using the PowerPoint would have kept me on track.
- **Field Trip:** I didn't describe the patch reef scenario before we went to the stairwell. It would have been better to do it before we leave the room and draw the scenario on the board.

Q3: Do you have any concerns?

I know that how you say things really matters. For things like grain size statistics, if you say it the right way there is no problem, but if you say it the wrong way you have a big problem. I have struggled with these statistics for years and can mix up mean and median. I really need to explain things like grain size mean and median right.

Q4: Do you have any ideas for how to change things or ideas for future lectures?

- **Follow the PowerPoint**: Make sure to follow my guide to keep me on track.
  → I want to USE POWERPOINT TO START STATISTICS.
- **Field Trip:** Make sure to follow this order:
  1. Discuss reef examples in the classroom
  2. Go to the hallway to look at brachiopods
  3. Come back classroom and ask class for examples of other geopetal structures

- **Statistics**: Emphasize the difference between mean and graphic mean

Mean – can't get because we would have to have the weight/size for each grain

Graphic Mean- can use this as proxy for the actual mean**.**

Ask the class: How would we get the mean age of the class?

Relate this to what data needs to be gathered from grains to get the mean

- **Macaroni Beaker:** In the future, this lecture is where we need the macaroni beaker.

Positive Observations:

- **Leading Questions:** You did a great job leading the students during the field trip to look at geopetal structures. Here is an example of where you really did this well:

You give the scenario of the patch reef and ask the students how someone would know that part of the reef at location B was moved from location A.

Student: "*They were flipped upside down"*
The instructor: "*How do they know it was flipped?"*
Student: "*The voids in the rock were filled like it says in the definition*"
The instructor: *"Good"* gives explanation that the geopetals indicated it was not in the original up position.
The instructor: *"Stephanie, come up here, we are going to try and tell which way is up?"*
Stephanie doesn't know so the instructor asks Student D to help
They still don't know so the instructor asks questions
The instructor: *"Does anyone know what these little black spots are?"* pointing at the brachiopod shells
The instructor: *"Anyone want to reason with me?"*
Student I gives an explanation of which way was up based on the shell orientation. He thinks the concave side is pointing down because that is the heaviest part and the shell will fall through the water with the heaviest side down.

[this shows a misconception that brachiopod shells fell down through the water column. Most probably died on the sed/water interface. The wave action may then change orientation. Need to look at if the shells are articulated/inarticulated]

The instructor uses his hand as a visual to help restate what Student I thinks. Points out that he is assuming the brachiopods are falling through the water column.

Student B gives an opposite hypothesis. The instructor asks everyone to vote. He says that Student B is right.

- **Transition from Quiz to Term review**: You very effectively incorporated review of terms while students corrected the quiz.

<Teagan's notes> The students had some physical experience to connect these vocabulary terms to. These type of experiences really make the terms mean something and give them a chance to see that maybe they don't understand the term as well as they thought they did. This makes quizzes a learning opportunity. Try to make future quizzes like this one. That way you can easily transition into checking what they know to discussing what they realized they don't know.

Suggestions for The instructor:

- **Term Review:** When going over terms that are on the reading guides, **ask students what definition they found.**

<Teagan's notes> This will give you a great opportunity to make sure the definition they found matches with the one you really want them to learn.

- **Quiz:** When going over the quiz, use the slide they are analyzing to point out the answers.

<Teagan's notes> This will let the students see how you would analyze it and what features they should look for. They may know the term by heart but still can't really recognize it. This ability to transfer book learning to application is KEY!!

- **Questions**: Restate questions when students make a joke

<Teagan's notes> I noticed that students sometimes make jokes because the question is hard and they don't know the answer. Ask again and make them really think about it. For example, you did this while looking at geopetal structures in the stairwell:

The instructor: *"Tell me how much original sediment was here before the pressure solution?"*
Student E: *"More than half"*
The instructor: *"Based upon?"*
Student E: *"that's what Student M said"*
The instructor: *restates the question "Carbonate goes into solution, how much is gone?"*

- Lecture **PowerPoints** on **Blackboard**: A student requested the PowerPoints be placed on blackboard. This would be best done after the lecture takes place. The TA can put them on blackboard.

<Teagan's notes>You mentioned that this would be good because you wouldn't be giving the students everything. The PowerPoints mainly give the key concepts that can then be used to study from.

Minor things to **Correct** or **Change** for next year
1. Change quiz directions to separate grain size question with the other things they observe.

Timing

Activity	**Estimated Time**	**Actual Order of Activities**	**Actual Time**
Quiz Review Terms	25 min	Term review Quiz + Review	5 min 22 min
Geopetal Activity	15 min	Textural Maturity HO	8 min
Textural maturity HO (4 pgs)	10 min	Geopetal Activity	18 min
Statistics (PowerPoint)	25 min	More term (flocculation)	5 min
		Statistics (No PowerPoint)	18 min
		Handouts for next lecture	2 min
Total Time	75 min		78 min

Lecture Debrief
Lecture 5
January 23, 2007

Q1: What went well?

I thought I accomplished the objective for fluid flow. I wanted to give them a flavor for fluid dynamics and expose them to the forces involved.

I thought the Exner equation went really well. I have never talked about this before but I think it is a very important thing for the students to understand. To understand that high flow does not mean erosion. I liked the Exner discussion because I feel like I am getting to the point where I know what to say and when to say it. I feel like I know how approach this concept without confusing the students.

Q2: What didn't work?

The **quiz** didn't work well. The question asked them to draw all the forces in vector form that influence a grain's entrainment. I don't think they got it. It may be because they took it right after we talked about Bernoulli so they were biased by that discussion. They were thinking about that so they didn't read the question or answer it right.

Q3: Do you have any concerns?

---- No real concerns

Q4: Do you have any ideas for how to change things or ideas for future lectures?
Change the quiz

Positive Observations:

- The students **didn't seemed confused** about any of the equations or lecture topics

<Teagan's Note> Either they understand it without a problem or they just don't realize that they don't fully get it. We can figure this out after they try to work with the equations and apply them to problems.

- **3 min activity** at the end to show the different rates of grain movement was effective.

<Teagan's Note> You picked three students to race across the room. One represented tractional load, one was saltation, one was suspension. You then told them how they had to move (jumping, feet not leaving the ground etc.) You could ask the students to decide how they should be able to move. For example, say Student A is tractional load. Without further describing what tractional load does ask: "Stephanie, Student A is tractional load. How should he move to represent that?" This will make them recall the definition and think about what it actually means. Or you could ask the class more generally "Okay class, Student E is a saltation load, how can he move to represent that?"

Suggestions for The instructor:

- Give examples of some of the fluid types. There are examples listed on the handout but questions the students about why that would be a good example:
  "Student D, why do you think ice is a good example of a psuedoplastic?"

- **Questions**:
    1. When you recognize a student answer is wrong, ask them questions to **help them realize the fault in their reasoning or why they are wrong**. You could also point out faults in their answer and ask them to account for that.

<Teagan's Note> While discussing the Bernoulli equation you asked them to answer a question about what has to happen to pressure if the velocity increases. They were looking at the equation and the diagram of the pinched hose. You asked the question and someone gave a wrong answer. You replied: "I'm screwing you up" and went on to rephrase what you said and explained what happened to pressure. Instead of assuming you screwed them up, let them struggle to think it through for a minute or half of a minute. Let them make that connection with what they see in the formula and what they understand with their logic. You could imagine a situation like the following:

The instructor: "*What has to happen to pressure*?"
Student gives an answer that doesn't work with the equation
The instructor: "*So you are saying…*" Briefly restate the student's answer and then ask a question that exposes the error: "*So, if that is correct, how would you maintain the same?"*
Student: "*I guess the pressure would be doing the opposite then*"
The instructor: "*Why do you think that*?"
Student: "*Because that would maintain the same discharge*."

2. While telling the ski jump story to show Bernoulli Effect, **stop** after you say the kid threw his head down to commit suicide. **Then ask them what happened.** See if they can connect it to the Bernoulli Effect.

3. When showing a diagram that is from the book, like the **Hjulström diagram**, (which they should have read and looked at before class) ask if they can see any limitations of using the graph/chart.

<Teagan's Note> If you call on students (not just volunteers) to answer questions that relate to the reading guides then they will realize you are serious about them coming prepared to discuss those terms.

Things to Focus on:

- Making the students accountable
- Ask questions
- Help students figure out if their answer is correct or wrong.

Minor things to **Correct** or **Change** for next year

1. Correct minor errors on handout
2. Change quiz

Timing

Planned Activity	Estimated Time	Actual Activity	Actual Time
Lecture	35 min	Lecture Handout pg 1 Handout pg 2 Handout pg 3 Handout pg 4	45 min 15 min 14 min 5 min 11 min
Quiz	10 min	Quiz	8 min
Lecture	30 min	Lecture Ski jump story Hjulström diagram Exner equation	19min 7 min 5 min 7 min
		Sediment load type race	3 min
Total Time	75		75

Lecture Debrief
Lecture 6
January 25, 2007

Q1: What went well?

Students were asking a lot of questions. There was a lot of discussion. I don't want to rush it through and lose that interest.

Q2: What didn't work?

I was uncomfortable in a transition at one point and I didn't need to be. I was grabbing overheads from different places and I got confused.

I forgot about the demo and asking what sources of error we were working with (i.e. the time that both objects were released at).

Q3: Do you have any concerns?

Q4: Do you have any ideas for how to change things or ideas for future lectures?

Positive Observations:

- Review: You showed an overhead with what has been covered so far. We may want to write this in terms of what they should be able to do and then put it in their packets.

- **Question Response Time:** After asking the following question about depositional systems, you gave them some time to think about the answer. When it looked like the students didn't know what the answer was. They then were able to figure out the answer for themselves.

The instructor: "*What would be the number one thing you would hope for to tell you this is the depositional system?*"
The instructor: "*Remember this for the rest of your lives, the best to interpret depositional facies is an in situ fossil.*"
The instructor: "*Why would we want this fossil?*"

<Teagan's notes> This was great because you let them process the question and then guided them further with a second question.

Suggestions for The instructor:

- Quiz: You had Student A correct both sections of the test. You could break make two different students correct it instead of just one.

<Teagan's notes> This gives more students an opportunity to stand up in front and show their work or defend their answers.

Things to Focus on:

Having students make assumptions

<Teagan's notes> This will help students get used to basing conclusions on their assumptions and deciding what alternative explanations they may have if their assumptions are wrong.

Minor things to **Correct** or **Change** for next year

1. The chapter needs to be broken up for reading assignments. Having them read all of chapter 4 for one lecture was overwhelming. It can easily be divided into two or three reading segments.

1. Stratification and bedforms p. 74-94
2. Soft Sediment Deformation p.94-102, Syneresis cracks, paleo-indicators p. 112-115
3. Trace Fossils p. 102 -112

Timing

Activity	**Estimated Time**	**Actual Activity**	**Actual Time**
Quiz	10 min	Term Paper intro	4 min
Stokes Law/Inertial Law Demo Bedding Fr. Overhead	17 min	Quiz	12 min
How to visualize in 3D	10-15 min	Stokes Law/Inertial Law Demo (5 min) Bedding Fr. Overhead	25 min
Bedform Lecture	10-15 min	Ripples Bedform Lecture	34 min
PowerPoint	18 min		
Total Time	75 min		75 min

Lecture Debrief
Lecture 8
January 30, 2007

Q1: What went well?

The lecture went well; there was a lot of discussion which opened up topics I wasn't intending to talk about. A student brought up preservation potential and we had time to discuss it. The experiment with the bottle showing soft sediment deformation also worked well.

I think it went well because I had the time to probe the students. I didn't' feel rushed so I was willing to ask questions and listen to their responses.

Q2: What didn't work?

Q3: Do you have any concerns?

I just don't have time like this in every lecture. This goes back to having to cut information out to get good discussions like we got today.

Q4: Do you have any ideas for how to change things or ideas for future lectures?

Positive Observations:

1. Discussion

VERY smooth transition from talking about things to asking questions. While explaining lenticular bedding the students asked:

> Student 1: "*Is it the opposite of flazer?*"
> Student 2: "*Is it related to turbidites?*"
> Student 3: "What *would be more common, flazer or lenticular in the rock record.*"
>
> After these questions were asked you asked the students what they thought.
>
> Student B: *"Doesn't the question have to do with preservation? I would think lenticular"*
> The instructor: *"Did anyone hear what Student B said…that was great"*
> And you continued to discuss with students preservation potential.

2. Student explanation

While a student is explaining what they are observing in a slide you gave them a laser pointer to show exactly what they are talking about.

> <Teagan's notes> This is great, make the students point to things on a slide and show you exactly what they think they are seeing. This will let you know right away if they are interpreting the right thing.

3. Clastic vs. Siliciclastic

While talking about clastic dikes you recognized that the students would probably be thinking of siliciclastic when they heard clastic so you asked this question:

> The instructor: *"Clastic dikes in a Silurian carbonate (limestone) reef. How could this be, I thought carbonates were different than siliciclastics?"*

The students were thinking about this and then you pointed out that clastic does not mean siliciclastic only. They could be ooids.
You then asked the class: "*What does clastic mean?*"
Which opened up a discussion about how clastic dikes don't have to be siliciclastic
<Teagan's notes> This is fantastic! You want to anticipate misconceptions before you teach and then teach in a way that confronts those misconceptions.

Suggestions for the instructor:

Make sure that students point to what they are interpreting or identifying like you did with the laser pointer. For example, when a student is asked to come up and identify something on a slide, have them point or use a laser pointer to show what they are referring to.

Things to Focus on:

Minor things to **Correct** or **Change** for next year
1. Animate the title for the Ball and pillow slide in PowerPoint- so students can be asked what it is.

Timing

Activity	**Estimated Time**	**Actual Activity**	**Actual Time**
Questions	10 min	PowerPoint review of bedforms	22 min
Handouts	2 min	PowerPoint of soft sediment deformational features	42
PowerPoint review of bedforms	10 min	Demo – mud	11 min
Demo – mud	8 min		
PowerPoint of soft sediment deformational features	45 min		
Total Time	75 min		75 min

Lecture Debrief
Lecture 9
February 1, 2007

Q1: What went well?

Q2: What didn't work?

Q3: Do you have any concerns?

Q4: Do you have any ideas for how to change things or ideas for future lectures?

Positive Observations:

- Bagnold Effect Activity: The tubes worked great. Everyone was actively trying to get the bigger grains to the top. I watched people tip it sideways, shake the tubes, and roll them. They all seemed eager to find out how to do it right. They then were interested in the convection that you showed them as a group. This was a good way to get and keep their attention.

- **Emphasis on trace fossils:** You emphasized that what the students were learning was the names of the traces that critters made, and not the critters themselves:

> The instructor: "*Cruziana is the next trace fossil assemblage (emphasizes assemblage) A group of criters making this trace.*"

<Teagan's notes> This is a common misconception that students may think these names they are learning are the critters and not the name of the assemblage. It is important to clearly emphasize things that could easily be misconceptions.

Suggestions for The instructor:

- Questions: While telling the story about the person who studied ducks and chicks to make trace fossils, remember to ask the students to predict what the scientist saw:

The instructor: "*He took baby ducklings, chicks, raised them; put them in a box with different sediments at different ontological stages of the animals."*
QUESTION: What do you think he found?
Instead of: "*What he found was…*"

Minor things to **Correct** or **Change** for next year
1. Put slides of trace fossils on PowerPoint
2. Make a handout from the overheads of trace fossil assemblages

Timing

Activity	**Estimated Time**	**Actual Activity**	**Actual Time**
Bagnold Effect	15 min	Introduction, Pass out reading guide and lab assignment	3 min
Test discussion	10 min	Bagnold Effect	12 min
Trace Fossils	55 min	Test discussion	5 min
		Trace fossils	40 min
		Slides	15 min
Total Time	75 min		75 min

Lecture Debrief
Lecture10
February 8, 2007

Topic: Siliciclastic Rock Classification

Q1: What went well?

There was a lot of good discussion. I feel like the student's inhibition to ask questions is gone.

Q2: What didn't work?

It felt a little disorganized. But, I knew coming into class today that it would be a scramble. I just didn't have the time to prepare.

Q3: Do you have any concerns?

Q4: Do you have any ideas for how to change things or ideas for future lectures?

One of the students suggested having images or samples to look at while we are discussing the siliciclastic rocks. I think that is a good idea, I just don't think we have a lot of samples that represent what we are talking about. We can do this in lab with the rocks we do have.

Positive Observations:

1. Explanation of QFL: Having a student come up and try to plot the data without knowing that they need to normalize the data.

> The instructor: "Get up here Student B. we have a QFL diagram, we have to position ourselves on it. What name are we going to attach to this rock?"
> **The instructor: "How do we get these values?"**
> Student E: "you have to look."
> The instructor: "Could you see cement on a hand-sample? Yeah, sometimes you can but what about feldspar/quartz in hand-sample?"
> (The instructor explains making a point)
> The instructor: (to Student B) **"Tell and show the class how you are going to put yourself on the diagram."**
> (Great, going to get to why they have to normalize)
> The instructor: "Student B showed us some half truths. Thank you very much, now sit down and learn."
> The instructor: "You don't need to worry about porosity and iron oxide, that is a truth. This diagram works like this…"

<Teagan's Note> I was worried that you wouldn't give the students a chance to do this themselves. We had talked about you doing an example first and then having the students do the example from their reading guide. Instead, you just did the reading guide sample together and was more effective because of way you did it.

Having Student B attempt to do the problem was GREAT. This is a good practice:

1. Scaffold their understanding (help build the background knowledge they need to get the context of the problem)
2. Give them the a problem that is beyond their understanding (shows them where they will need to do)
3. Have them attempt the problem and guide them to see how their answer may not represent what they are trying to calculate (with the QFL they see that without normalizing they are using values that don't add up to 100%)

4. Show them what they were missing and then have them solve the problem. The information you give will have more meaning to them because they now see the immediate application for the information.

2. Probing Questions: Great job probing students with questions. This helped them clearly explain what they were trying to say.

Student F was trying to explain why grains in breccias are angular:

The instructor: "Why are they angular?"
Student F: "not so far along…"
The instructor: **"Not so far along?"**
Student F: "rolling…
The instructor: "like being transported?"
Student F: "yeah"
The instructor: "exactly"

While trying to get students to distinguish conglomerates and diamictites:

The instructor: what is a diamictite?
Student I: Matrix supported conglomerate
The instructor: Except not conglomerate. It is a rock
The instructor **What do you mean by that?** (referring to the matrix supported rock)
Student I: No tangential contacts
The instructor: Student I is talking the talk, Larger clasts are floating in a matrix

Suggestions for The instructor:

1. QFL diagram questions: If a student uses terms that you know are not in the book or the lecture, ask them to explain what they mean.

While working out the QFL diagram with the students Student A commented that you had to normalize the data even though you hadn't mentioned that yet. You then continued to set up the fractions. I heard several students say "What does it mean to normalize?"

The instructor: "Can we just take that 37% quartz."
Student A: "No, you have to normalize your QFL"
Could ask Student A **"What do you mean by normalize?"**

Things to Focus on:

- Probing questions (i.e. "What do you mean by that?")
- You were pressed for time for this lecture, maybe **focus more on changing this lecture for next year.**
-

Minor things to **Correct** or **Change** for next year

1. Put some QFL problems on blackboard that students can practice on if they want.
2. Get samples/pictures to use while discussing siliciclastic rocks.

Timing

Activity	Estimated Time	Actual Activity	Actual Time
Test Overview	15 min	Test Overview	27 min
Overheads: QFL diagram Shales Conglomerates Petrology	60 min	Overheads: QFL diagram Conglomerates Shales Clay Mineral trends	45 min 23 min 13 min 5 min 4 min
		Bill Dickinson research	3 min
Total Time	75 min		75 min

Lecture Debrief
Lecture 11
February 13, 2007

Q1: What went well?

The activity went well. We got to talk about a lot of things I wanted to talk about (like retrogradation, progradation etc.). During the activity the students had good discussions, especially the aggradation group. At first they seemed flustered but then they talked it through and got it.

Presentations – I liked having them present but they aren't quite defending their position yet. I want to get them to the point where each time they know they are expected to defend their position.

Time – I got through everything I wanted to do today.

<Teagan's note> This is the first time we have gotten through what you wanted to while doing an activity. You even had 5 minutes left at the end!

Q2: What didn't work?

Q3: Do you have any concerns?

At one point I realized I had been talking for 10 minutes without interaction so I stopped to ask a question. I was just really excited about what I was talking about and need to watch that when I am excited about the topic that I don't just ramble.

Q4: Do you have any ideas for how to change things or ideas for future lectures?

Positive Observations:

1. Students Using Vocabulary – The presentations gave the students a great opportunity to practice using the vocabulary.

2. Activity Wrap-up – You concluded the activity by talking about relative vs. eustaic sea level change:

The instructor: *"Here is what I want you to remember, you are standing with one foot on the water and one foot in the beach. Relative rise and fall only means exactly where you are…"*

<Teagan's Note> You were able to wrap up this activity by teaching them something new. You connected the concepts of regression and transgression to retrogradation and progradation. You used the board to write the words they were familiar with from historical geology (regression, transgression…) and connected the to the words used to describe facies change. This was a very effective way to emphasize what the terms are really describing.

3. Focus on Misconceptions – You asked the class what strike is. Many were getting dip and strike confused. Good opportunity to help them understand the difference.

<Teagan's Note> If there are topics that seem easy to get misconceptions about, try to bring those out in lecture.

4. Realized No Interaction – At one point you stopped and said:

The instructor: *"I fell like I'm not getting any interaction right now. Am I too authoritative?"*

You then went on to start a discussion:

The instructor: *"Student J, what is a model"*
Student J: *"A replica of something"*

The instructor: "*So Student J is saying it is a replica, are you making a smaller scale*"
Student J: "*Usually, you wouldn't make a full scale replica of an airplane*"
Student A: "*Something you use to represent something else, may not be exact, but a good representation*"
The instructor: "*Is it kind of an average?*"
Student I: *"The model does not pigeon-hole every situation. You can't fit every depositional to the model"*
The instructor: *"Exactly, everyone hear that, it is kind of an average but doesn't capture every situation"*

<Teagan's Note> This is fantastic!!! You realized that there wasn't interaction and adjusted to get students involved. It seems like you are getting used to having students interact and when it goes for more than 10 minutes without student participation you naturally adjust.

5. Encouraging Students – You observed Student E had been filling out the reading guide sheets and commented:

The instructor: *"Student E, looks like you are doing something with these"*
Student E: *"I've been working hard"*
The instructor: *"It shows"*

<Teagan's Note> This was a great comment. You said earlier this semester that you wanted to encourage the students and comments like this really help students know their efforts are not in vain.

Suggestions for The instructor:

1. Designate Time for Activity – If you are worried about time you can tell the students they only have 10 minutes to be ready to present. This will let them know the pressure is on and you won't use time needed for discussion.

2. Spokesperson for Presentations – If you notice a trend in who presents, assign the groups their spokesperson when the class breaks up into groups. That way, you can give the more quiet students the opportunity to work on their presentation skills.

Things to Focus on:

1. Getting students to defend when presenting
2. Realizing when there are long periods of time without student interaction

Minor things to **Correct** or **Change** for next year

1. Make a handout of the overhead of facies (this overhead shows where they will be going using facies, down to basin analysis).

Timing

Activity	**Estimated Time**	**Actual Activity**	**Actual Time**
Introduction	5 min	Introduction	4 min
Activity Introduction Groups Discussion	 3 min 15 min 15 min	Activity Introduction Groups Discussion	 1 min 15 min 20 min
Facies Model Handout	35 min	Facies Model Handout	25 min
		Sequence Discussion	5 min
Total Time	75 min		70 min

Lecture Debrief
Delta Lecture
March 8, 2007

Q1: What went well?

I tried to ask a lot of questions and seemed like they led into things that I wanted to talk about. The discussion was good. Students seemed involved and were asking questions.

I know this material so I feel comfortable working with it.

<Teagan's Note> We got back from the Advanced Strat. Field trip late last night and didn't have a lot of time to plan for today. Your comment about feeling comfortable with the material had to do with not having much time to prepare and yet you still felt like you could talk about it well.

Q2: What didn't work?

I didn't get through all the material but again I guess that is a trade off.

Q3: Do you have any concerns?

Q4: Do you have any ideas for how to change things or ideas for future lectures?

Put together a lab where students use the density flow tanks to investigate hypopycnal, hyperpycnal and homopycnal jet flows.

Positive Observations:

- Used group presentations to **distinguish inferences and observations.**

The third group to present gave more inferences than observations about the delta they were looking at. You took the opportunity to point out the differences between an observation and interpretation. The group first described the shape of the bay instead of the shape of the delta and then they made inferences about jet flow. This was your response to their report:

> The instructor: *"First you gave me the geometry of the bay. Then you gave me an interpretation of the water flow. This is an observation: I can see the trunk is bifurcated is split into two.*
> *The other way around is bad science…not that you guys are bad scientists."*

<Teagan's Note> You did this very well!! You didn't offend this group or make fun of them. You helped them realize the error in their report. Making observations is an important skill for them to master and here they had a very important learning experience about what is and is not observations.

- Discussion.

You led a great discussion on why the Mississippi delta is not wave dominated. It really got several students involved.

> The instructor: "*Why aren't waves affecting Mississippi?"*
> Student A: "*It is protected by Florida and Cuba"*
> The instructor: "*did they protect it from Katrina?"*
> Student L: "*I have been to the gulf of Mexico and there are waves"*
> The instructor: "*but they aren't that big, so what makes it so they aren't that big?"*
> Student H: "*maybe it doesn't have to do with the waves, maybe it is the fluvial system compared to the waves"*
> The instructor: "*you are talking two things. You are talking currents vs. waves. Can you have a current moving one way and waves moving the other way. Yeah, so currents aren't necessarily going to stop waves"*
> Student L: "*slope of the beach is low enough that the wave base doesn't get big enough"*
> Student I: "*yeah when I was in Texas the waves weren't big at all"*

The instructor: "*yeah, they get attenuated, the drag on the waves. The gradient on the shelf is so low that the wave can only develop until it hits the shallow stuff and the energy is gone.*"

<Teagan's Note> This was a good discussion. You did a great job helping students think about why their answers may not be correct without putting anyone down or making them feel stupid! They need to know it is okay to be wrong and they need to keep thinking through things.

Suggestions for The instructor:

- **Probing** when **correct answers** are given.

While talking about destructional vs. constructional forces on deltas you asked Student I to give you an example of a Destructional force:

The instructor: *"Student I, what do you think a destructional force could be?"*
Student I: *"Subsidence"*
The instructor: *"great, compaction…(went on to explain about how subsidence is destructive)"*

(ask "How would that be a destructional force?" instead of explaining right after their answer)

<Teagan's Note> This is going to take some time to really get into the habit of discovering what students are thinking. Student I gave the right answer but does he understand why? Just asking why after these types of questions can help expose the students true understanding. Then you can continue their statement to solidify a concept.

Things to Focus on:

Minor things to **Correct** or **Change** for next year

1. Make a handout for the jet flow notes
2. Fix activity
   - Better images of deltas
   - More pictures of deltas (want groups of about 3 but no more than 4)
   - Instructions to focus students' efforts on making observations

Timing

Activity	**Estimated Time**	**Actual Activity**	**Actual Time**
		Students copy notes from board	10 min
		Discuss assignments/party	7 min
		Activity looking at aerial images of deltas	7 min
		Report of student observations from their images	7 min
		Discussion on destructional and constructional forces	25 min
		Jet flows	14 min
Total Time			70 min

Lecture Debrief
Lecture 18
March 13, 2007

Q1: What went well?

The students seemed to be thinking about accommodation space. They seemed most mentally engaged when I told them conditions (like subsidence is just less than sediment supply) and asked what relative sea level was doing.

<Teagan's Note> I agree, they really had to think about the different factors to determine what relative sea level was doing. These type of scenarios are great because they force the students to think through the situation. They will be more engaged because they are required to give more than a simple answer they have memorized.

Q2: What didn't work? Things to change?

Today was a scramble. But, I think it went slow enough that we got some ideas across.

- The transitions from one topic to the next were week.

<Teagan's Note> Change the order you teach the concepts to have them flow better. See below for the order we came up for next year.

- I also think we need to think more about the exercise, add a key.
- We also forgot to discuss the bottom question about if the shoreline was prograding, retrograding or aggrading.

<Teagan's Note> Next class start the class with that question. This will give you the opportunity to briefly review what happened on Tuesday and start the class with activating the students' minds.

Q3: Do you have any concerns?

Q4: Do you have any ideas for how to change things or ideas for future lectures?

1. Change order that I cover topics for next year to help transitions.
2. Change the exercise to include a key for symbols Coe uses on her diagram.

Positive Observations:

- **Questions!** You did a great job asking LOTS of questions. You called on students and encouraged them to think through their answer before they said it.
- **Requiring better answers.** You said several times "Give me as clear and concise of a definition for this term." When students tried but still didn't quite phrase it right you asked other students to try building on that answer.

<Teagan's Notes> This is a great way to train the students to be more precise in their answers. Calling on several students to try until a good answer is given also shows the class that you expect them all to be able to clearly explain terms or concepts.

- **Student Response Vote.** You asked Student E to predict what relative sea level would do in response to subsidence and sediment supply. He gave an answer and then you didn't tell him he was correct. Instead you polled the class to see if they agreed.

<Teagan's Notes> Votes are a good way to get more students involved in a question instead of just one person in the hot seat. Having Student E restate what he had said is also effective because most likely half of the class didn't hear it the first time.

Suggestions for The instructor:

- **Reading Material.** As we were discussing shorelines before class you said that Coe's book is almost better than the book the students use. It might be worth photocopying part of Coe's book (if copyright says its okay)
- **Same students answer.** I notice the same handful of students answering. These are vocal students who have no problems with giving answers that may be wrong. Make sure you call on students you don't hear from often.

<Teagan's Notes> I noticed in my notes that Student A, Student C, Student L, and Student B answer a lot. Its not just that you call on them but they participate often. That means a lot of students don't put their neck on the line and are just riding on other student's comments.

- **Methods To Involve More Students.** Something you can try to get more people to pay attention when one student is being "interrogated" is to call on a student randomly to restate the answer that the other student just gave. This puts some heat on the other 20 students in the class to pay attention. If the student doesn't know, just ask if anyone can restate it. The students will start to realize that this is what The instructor does; that you expect them to listen and be ready to defend their answers.

Things to Focus on:

1. Calling on the quiet students who don't readily volunteer to answer questions.

Minor things to **Correct** or **Change** for next year

1. Exercise sheet

Timing

Activity	**Estimated Time**	**Actual Activity**	**Actual Time**
		Discussion about: accommodation sea-level change eustatic vs. relative Factors	45 min
		Shoreline Activity	15 min
		Discussion of results	15 min
		Barrier Island systems	10 min
Total Time			85 min