FACULTY LEARNING COMMUNITY

COLLEGE OF NATURAL SCIENCES & MATHEMATICS

FINAL REPORT : FALL 2014 COHORT

FALL 2014 FLC COHORT MEMBERS

Ladera Barbee

Ryan Blair

Montserrat Geier

Gwen Goodmanlowe

Benjamin Hagedorn

Zvonimir Hlousek

Darren Johnson

Younghee Kim Park

Enrico Tapavicza

Raymond Wilson

FLC Leader : Prashanth Jaikumar

Co-leader : Shahab Derakhshan

Assessment Advice : Susan Gomez-Zweip

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Summary of Individual Reports

1. ***Ladera Barbee*** wanted to promote student reflection on each lecture in her Business Calculus class MATH 115 and increase engagement with the material, based on a study that showed why class time is more important to learning than homework. Students were required to complete a multiple choice quiz within 48 hours of each lecture (Mon, Wed). She gathered data on quiz completion rate, when the quizzes were being completed, and analyzed the difference in exam scores from an earlier version of the same course without such a quiz component. She found that exam scores were better on the first 2 exams, but worse on the third exam, possibly due to an extremely difficult question being worth a large percentage of the grade. Significantly more students completed the quiz in a timely manner after the Monday lecture than the Wednesday lecture. She concluded that attending class also acts a reminder to complete assigned tasks, and that students are more involved with class in the first part of the week. She also came to appreciate how quizzes could assess various aspects of student learning, including knowledge of the syllabus, and became better at using the quiz features of Beachboard.

2. ***Ryan Blair*** chose to focus on the low-completion course MATH 123 (Calculus II) currently undergoing re-design. Based on FLC readings about active learning, he introduced problem solving sessions during class to address conceptual difficulties that students might have with the material. Students were split into small groups and asked to plan, present and critique solution methodologies prior to executing the actual solution. They were then presented with exit questions at the end of class to test their comprehension and problem-solving skills. Students earned a grade based on participation and quality of their work. Ryan gathered data from his exit questions on how students arrived at a correct solution based on this group activity. His results showed that a large number of students benefited from peer-discussions and gained meta-knowledge about the best way to solve a problem, in addition to problem solving skills. Although the pass rate did not improve, possibly due to the many changes being implemented in this course, he will persist with this technique and refine it based on his and his students' positive experience.

3. ***Montserrat Geier*** explored new online systems for student collaboration to drive peer-driven learning. Using the ``Social Homework" online system developed by faculty in CNSM, she was able to make students in PHYS 151 take on the role of responsible collaborators and drivers of their own learning. As one of the most active participants in this FLC cohort, she adopted the ``blended" learning approach in all three of her introductory physics courses. Students interacted online and in the class in a similar manner, reinforcing this novel method of learning. Through powerpoint lectures on beachboard and the iClicker system, she addressed specific questions for the class to solve in small groups. Using a mix of data analysis tools within ``Social Homework" and her own survey data, she showed that students were more engaged with the material and helped each other out with difficulties, thereby improving the performance of the class in the weekly homework assignments. As an early adopter, she also identified issues that need to be improved in ``Social Homework" to make it more comfortable for students to use.

4. ***Gwen Goodmanlowe*** implemented changes to promote active learning in her BIOL 213 and BIOL 411/511 classes. The former, which she team-taught, has a completion rate between 82% and 87%, but Gwen raised it to 94% in Spring 2015 using active learning methods. She instituted the practice of ``cold-calling" in the classroom as well as a Clicker question at the end of each lecture, so students had to pay attention to each and every lecture. They also had out-of-class extra credit activities related to the lecture material, as opposed to extra credit on exams only. In the more advanced class, she required students to read scientific papers and then formulate questions in advance for in-class discussion every week. Based on survey data, students became better at understanding scientific papers, were more motivated to do research, and did better on related topics in assignments and exams in both courses, as compared to previous editions of the course. Gwen intends to continue with these techniques in the future.

5. ***Benjamin Hagedorn*** wanted to improve students understanding of real-world applications of Geochemistry in his GEOL 461 course. He had observed from previous editions of the course that students had problems applying the theory of Thermodynamics to real-world problems. To address this problem, he brought his experience in industry to the classroom by adding a Case Study component to each of his lectures. Students then had to answer a Clicker question about the study, followed by discussions about the choices and the right answer. By making these changes to his powerpoints, Benjamin was able to increase student engagement with the lecture material, and exam performance in the laboratory component improved from 83% to 86%, as inferred from a statistical study. Students were much more forthcoming with questions, and lectures became more interactive. He will continue with this new way of teaching the class in the future.

6. ***Zvonimir Hlousek*** was concerned that students in introductory physics courses, such as PHYS 152, are presented with idealized textbook problems which do not train students to appreciate the true power of physical thinking. He came up with the idea of ``Crowdsourcing" the answer to a complex but realistic problem using online social dynamics. He used the Koondis platform, developed (in part) by him over the last few years to address the deficiencies of online homeworks sold to students by education companies. Students were divided into groups, and each group solved part of the complex problem through their individual task by communicating online over the course of a week. After some minimal checks and balances, the group solutions were collected to map out the full solution in all its complexity. Zvonimir found that, in the process, students became more responsible for their learning and were able to find new directions to apply their knowledge. He observed that students who participated actively in Crowdsourcing did better on similar problem in the exam.

7. ***Darren Johnson*** aimed at improving his students skills in mathematical modeling of biological systems through hands-on programming as a concrete tool for active learning. Through a progression of exercises that included diagrams, equations and coding, he was able to relieve some of the apprehension students faced in dealing with math in his BIOL 463/563 class. He also introduced reading and discussion of specific research papers dealing with mathematical models in biological systems, which helped students contextualize the classroom exercises. Darren carried out 3 different assessments: surveys about the exercises and paper reading, overall proficiency in mathematical modeling and exam scores. He recorded slight increases in scores in all 3 categories, but none were statistically significant, possibly due to the low enrolment in the class. However, a majority of students expressed very positive subjective opinions about the changes.

8. ***Yonghee Kim Park*** explored the online WebAssign homework system as a replacement for the conventional turn-in paper homework. As a long-time instructor of a low completion rate course: MATH 122 (Calculus I), she wanted to see if online homework can make a difference to the pass rate. In the past, she assigned close to 100 problems a week, and would grade the turned-in paper based on how complete the work was. With the online homework, she assigned fewer problems, and the system did the grading. She notes that students had fewer questions on the homework than before, and were more successful in working the problems themselves. This freed up class time that would otherwise have been consumed in explaining homework problems. However, apart from the quizzes, no significant improvement was seen in the pass rate or exam performance. She plans to continue using Webassign due to the positive changes in administering the course.

9. ***Enrico Tapavicza*** decided on increasing the amount of homework while simultaneously decreasing grading to probe deeper into the specific motivations behind student learning. He hypothesized that a break from too frequent assessment while providing a wider variety of problems would lead to more time for reflection and thereby deepen specific content knowledge and exam performance of students in his CHEM 371B class. Since this was a new class for him, he chose the basis of comparison as a different but similar class: CHEM 377B. He increased the number of homework problems in CHEM 371B relative to CHEM 377B but did not grade as many. The assessment tool used was the ACS exam, whose first 45 questions were included in the final exam of both CHEM 371B and 377B. Enrico found no statistically significant difference in overall exam performance, but a close examination revealed that students who took his CHEM 371B class performed better on specific fundamental conceptual questions compared to his CHEM 377B class, validating his hypothesis to some extent.

10. ***Raymond Wilson*** addressed the impact of attendance taking in BIOL 370 and personal anecdotes in BIOL 353 on student engagement and exam scores in these courses. In BIOL 370, he took attendance multiple times and in different ways, while in BIOL 353, he used class time to speak about his personal journey in Science. A regression analysis of exam data collected over several editions of this course showed that high attendance correlated positively with exam scores, although there was wider variation in scores for students with very high attendance. He concluded that while high-performing students generally have high attendance, the latter does not necessarily improve scores across the board. The year-to-year comparison suggested that the practice of attendance-taking may not drive high attendance. However, variances in the data suggest that attendance-taking can still be an effective tool, all other aspects of the course remaining the same. In BIOL 353, Raymond noticed a discernable improvement in student engagement through questions and enhanced interest, but no corresponding increase in exam scores.

Personal Summary & Suggestions on the FLC

- I appreciate the opportunity given to me to lead the FLC this past Spring. Besides the fruits of responsibility that any leadership position brings, I got to know some colleagues outside my department and was impressed by the shared passion for teaching and improving student learning in our College. I'm also very grateful to Shahab for his help as co-leader in stimulating the online discussions and organizing the munch'n'learn.

- I tried to emphasize the importance of data-driven analysis for the changes. Participants were asked to keep in mind how they would assess the change well in advance of implementing them. In this respect, Susan Gomez-Zweip was particularly helpful during our face-to-face meetings, as she offered assessment advice tailored to individual change hypotheses. However, I do not have feedback from the FLC participants on whether they used this advice and to what extent. This information can be gathered from the end-of-term survey that is yet to be done.

- I would like to specially recommend the wonderful enthusiasm and participation of the 3 lecturers: Monstserrat Geier, Gwen Goodmanlowe and Ladera Barbee, all of whom were among the top posters on the FLC discussion board, and carried out changes in all their classes. For the smaller departments in the College, the FLC can and should be expanded to include more lecturers to bring their unique insights and needs to the conversation.

In my opinion, the main success of this FLC cohort was the data-driven analysis that is evident in the reports as well as the widening of the conversation to include lecturers for the first time. I did not, however, go through with the initial idea of mutual class visits among the participants or other College faculty, as there was not much support for this.

From a reading of individual reports (overleaf), suggestions made by this cohort to improve the FLC experience include the following (the FLC survey should reveal more in the near future):

- More time to conduct the analysis and write up the report at the end.
- More luncheon meetings to share faculty ideas about teaching and learning, possibly with lunch provided!
- Setting up a plan for class visits so any interested faculty can observe implementation of changes in action. This can expand the reach of the FLC beyond the immediate cohort and also avoid duplication of effort as the FLC progresses through the College and possibly the same courses are targeted for changes.

Participation Data on the FLC

The *Piazza* forum was used to enable online discussions on the modules. Some data is presented below, which I suggest to use as the basis to recommend the level of the stipend (full or partial).

* Fewer than 5 contributed posts earns 50% stipend while the rest may be awarded the full stipend.

Name	Days Online	Threads Viewed	Contributions
Benjamin Hagedorn	14	13	8
Darren Johnson	9	9	2
Enrico Tapavicza	16	11	3
Gwen Goodmanlowe	21	14	26
Ladera Barbee	38	14	35
Montserrat P. Geier	55	13	16
Raymond Wilson	7	10	7
Ryan Blair	19	14	5
YongHee Kim-Park	21	12	3
Zvonko Hlousek	8	10	6

Prashanth Jaikumar	33	16	20
Shahab Derakhshan	67	17	7

Faculty Learning Community
College of Natural Sciences & Mathematics
Spring 2015 Implementation Project

Ladera Barbee
Department of Mathematics & Statistics
Math 115 Business Calculus
Enrollment: 129 students

Hypothesis

The activity of reflection as a part of active learning is something I already have experience with. I incorporate reflection activities on some levels after teaching each new concept. What I was not familiar with was the idea of having students reflect on the lecture as a whole. This was a new concept that really interested me. Also, there is a study, which found that the most important time spent for a course was in the class verses completing homework, working on projects or other tasks. My goal was to combine these two concepts. Student would have to attend class so that they could have the lecture notes needed to complete an online quiz about the class notes. My hypothesis was that by requiring students to review their lecture notes shortly after class, that they would better retain the lecture information and understand the content more clearly.

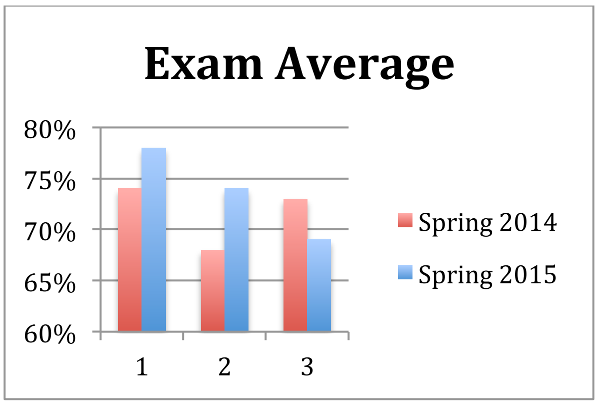
After each lecture, students were required to take an approximately 4-question quiz regarding material from the lecture. I used beachboard to set up the quizzes. Most questions were multiple-choice although there were a few true-false and matching questions. Students had roughly 48-hours to complete the quiz. Another benefit of the quiz was that the students theoretically looked over their notes before they did their homework since the online homework had a later due date than the quiz. This was another issue that I had always wanted to tackle.

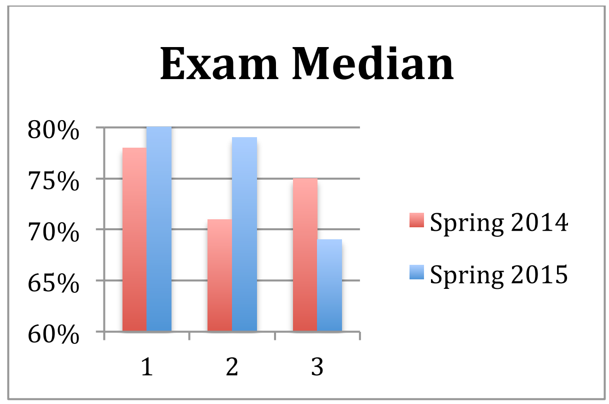
Results

Although I'd like to think that having students take a quiz from their lecture notes improved their understanding of the material, the results are inconclusive. Exam scores started off higher but the trend did not persist. There were known confounding variables contributing to exam score, which I will discuss later. There were also a few other qualifiers I would have liked to examine had time allowed. I would have liked to tie back a few quiz questions to corresponding exam questions. Also, I would have liked to look at the quiz scores and exam scores of students based on when they took their quiz. Even though I was not able to extract data directly related to performance, I was able to review data related to the student's behavior regarding the quizzes. This turned out be very informative and I will be making adjustments in the future based on these findings. And lastly, a positive result was that I improved as a quiz creator, and lecturer throughout the semester based on this experience.

Exam Score Comparison

I compared my Spring 2014 student's exam performance to the current Spring 2015 exam scores. The comparison is not completely apples to apples because of a slight shift in content covered over each exam. This was one of the known confounding variables. The spring 2015 students did better on the first two exams but not as well on the third exam. Of course the third exam now contained a problem worth 16% that turned out to be extremely difficult and usually is not asked until the final exam.

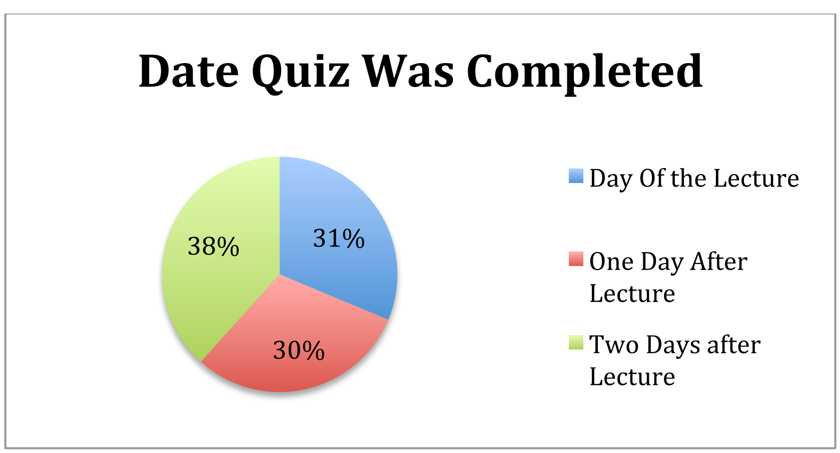




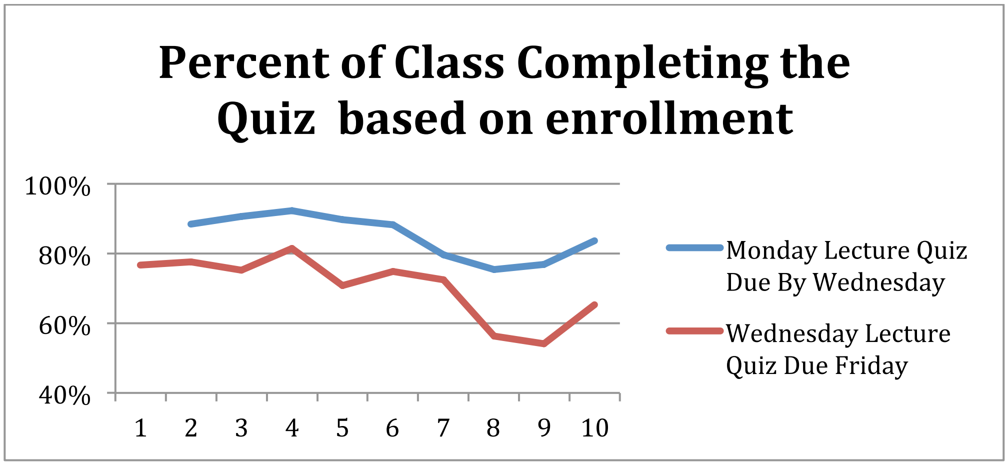
It might seem wiser to have studied homework success rates. This class utilizes online homework with multiple attempts allowed for each problem. Therefore, the success rate of homework may not be as related to lecture as it is to tenacity. Although I would be interested if reviewing lecture notes before completing online homework affected the number of attempts.

Quiz Completion Date

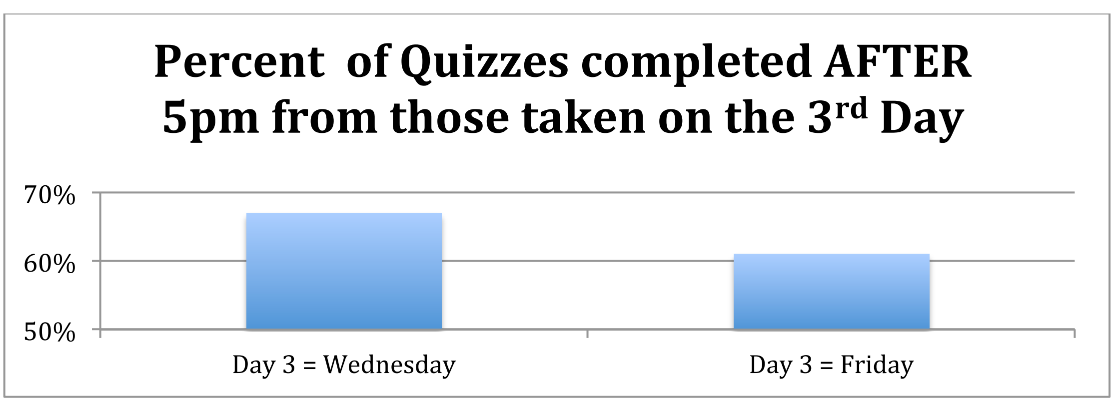
The other area of interest was the timing as to when the students took their quiz. Class ended at 4:45pm on Mondays and Wednesdays. The students had until 11:30pm, two days later to complete their quiz. It was almost equally split as to when they took their quizzes. Realize that the students, who took their quiz on day 1, only had a 7-hour window of time to do so, verses the next two days, which were both 24-hour windows of time.



There was a noticeable difference between how many students completed their quiz based on which day of the week it was due. The number of students who completed their quiz by Wednesday, from a Monday lecture was greater than the number of students completing their quiz by Friday from a Wednesday lecture. An average of 85% of enrolled students completed their quiz from a Monday lecture, while only 70%, on average, completed the quiz from a Wednesday lecture.



This made me curious as to how many students took their Monday lecture quiz after the end of class on Wednesday, since the deadline was not until 11:30pm that evening. Was attending class itself a reminder that there was an outstanding quiz? Did my in class reference to the quiz encourage completion? It does appear that attending class increased the percent of students completing quizzes. There were 6% more students completing their quiz on a Wednesday after 5:00 P.M., than there were completing their quiz on a Friday after 5:00 P.M., when there was no class. This begs the question as to whether taking the quiz regarding a previous lecture, after receiving a new lecture, affected quiz performance. Did the older material get confused with the newer material? Did the newer material clarify the older material? This is something to look into. And interestingly, of the students that wait until the final day, Wednesday or Friday, to complete their quiz, over half of them took that quiz after 5:00 P.M. Sadly, while gathering this data I also found that there were on average 1.4 students taking their quiz during class on Wednesdays. I didn't cross-reference the individuals to confirm if they were actually attending class at the same time.



Quiz Creation
I had not used the Beachboard Quiz function prior to taking on this assignment. I utilized many different types of question formats. And, I appreciated that I was able to create a quiz that was a randomized subset of questions in order to help minimize the number quizzes that were alike. Not only did I improve my technical skills writing quizzes but also over time my ability to write deeper more complex questions increased. And lastly, I found that writing the quiz questions required a more intense focus on wording. This in turn caused me to alter my lectures for clarity and preciseness in areas I had not seen the need for previously.

Discussion

I definitely plan on continuing the practice of requiring after-class lecture quizzes covering material just taught. There were numerous benefits that I look forward to continuing. Also, it was great to throw in a few questions from the syllabus a couple of weeks into class. My syllabus had a section regarding how to prepare for an exam. The week before the first exam, I asked questions from that section. This allowed me to be sure that the students read the portion of the syllabus at the appropriate time. After the first exam I received quite a few emails wanting to know when and where my office hours were. I immediately made that a question on the next quiz.

I encourage other faculty to add after-class lecture quizzes to their courses. I believe that once they start the process they will find multiple benefits and be able to adjust the process in a way that aids their needs. They don't need to worry about having a bank of questions. Most of the time, I wrote my questions the day of the lecture. This was a great review for me and allowed me to mention the quiz as I covered certain topics since it was fresh in my mind. And by writing the questions, I thought more deeply about the concept to be covered, which also enhanced my lecture for the day.

Based on my experience, I suggest that the quizzes should be due within roughly 24 to 36-hours. The students need time to digest the information but not an excessive amount of time. Also the due date should be set to allow the instructor time to review the results before their next class. This provides the instructor time to make changes in their upcoming lecture. I plan to implement this quiz due date timeframe the future.

Name: Ryan Blair
Department: Mathematics and Statistics
Class: MATH 123, Calculus II
Students: 40 initially enrolled and 39 completed

Introduction

MATH 123 is a low-completion course currently undergoing redesign. Historically the average pass rate for this course is about 70%. When I last taught this course in the fall of 2013, 78.4% of my students earned a passing grade. This semester 74.4% of my students earned a passing grade. Since this semester I was participating in the redesigned MATH 123 being piloted by the department, there were many changes between the course I taught in the fall of 2013 and the course I taught this semester. These changes include the implementation of online homework chosen by the redesign team, written homework chosen by the redesign team and graded by a student grader, mandatory SA sessions for students designated as "at risk", coordinated exams, coordinated online practice exams and the change hypothesis described below.

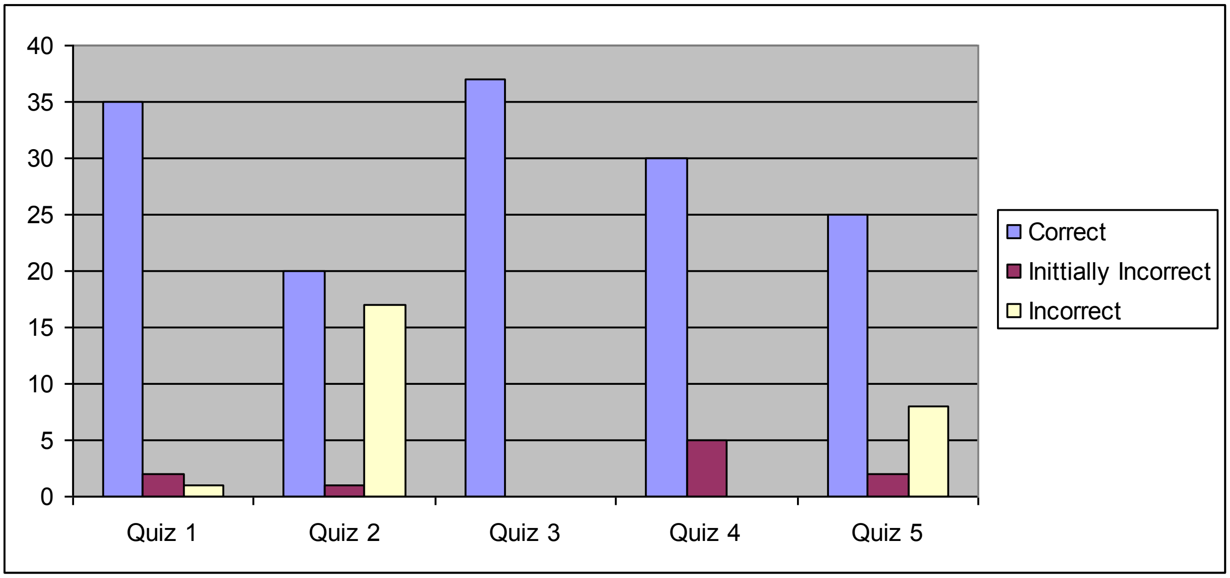
Hypothesis

In an effort to integrate consistent active learning experiences into my class, I designed weekly active learning activities with an eye toward assessment. The activity started with students writing down their own conjecture about how they might go about solving several challenging test-style questions without solving the problem. Then students were broken into groups of 3 or 4 with a mix of performance levels as indicated by previous assessments. When students got into their groups, they each had something to contribute and the group could discuss an idea provided by each person. Before solving, they discussed the merits of each conjecture for a solution path. A rejected idea was given a reason for rejection, thus giving that student feedback. After choosing the best path, they solved the problem as a group using the method they agreed on. Although students worked as a team to solve the problems, each student submitted solutions (in their own words) to all problems. While they worked, I circulated and helped students when they had questions or got stuck. At the end of the activity, I often called on students from different groups to present their group's solution to one of the problems. Other students asked questions and critiqued the group's solution during a group discussion. Thus, after the presentations and group discussions every student had a correct solution to the problems asked. Students earned a participation grade based on being willing to present and the quality of solutions submitted at the end of the activity.

After the activities were over, I gave an exit question consisting of a problem similar to the questions tackled by the groups, but not as difficult. On each of these questions, students were asked to make a hypothesis about how they should go about solving the problem. They were then asked to proceed to solve the problem in detail. Student performance on this question allowed me to assess how successful this active learning approach was at promoting student learning.

Exit Question Data

Because of the demands of the coordinated online practice exams and the coordinated exams in the redesigned MATH 123, I was limited to giving only five exit question quizzes. In addition to grading the student solutions, I recorded how often the student hypotheses were correct. Each student hypothesis could fall into one of three categories: correct hypothesis, initially incorrect hypothesis that is corrected to the correct hypothesis over the course of the student's solution, and incorrect hypothesis that is not corrected. Below is a table of student hypothesis:



Positive Results

I believe that, overall, the experiment was a success. There are several key concepts in MATH 123 that require students to deduce the correct method for a particular problem from a lengthy list of possible methods. These concepts include choosing an integration technique when asked to evaluate an integral and choosing a test for divergence or convergence when determining the behavior of a series. Students often struggle to make the correct choice when solving these problems because the meta-knowledge of which technique works on which problem can be lost in the details of the techniques themselves.

By forcing students to make hypotheses on both their group work activities and on their exit quizzes, students were continually pushed to grapple with the higher order thinking question of which method works. As shown in the exit quiz data, the majority of students were able to identify the correct method on every quiz I gave. Moreover, there were very few incorrect hypotheses that were never correct by the students. Anecdotally, I found that students were much quicker and more accurate when I asked them questions about what method worked for a particular problem.

Negative Results

Despite the implementation of this change and the changes due to the redesign, the overall pass rate for my MATH 123 class this semester was lower than the pass rate for my MATH123 class in the fall of 2013. This change could be due to a number of factors, including the variability of student populations. Since each class had less than 40 students enrolled, the law of large numbers does not apply. Additionally, MATH 123 courses offered in the spring tend to have a lower pass rate than those offered in the fall. Anecdotally, I did sense that the students this semester had overall weaker backgrounds than the students I had in fall of 2013.

Although I believe that the discussion of what methods work on what questions was very useful for students when covering certain material, it seemed less effective when covering other material. For example, students benefited from discussing which integrals could be evaluated using integration by parts; however, it seemed like an uninteresting tautology to tell students that when a question asks you to find the arc length of a curve you use the formula for arc length.

Discussion

I will certainly implement this change again. As shown by the collected student data, pushing students to create hypotheses was effective in helping students to develop critical thinking skills. This experiment was most effective when problems had multiple possible solution paths.

However, creating hypotheses was less effective with other problems. In problems with only one, or very few, possible solution paths, this experiment was not an effective use of instructional time. Therefore, in the future, I will revise the hypothesis approach and only use it with a select number of problems. I will plan instructional time carefully to maximize the use of different teaching strategies.

In addition, time was a scarce resource during activity sessions. It was difficult to find a balance between student work time and student presentation time. In the future, I would like to shift the balance to allow more collaborate work time for students, since that was the most effective use of time this semester.

I enjoyed the collaborative experience of working with the other faculty members participating in the FLC. I found the reading material we were given informative and thought-provoking. I appreciate the opportunity to experiment with implementing new ideas in my classroom. I feel that the FLC helped me develop changes that would be most beneficial to my students.

Montserrat P. Geier

Physics and Astronomy Department
- Physics 151 (140 students) *not a low completion rate course*
- Physics 100A (120 students) *not a low completion rate course*
- Physics 100B (157 students) *not a low completion rate course*

What I tried and why

In my section PHYS 151 (Mechanics and Heat) I incorporated Social Homework for the first time because I believed that this would be a good chance for students to bounce ideas off each other and facilitate their own learning while they reinforced concepts learned in the course. Social Homework is a critical thinking and communication tool which requires students to present their written ideas to one another in a chatroom format. This thinking and writing component is very powerful because it causes students to make sure they are writing clearly. I placed students in thirty-two groups comprised of five persons in each group. Group members were assigned predetermined roles (Director, Investigator, Executor, and 2 Skeptics) to discuss one assigned problem chosen by me from the weekly Webassign homework. The roles of each group member changed weekly. Besides their own group assignments, individual students were supposed to monitor and participate with comments to other students in groups that were not their own. Every week, the end of the problem solving period, each group's director posted a detailed solution to the assigned problem two days before the Webassign was due. This posted solution was made available to all the groups online. As a result, students were able to view their peers' thinking. This helped them to turn in the WebAssign on time and they seemed to enjoy the process.

Additionally, in all three of my classes I used a blended learning approach using online and classroom activities. I felt that this would provide students with more classroom opportunities to actively engage and interact with one another rather than having them listening passively and taking notes. I loaded new material such as PowerPoints and animation Figures into beach board and assigned conceptual readings in WileyPlus several days before class meetings. This way, students would be able to read and study at home before class. Then, instead of merely relying on traditional lecture, I used a big portion of my class time for students to be able to collaborate and practice with each other. I usually began with a few well-selected, conceptual iClicker questions where all students discussed amongst themselves some possible outcomes to the question before students got a chance to "vote" for the best answer via iClicker. I took this student discussion technique a step further in all my classes. I presented a problem similar to the ones students encountered in their homework. They were then given a short time to think about the problem on their own. Next, students were allowed additional time to discuss the problem in small, informal groups, and finally, the entire class talked about the solution using volunteer students who explained reasons for their outcomes.

Results

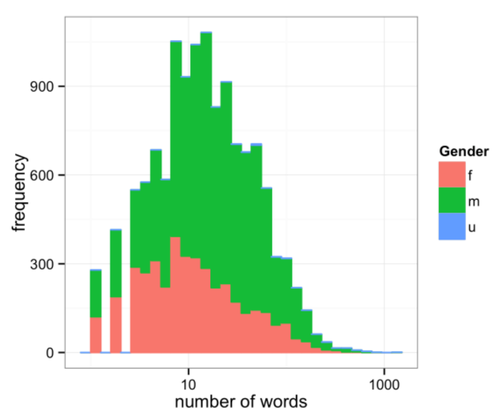
Generally speaking, peer interaction of students puts weaker students with stronger ones who reinforce the concepts in their own words in ways that the weaker student may be able to easily understand. With respect to the blended classroom approach, I found a very positive experience to be the "guide on the side" while I allowed the students do the teaching and talking. During whole-class discussion and problem solving, students were in rapt attention as they witnessed their peers at the whiteboard solving problems. It was quite clear that during this part of class, students were fully attentive to the learning activity.

I gave my physics 100A and Physics 100B students a survey at the end of the semester, and got some positive feedback. Below are statistics of student responses:
The scale was 1 to 5, with 1 meaning "I strongly disagree" and 5 meaning "I strongly agree."
Here are the "4" and "5" responses combined:

1) The PowerPoints were useful to me in learning.
   Physics 100A: 92%   Physics 100B: 96%
2) Whole class problem solving activities helped me to understand the material.
   Physics 100A: 93%   Physics 100B: 94%
3) IClicker questions helped me to understand the material.
   Physics 100A: 93%   Physics 100B: 93%
4) The animation Figures shown in class helped me to understand the material.
   Physics 100A: 78%   Physics 100B: 82%

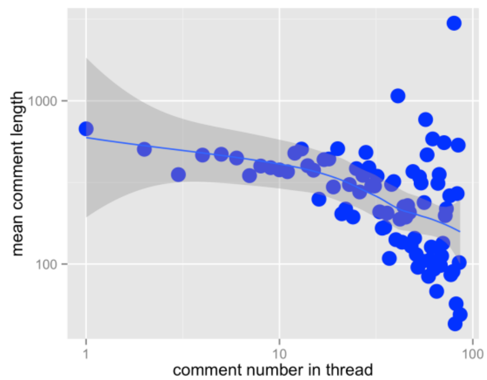
I also conducted a similar survey for students involved in Social Homework and the results were generally positive. The majority of students indicated that Social Homework added value to the class. Many students felt it helped them understand how to solve problems, work as a team, and be more enthusiastic learners. On the other hand, students also claimed that there were some problems with Social Homework. They did not understand the grading rubric, and they also did not know how they were to get the most points for their discussions. I personally think that the grading rubric needs some modification.

Some results from the Social Homework:

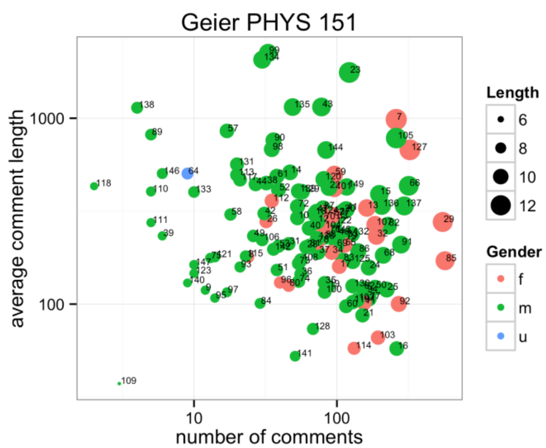


The histogram above is showing average student activity of a group in the text discussions.

The following graph shows how the length of the comment varies with the position inside the thread. Commonly, earlier comments are longer, while later comments will be shorter.



In the graph below, we see a student by student graphical representation of the average number of comments and the length of those comments. Some students submit lots of short comments, some submit few longer comments. The size of the point corresponds to total submitted text "Length", which is the natural logarithm of the number of characters submitted.



Discussion

Social Homework is a collaborative learning tool that strongly engages students in the problem solving process. This is why I will be using it again next semester. I will also continue using the blended learning approach for the same reason. During problem solving and iClicker questions, it is very important for the instructor to hold back a little and allow the magic of student collaborative learning to occur.

The FLC was a very good opportunity for me to learn new teaching methods and meet other professionals at CSULB. Through the literature I read and the peer discussions, I believe my teaching was surely enriched. I found it interesting to hear of other instructors' modes of teaching. It has been very helpful. Thank you for allowing me to be a part of this group. The FLC is a fantastic tool for all teachers!

Introduction

- Gwen Goodmanlowe
- Biological Sciences
- Intro to Ecology and Physiology, BIOL 213
  - 120 students
  - Completion rate is typically 82-87%
- Marine Mammalogy, BIOL 411/511 (18 students)
  - 18 students
  - This is not a low completion rate course

Biol 213:
Hypothesis and Methods:
In my large lecture class, I asked questions of 10 students per lecture to ask questions I have posed, rather than just asking if anyone has any questions. I had a list of a different 10 students set up before class so that I was able to call on different students during each lecture. My goal was to make them more active in their learning- if they thought they were going to get asked a question by name, I hoped that they would pay more attention during lecture and ask more questions during the lecture.

I also asked one clicker question at the end of lecture, based on what they learned in class that day, rather than on the previous lecture. I also hoped that that would also make them more active learners since that would require them to pay attention during the current lecture.

Lastly, instead of having one or two extra credit questions on each exam, I offered outside extra credit. For example, one week they are learned about flower reproduction, so I had them look for the different types of flowers in their everyday life and send me a photo of the flower (with them in the photo to ensure they are actually doing the work themselves) for 1 extra credit point. I had a total of two extra credit assignments that were similar and based on that week's lecture material.

Findings
Informal feedback on these three changes were very positive. Students said they paid more attention during class both because they didn't know if they would be called on, and so that they would do well on the end-of-the-lecture clicker question. They also read the notes and textbook in advance so that if they were called on, they would be able to answer the question. The students liked having the extra credit assignments, and students did better on exam questions that were directly related to those assignments:

	Fall 2014	**Spring 2015**
Plant Question	35% correct	60% correct
Ecology Question	65% correct	80% correct

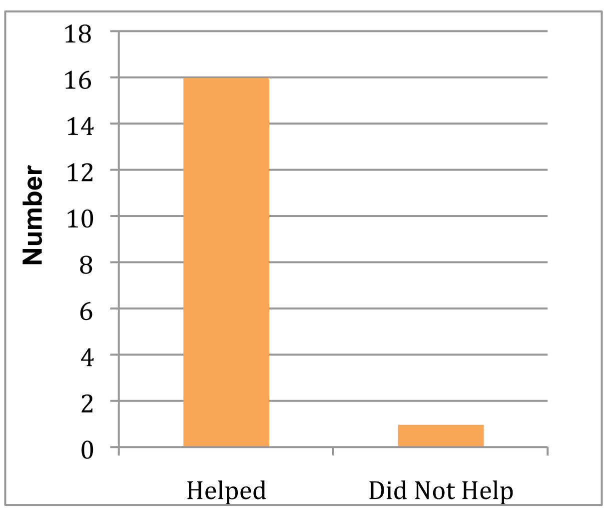
Lastly, the overall pass rate of this class has gone up considerably, which I feel is partly related to these three changes. In previous semesters, the completion rate for this class averaged 84%. This semester the completion rate will be 94%.

Discussion
I already do many of the things that were put forth in the articles we read for the FLC, including using personal stories, incorporating video clips of relevant topics, using news items to connect every day life to what the students are learning, and helping the students to think critically with topics discussed. One of the challenges of implementing changes in this large class that is a team-taught class, split by time of the semester. I typically teach the first half of the semester. It is difficult to get both instructors to make sweeping changes.

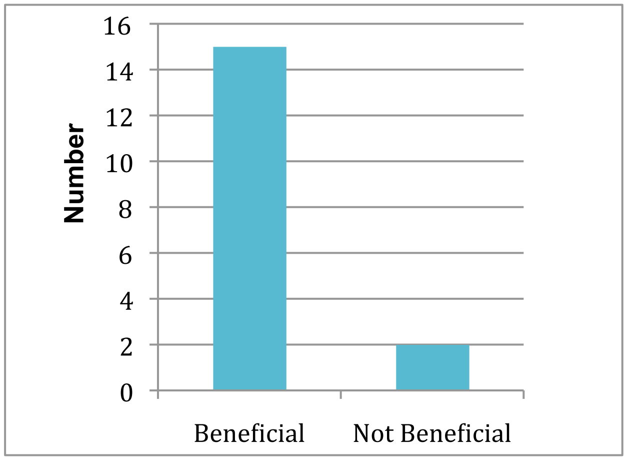
I do feel that the changes I made during my half of the semester, combined with the new online quiz system had a very positive outcome for the students, and I plan to keep these strategies in place for future semesters. They were easy to implement in a large lecture class with limited time, and the students responded positively to them.

Biol 411/511:
Hypothesis and Methods:
I had the students send me two questions each week based the assigned primary literature readings. They were worth 5 pts each week. Depending on how much time was available each week, I chose between two and 10 questions to discuss as a class. I felt that this would encourage the students to read the scientific papers in detail each week, rather than waiting until they studied for the exam, while also having their questions addressed early on.

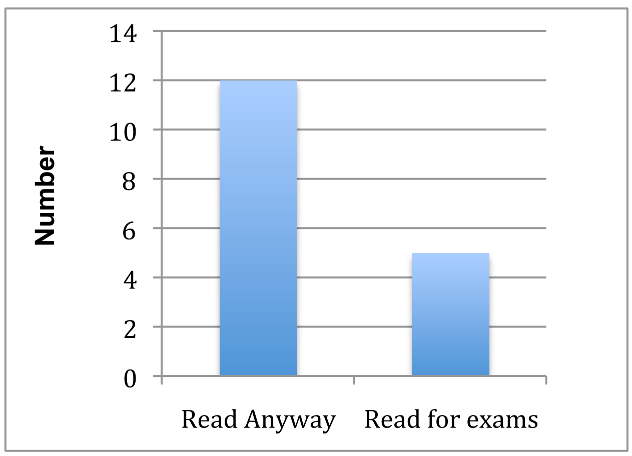
Findings
I administered an informal, anonymous survey in class and found the following:
1) A majority of the students found that the in-class exercise where they learned how to critically read a scientific paper helped:



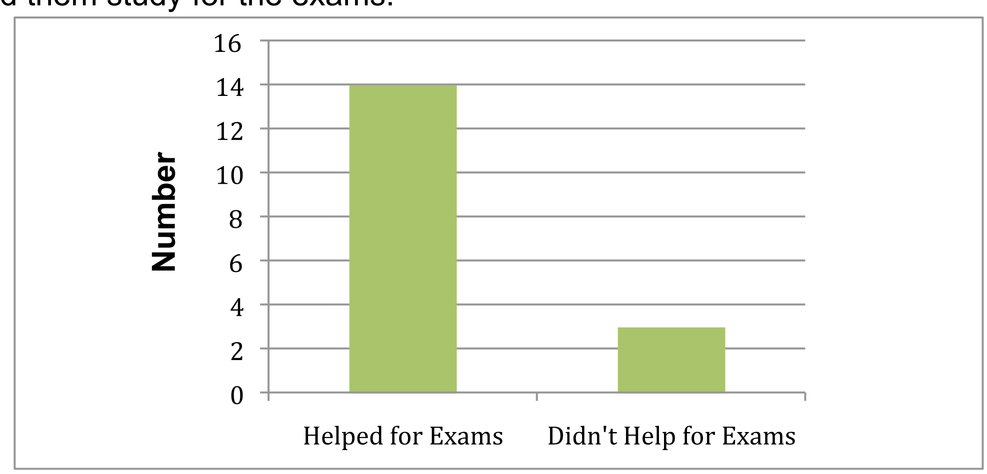
2) A majority of the students found that having to write a question about the paper helped guide them when reading the paper:



3) Some students felt that they would not have read the papers had the weekly questions not been assigned, even though they knew they would be tested on them:



4) A majority of the students felt that reading the papers for the assignment helped them study for the exams:



Discussion
Again I already do many of the things that were put forth in the articles we read for the FLC for this small class, including using personal stories, incorporating video clips of relevant topics, using news items to connect every day life to what the students are learning, and helping the students to think critically with topics discussed. In addition, the lab component of the class is very hands-on, with much discussion of topics, and working together in groups.

I feel that having the students read the literature and send questions to me each week was very beneficial. In the past, I have had students do poorly on the exams because they either didn't read the papers, or they skimmed the papers while studying. It was evident in the students' answers that they had read and understood the scientific literature at a much higher level.

Introduction

- Name: Benjamin Hagedorn
- Department: Geological Sciences
- Class: Introduction to Geochemistry (GEOL 461)
- Number of students: between 15 and 20
- This is not a low completion rate course

Background

Introduction to Geochemistry (GEOL 461) is a required upper division course for geology majors. I have taught the class in the previous two spring semesters (the course will be offered in fall semesters starting 2015). I incorporate a lot of hands-on learning in the form of labs, field trips, in-class or take-home assignments. Even though the course has three pre-requisites (CHEM 111A,B and MATH 123) I have noticed in my first offering of the class that my expectations were set too high on what the students can be expected to know about some of the fundamental principles of geochemistry; that is thermodynamics. I have designed the class content using power point presentations, exercises, evaluations, and grading structure to emphasize the *application* of concepts and theory presented in the class, but have noticed that many students struggled relating the abstract theory of thermodynamics to the practical problems. Given this, I implemented 2 changes in the second offering of the course (Spring 2015):

1) involving my students more in active discussions on lecture materials covered, and
2) incorporating more case study applications of theoretical principles that geoscientists experience in the industry in my lectures.

To achieve these goals, I introduced new lecture slides in each lecture with case study problems on particular scientific principles. The key was not only to present these case study examples, but also have each case study presentation being followed by a clicker quiz to test students' learning progress and to provide direct feedback.

Hypothesis

The hypothesis that I tested was that using in-lecture clicker quizzes on practical case study examples enhances the students' learning experience because it sparks active discussions with me or their peers and it provides me (the lecturer) the opportunity to observe their learning and provide direct feedback.

Methods

Each lecture was subdivided into several sections (usually 3 to 5). In each section, I first address theoretical aspects (using mainly textbook materials) and then move on to case study examples (each containing 3 to 5 lecture slides) that were taken mainly from the scientific literature, but also from my experience in the environmental consulting industry. Each of these case study presentations illustrates the more practical applications of the theory presented. Each case study presentation is followed by a clicker quiz with multiple choice questions on the covered materials. Students have 5 minutes to provide the answers and once all answers were submitted, I discuss with the students all multiple choice options and explain the reasoning for the right answer.

Results

The quantitative results are – as of yet – very encouraging. On average, students' performance of the lab exercises improved from 83.0% to 86.8% by (see Fig. 1). I have not graded the final yet, but I am confident that the students will perform better than in last year's class. On a personal note, I am also very pleased with the direct feedback and active discussions that I noticed during my lectures. During my first teaching of the class, I students appeared more reserved and shy about asking questions in the class setting. This changed dramatically with the introduction of the case study slides and clicker quizzes.

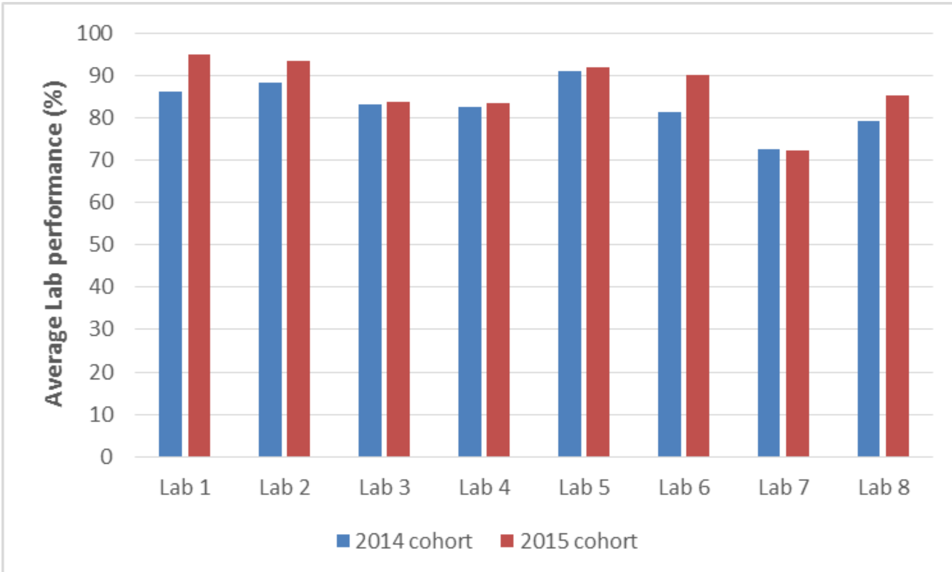


Figure 1. Comparison statistics of average score performance of GEOL461 laboratory problem sets for the Spring *2014* (blue) and Spring *2015* (red) classes. There have only been minor changes in the problem sets between 2014 and 2015 GEOL461 labs. The total student enrollment was 23 and 19 for the 2014 and 2015 classes, respectively.

Results

The observation that student performance increased (at least in the lab section of the class) is supported by the quantitative data shown above. However, there are several limitation in the analysis that must be kept in mind before interpreting the statistics. First, Lab exercises were slightly modified from 2014 to 2015 to keep them up to date with current scientific developments and to ensure students would not be able to copy solutions. However, the overall degree of difficulty should not have changed significantly as the particular exercises were only changed slightly. Another limitation that should be addressed is that the enrollment from 2014 to 2015 decreased from 23 to 19. As such, the effect of positive outliers could be more significant in the 2015 data. Nevertheless, my personal feeling is that the student's learning experience increased through the implemented changes, so I will continue following this approach in future offerings of the course.

Pros and Cons

Having implemented my approach for one semester, my conclusions are mainly positive. The main benefits of the implemented approach are (1) the possibility to provide students direct feedback, (2) the opportunity to apply learned theory and practice *doing*, and (3) to break up the monotonous lecture structure with compelling multiple choice quizzes. However; there are also some issues. For instance, the fact that having to buy or rent a clicker to participate in the class only adds to the students' busy schedule. A grading criterion that requires continuous attention also creates problems for students that, due to urgent reasons, cannot attend lectures in certain instances.

Overall, I learned a lot through the FLC. I particularly enjoyed our open discussion in which the pros and cons of new ideas and approaches were addressed. It was interesting to hear what other, more *seasoned* faculty thought about some of the more recent technological approaches (e.g., using clickers) and to find out what approaches they were following. One suggestion for the future would be having more luncheon meetings (maybe with lunch being provided) to encourage more discussions and maybe talk about recent (i.e., current semester) experiences. It may also be helpful to have each FLC member attend the lecture of a peer to experience implemented changes *in action*.

STEM Faculty Learning Community, CNSM
Academic Year 2014-2015

Report by Prof. Zvonko Hlousek
Department of Physics and Astronomy

Course: PHYS 152 – Electricity and Magnetism,
Enrollment: 75 in Spring of 2015, 74 in Fall of 2014

The course is not a low completion rate class

Title: Crowd-Sourcing as a learning technique

June, 2015

Background

Physics 152, Electricity and Magnetism is the second part of a two semester sequence in general physics for science and engineering majors. Together with two similar classes for science and health-sciences majors it represents courses where many students get their first-time exposure to scientific methods and approaches of Physics. The primary difference between classes taught to physics and engineering majors and classes taught to science majors is the level of math. Physics for science and health-sciences majors is taught without reliance on calculus.

Primary issue we face in teaching physics at the general physics level is almost exclusive reliance on "certain kind of problem" solving. A typical physics problem from a typical general physics textbook published by a major publisher almost exclusively describes some artificial situation occasionally embellished with words intended to give an impression of a reasonable narrative. An answer to this typical problem is a numeral or a collection of numbers that represent values of certain physical variables in some circumstances. As a scientist and educator I have to say that most often, numerical answers to such questions are irrelevant and have no significance. While they can be computed, at the same time they represent no useful or important information that anyone cares to know. Here is a simple and typical example. When studying the free fall, we often ask a student to calculate the speed with which some small object hits the ground below when it is dropped from the height of few yards. The value of the speed does not matter, it is irrelevant and knowledge of it has no practical information. The ability to compute this speed rests exclusively on student being able to pick one suitable formula from many and punch in the numbers into the calculator. An instructor having knowledge that a student can get this number correct says absolutely nothing about the understanding of the free fall that student has.

To facilitate administration of practice problems, homeworks and even exams to a large number of students we frequently rely on online problem solving systems to which students subscribe for a small fee. Unfortunately and by limitations of possible software designs, such systems, while they grade automatically, are easily duped, not to use the stronger word, cheated and students quickly figure out how to achieve incredible scores that do not translate into real knowledge and skills. Automated problem solving systems do not think and cannot think. Automated make a determination about the student response being correct or incorrect only based on a number or in some cases on the symbolic expression submitted by the student. With such automated system, the final result is the only things that matters and is the only thing used to make the evaluation. In a perfect world of perfect students maybe that would suffice. However, in the real world it falls short. It is impossible to make a reflective evaluation of student work that's necessary to determine the level of competence.

The problem is not unique to Physics. It also plagues teaching and learning in Mathematics, Chemistry and probably Biology.

Online homework systems are a technology solution that are necessary because we have to teach hundreds of students with limited number of instructors and resources.

Hypothesis

We can supplement and perhaps replace an automated online homework system by introducing reflective exercises where students have an opportunity to solve simple as well as more complex tasks that by their nature require introspection and communication. On the surface this appears as a prohibitive task when large number of students are involved.

We believe that we found a solution provided by a new kind of online learning system – Koondis. Koondis is designed with a primary goal to facilitate communication, exchange of information, peer evaluation and team work. In some sense, the Koondis is an attempt to implement the social network in the learning environment and to benefit from implicit learning behaviors of the social network. By implementing the Koondis learning system in the class we can focus on the problem solving process instead only on the final result. The Koondis learning system is scaleable and can serve few dozen as well as several hundred students.

The Koondis system has analytics part that tracks student work, participation and activity levels and indices that relate to sentence complexity and vocabulary and that can be used to measure the quality of the discourse.

While the Koondis is flexible and can accommodate many different workflows, I have focused on using the idea of *crowd-sourcing*. A class works on an assignment that has many parts, some possibly repetitive, where a small result produced by every individual student is needed to assemble the large whole. The assignment as a whole is probably prohibitive for the most individual students to carry out alone at this particular stage in their learning process. However, the class, divided into small teams can break down a complex task into a number of smaller tasks. Each small task can be executed by a team where members also serve as peer evaluators. Groups then publish their results and use their result with results provided by other teams to assemble the answer to a big problem.

The hypothesis

- The Koondis platform can be used to to have students perform complex, more realistic exercises and to acquire necessary skills. Koondis platform capabilities are essential in all aspects of the work flow. Within the Koondis platform students break down the large problem into smaller problems, present the analysis of smaller problems, publicly display the process of solving smaller tasks, present their findings and results, collect these results and then assemble and present the solution to a large question we started with.
- On completing the exercise students have better comprehension of the subject and better skills and working habits.

Let me emphasize that my goal was not to replace topics and subjects covered in the class and are necessary to have the good grasp of the material in the end. My goal was to enhance understanding of few special areas where a more traditional approach falls short and results in many misconceptions or partial knowledge.

Results

In this discussion I'll focus on one exercise – the calculation of the electrical field of a uniformly charged metal plate. Standard textbooks present the result in the special case where the plate is for all purposes infinitely large. The special case result is so simple and easy to memorize and use without thinking even when it is not applicable. Many textbook questions then revolve around inserting numbers into this special case result and hope that meaningful learning happens.

What did students do?

Using Koondis Learning, students were divided into working teams of 5 members each. Each team member had a specific role: the Directory or the Team leader, the Investigator, the Executor and the Skeptic (there were two of those per team). Every team member has to participate in all aspects of the team work but also has to produce a specific report that in the end is put together into the team product or the team result. Team members check each others contributions and work to assure accuracy.

1. Following an example presented in the classroom students were able to figure out a way to break down a problem into 15 smaller problems. Basically, they successfully created a coordinate system, a three-dimensional map to keep track of the pieces of the plate with source charges and places where they needed the resulting electric field. In this case small problems were essentially identical in principle but did involve different parts of a larger puzzle. It was not possible that one team could simply copy the work of another team and claim it as theirs. It was possible that a team reviews the work of another team and replicate their approach on their own piece of a puzzle. In fact, I consider that a positive aspect of the exercise.
2. Each team then used the basic and simple principles (Coulomb's law, and the principle of superposition) presented and shown how to use in the lecture, to calculate the electric field configuration at a select collection of points in space. Each team created a table of computed values of electrical field and published their results.
3. Finally, each team then used results generated by all teams to assemble the map of the electric field of the uniformly charged plate.

Students had one week to complete the exercise. I did not monitor their work beyond using Koondis analytics to see the level of engagement measured by the number of posts and conversations and by answering questions they sent me.

Later in the semester we had two more exercises of the similar type.

I tested what students have learned by asking homework questions where they had to qualitatively determine the electric field configuration of some configuration of charges. I also used questions in the midterm exam to test the level of comprehension of the process of calculation of the filed configuration as well as questions to determine the qualitative look of the field configuration.

Discussion

The primary challenge was to create suitable exercises. In the electricity and magnetism there many such possibilities. One important area is to understand the pattern of electric fields in space generated by a distribution of charges. The traditional textbook approach limits such explorations to very special geometries that can be analyzed with analytical tools and more importantly, are seldom found to occur in nature in pure form. The deduction required to more complex cases is possible but is also a complicated task well above the level of beginner students. Yet, beginner students are introduced early to all the tools necessary to analyze complex cases. What we fail to teach them because we focus on trivial standard textbook problems is how to use the tools they are given.

When asking students to solve a complex problem I cannot simply ask, "Calculate the electric field of such and such charge distribution". Instead, I have to provide the context as well as a relatively transparent case where students can begin to break the problem into smaller pieces that teams can work on. Finally, I have to provide the framework they can use to piece together their results.

There are several challenges that I encountered.

- There were few students that choose not to participate
- There were occasional miscommunications among group members about who has what responsibility
- Some students waited to long to start and did not contribute in time

I think that the second and the third problems listed are to a good degree a result of my failing to clearly anticipate and thus articulate the work flow students need to follow.

There were also many benefits

- Students were able to correct calculations that did not fit the pattern. They were easy to spot and repeat to give correct results
- In the exam, I had large number of students being able to articulate how to calculate the pattern of electric field
- In the exam I had large number of students correctly present the qualitative pattern of electric field configurations in space
- In later practices and exam questions where knowledge of field patterns is important I experienced a greater degree of success by students that participated in the crowd-sourcing exercises.
- One particular successful later instance, and definitely not anticipated, I can only contribute to students successfully working out the problem I described. The knowledge they have acquired by completing the electric field exercise they were able to apply to understanding how a neuron uses electrical charges to create electrical field that pushes a signal, a molecular ion, down an axon.

I will continue to use the crowd-sourcing together with Koondis. Crowd-sourcing would be simply impossible without the tools made available by Koondis. Crowd-sourcing is a viable and promising technique to engage students in solving realistic problems.
Clearly, in the next implementation I need an improve the articulation of the workflow.
One challenge will remain – good questions. Standard textbooks are not a useful source of good problems suitable for the approach. However, in time this can be overcome by my creating more good questions and also by collaborating with colleagues willing to try the method.

The spring semester of 2015 during which I though the class where I used the crowd-sourcing teaching technique finished too recently and I have not completed the data analysis.

My suggestion for FLC, if any, is to allow more time for report preparation so that instructors have time to analyze and present the data. Having just few weeks to prepare the report makes the class data analysis and presentation impossible.

Introduction

Darren Johnson
Biological Sciences
BIOL 463/563 Computer Modeling in Biology
Enrollment = 14 students (8 undergrad, 6 grad)

This course concentrates on using mathematical models to describe biological phenomena. The course format is two, 50-min lectures and a 3-hour lab per week. This is my second time teaching the course. On the first time through, I felt I lectured too much. This time, I wanted to incorporate more active learning and hands-on activities in to my teaching. I believe that biological modeling is a learn-by-doing activity. ***My hypothesis*** was that adding more student-lead, hands-on activities would lead to greater engagement in the material and would ultimately increase student's ability to use math to represent biological processes. A second, related goal was to improve student's mathematical abilities. Many students within the biological sciences tend to fear or at least ignore math. I hope that this course helps them embrace a quantitative approach to studying Biology and that the changes I made this semester will help us make progress toward those goals.

Methods

This semester, the change I made was to incorporate many more active learning techniques into the regular class time. For example, when discussing different types of infectious diseases and their dynamics, I tasked student groups (2-3 people) with diagramming a model for the dynamics of a particular disease (e.g., chickenpox, measles, HIV, etc.). They then had to take the model they drew, translate it into a system of differential equations, and explain the model to their peers. Similar exercises were done when introducing the concept of statistical likelihood and when discussing how to program recursion equations in the computing language R. I also had two paper discussion sessions. Students were required to read original literature where mathematical models were the main focus of the studies. Students were responsible for answering a series of questions about the study and students participated in discussions of the models, and how they were applied and presented.

Assessment

Responses to this semester's changes were evaluated in three different ways.

1. In an anonymous, end-of-semester survey, students were asked to rate the effectiveness of both the in-class exercises and the paper discussions. I asked students whether each of the techniques helped them to learn the material. Responses were enumerated on a 1-5 scale (1 = strongly agree, 2 = slightly agree, 3 = neutral, 4 = slightly disagree, 5 = strongly disagree).
2. Additional questions in the end-of-semester survey asked students to score their proficiency with quantitative analyses and their expertise in the use of models in Biology before and after the course. Each was to be rated on a 1-10 scale (10 highest). I compared the average improvement score reported by the 2015 class (which participated

in more active learning activities) to the average improvement score reported by the 2014 class (few active learning activities in lecture)

3. For each year I have taught the course, I have tracked test scores in a number of conceptual categories (e.g., application of models, computational skills, mathematical comprehension, etc.). One measure of student learning is to evaluate how a student's average score in these categories improves between the midterm and the final exam. Because my changes were geared toward improving students' ability to represent biology with math, I compared improvement in questions that centered on applications of biological models. Specifically, I tested whether the midterm-to-final improvements in 2015 were significantly different than those observed in 2014 (when active learning was less used).

Results

On average, students' responses to the in-class exercises were positive. Ten of fourteen students agreed that the exercises helped them learn (Fig. 1, left panel). In the survey many students added written comments to the effect that they also benefitted from working through the problems in groups of two or three. On the other hand, not all students found these exercises helpful. Three of fourteen did not find the exercises effective. One commented that they did not like group work, and another commented that class time could have been better spent on other activities.

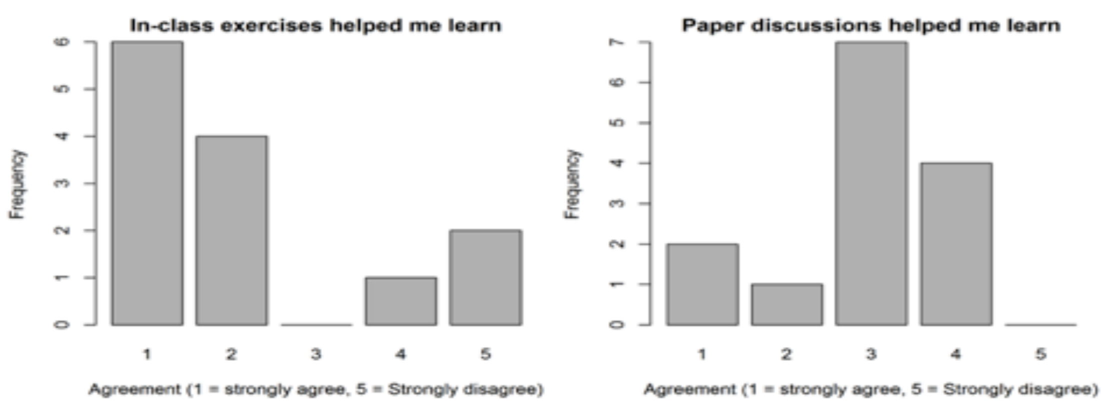


Fig.1 Students' perception of the effectiveness of active learning techniques used this semester

Student responses to the paper discussions were more equivocal. Half of the students (7 of 14) had a neutral impression of the exercises (Fig.1, right panel). Three agreed that they were useful and the remaining four disagreed.

Students were asked to rate their level of proficiency with quantitative analyses before and after taking the course. In 2014, the mean improvement was 2.72 (0.45 SE) units (on a 1-10 scale). This year (with a greater emphasis on active learning) the mean improvement was 3.10 (0.34 SE) units. This represents a slight, but non-significant improvement (Wilcoxon rank sum test $W = 62.5$, $P = 0.675$). Similarly, students were asked to rate their level of expertise with the use of mathematical models in biology before and after the course. In 2014, the mean improvement was 3.06 (0.32 SE) units (on a 1-10 scale). This year (with a greater emphasis on active learning) the mean improvement was 3.18 (0.42 SE) units. Again, this was not a significant improvement (Wilcoxon rank sum test W = 59.5, P = 0.85).

I also analyzed how students' scores on questions that related to model construction changed between the midterm and final exams. In 2014, the mean improvement was 19.3% (0.06 SE). This year (with a greater emphasis on active learning) the mean improvement was 22.0% (0.08 SE). There was no significant difference in student improvement between the years (Welch's two sample t-test t = 0.27, df = 21.5, $P = 0.79$).

Discussion

In general, students believed that the addition of more hands-on activities in lecture helped them learn. When asked directly about this, the vast majority indicated a positive response. From my own observations, students enjoyed the activities and all but a few of them engaged in the activities wholeheartedly. However, a better assessment of the efficacy of changes in course structure would be to compare measures of student learning in situations with and without the changes (i.e., with a regular lecture format, and with more active learning exercises during lecture). The best I could do was to compare whether measures of student learning differed between the two years I have taught this course. No significant differences were detected for any measure, though all showed a very slight increase this year.

It could be that using more active learning techniques does improve student learning in this course, but that the effects are slight and statistically undetectable with low sample sizes. This is an upper-level course that is regarded as a difficult one within the discipline. Students are a self-selected group, and student engagement is already high. The lab component is very much hands-on and it could be that the skills I was assessing (increases in quantitative aptitude) are learnt primarily in lab (which did not undergo any changes this year).

On the other hand, if there is truly no difference in student learning with and without an emphasis on active learning techniques in lecture, then another argument can be made for the inclusion of active learning. The exercises are fun. Students clearly enjoyed them, and with a little refinement, I believe I can integrate them into course content in a more formal and permanent way. For example, one of the papers we discussed presented a fantastic teaching opportunity that I did not notice until it was too late. The paper was a recent study that used a mathematical model to describe the dynamics of HIV, and how the disease could be nearly eradicated if antiretroviral therapy was in widespread use. During the discussion I made an offhand remark that one day, they could be working for the World Health Organization, doing interesting work (and making a very comfortable living!). Almost immediately after I said that, I realized that we had covered all the techniques used to make the model in the paper we were discussing. In fact, at the time we were reading the paper, all of the students had the tools and the ability to make the model themselves. I tried to illustrate this by sketching out the process on the whiteboard (as opposed to coding the model on a computer, which there was no time for). Most of the students saw the connection, but the lesson was off-the-cuff and not as effective as it could have been. Next time, I will combine a reading of this paper with a lab. We will discuss the model as an example of cutting-edge research. Then I will have students re-create the model based on a few techniques they have already learned (albeit in different contexts). By giving them time to work through the exercise on the computer, this will be a great opportunity for them to synthesize what they have learned. It should also open their eyes to the fact that what they have learned in the course will make many of the tools of modern research accessible.

The FLC experience was a positive one. Although the changes I made did not produce any noticeable improvements in measures of student learning, making changes did help me to think about how to improve this course (and others). In fact, I believe that the types of changes made here (more active learning) will be especially valuable to another course I teach (an introductory statistics course). I did not apply the changes because I have taught the course only once and there was no opportunity to apply these changes during the second semester of the FLC. That said, I do look forward to changing a few things next time I take the course (Fall 2015).

Introduction

YongHee Kim-Park

Name: YongHee Kim-Park
Department: Mathematics and Statistics
Class: Math 122 Calculus I
Students: 34 (initially enrolled) 22 (completed)

Background/Method

I have been teaching Math 122 Calculus I every semester for at least last 5 years. This course is known to be one of the lowest passing rated courses at the university. Grades are based on three tests, quizzes every week during activity sections (about 8-10 quizzes), homework, and final examination. Since I assign about 100 problems as homework each week, I randomly choose few problems and grade them each week. Students get 2 points for turning in rather completed homework, 1 point for turning in not so completed homework, and no point for not turning in homework each week. But outcome has not been satisfied.

In spring semester of 2015, as a part of Project of FLC, I adopted web-assign for homework as a mandatory for the course.

Hypothesis

Would web-assign homework result in better student learning than the traditional turning-in paper homework?

Analysis

I compared two consecutive spring semesters assuming those two groups of students have similar academic backgrounds. The comparison chart for tests and quiz scores is shown below.

	Test 1	Test 2	Test 3	Quizzes (8)	Overall Aver.
Spring/14 average min/med/max no. of stu=30	62.42 14/62.5/96	69.77 16/75/98	73.2 53/72.5/88	79.9 31.4/83.4/99.4	76.4 50.9/76.55/96.5
Spring/15 average min/med/max no. of stu=31	77.8 54/79/93	68.5 33/73.5/100	65.2 23/67/99	91.7 60/93.3/100	76.7 42.7/78.7/92.2

Two sample t - test was performed using overall averages of two groups. $\bar{x}_1 = 76.43$, $\bar{x}_2 = 76.69$, $s_1 = 11.114$, $s_2 = 11.284, n_1 = 30, n_2 = 31, t = -0.086$, $p - value = 0.9315$.

Results

Based on the hypothesis test, I concluded that there is not enough evidence to claim that using web-assign homework result in better student learning than the traditional turning-in paper homework.

Discussion

There are two positive results I noticed with this project. One is that students' quiz scores were significantly higher in web-assign class than the other class. The other is that there were a lot less questions about homework problems from students during activity sections. Before spring 2015, I did numerous homework problems over and over on the board at students' requests. As I adopted web-Assign homework, it reduced tremendously.

Even though the result was not statistically significant, I will definitely use web-assign homework in the future.

Faculty Learning Community Project

Enrico Tapavicza

May 2015

1 Introduction

In this study I will investigate how homework problems contribute to student learning. In particular, I will investigate the effect on changed homework conditions in the classes CHEM 377B and CHEM 371B, which both have quantum mechanics and spectroscopy as the main subject. In fall 2013 and spring 2014, I taught CHEM 377B, targeted to biochemistry students. In these classes I gave 5 and 4 homework problems, respectively. Homework was graded and the sum of all homework contributed 10% to the total grade. In the new homework format, applied in the spring 2015 class of CHEM 371B, I gave 7 homework problems. In contrast to the previous two semesters, the homework was not graded. In addition to the homework problems, previous CHEM 377B exams were given for additional practice.

As a measure to assess the effect of the changed homework conditions on student learning, I chose to monitor the total score of the final exam, which consisted in 45 questions taken from the official exam provided by the American Chemical Society (ACS). Although the classes CHEM 377B and CHEM 371B have slightly different focus, the first 45 questions of both final exams were identical and therefore provide a way to compare the current semester with changed homework setting to the old homework setting of my class.

2 Hypothesis

- The first hypothesis of this study is that increased amount of homework problems will lead to an increased number of students that successfully master the targeted student learning outcomes.
- The second hypothesis is that grading of the homework is not a crucial motivation for students to study the proposed exercise problems.

3 Methods

I will compare the score of the current spring 2015 semester with two previous semesters, fall 2013 and spring 2014. In the latter semesters, 4 and 5 homework sheets, respectively, were given. In the current spring 2015 semester 7 homework sheets were given. Since Spring 2015 was the first time I taught CHEM 371B - Quantum Mechanics and Spectroscopy, I can only compare the results to the results of the class CHEM 377B. Differences in the two classes are small: CHEM 377B provides biochemical examples for illustration of the physical chemistry phenomena, furthermore spectroscopic techniques employed in biochemistry and biophysics are the focus of the applications. CHEM 371B in contrast, focuses more on fundamental quantum mechanics and approaches the problems from a more fundamental point of view with a deeper mathematical treatment. In addition, CHEM 371B includes statistical thermodynamics, but the problems focusing on this subjects in the final exam are excluded from the analysis here.

Results will be clustered into different sections:

- Basic quantum mechanical models and phenomena (Basic QM)
- Molecular quantum mechanics (Mol QM)
- Spectroscopy (Spec)
- Molecular symmetry (Symm)

4 Results and discussion

The average number of correct answers in the CHEM 377B classes in Fall 2013 Spring 2014 were, 25.3 (56.2 %) and 26.3 (58.4 %), respectively. For the CHEM 371B class, the average of the total number of correct answers is 26.8 (59.6 %) and only slightly higher than for the two 377B class populations.

From the table below it can be seen that main contribution of the improvement of the CHEM 371B class compared to the two CHEM 377B classes arises from the section Basic quantum mechanics. In all other sections, CHEM 371B students perform worse than CHEM 377B students. An item per item analysis is given in Fig. 1- 4.

	Basic QM (22)	Mol QM (5)	Symm (3)	Spec (15)
Fall 2014	61.2	71.8	35.3	56.1
Spring 2014	60.0	66.3	37.1	60.5
Spring 2015	66.6	59.3	25.6	57.9

Table 1: Percentage (%)of correct answers of the 4 categories Basic quantum mechanics, Molecular quantum mechanics, Symmetry, Spectroscopy. Total number of questions are given in parenthesis.

However, since most ACS problems focus on Basic quantum mechanics, the overall performance of the CHEM 371B students is slightly higher.

The weaker performance in the other areas might be caused by the less amount time spend on these subjects during the lecture time.

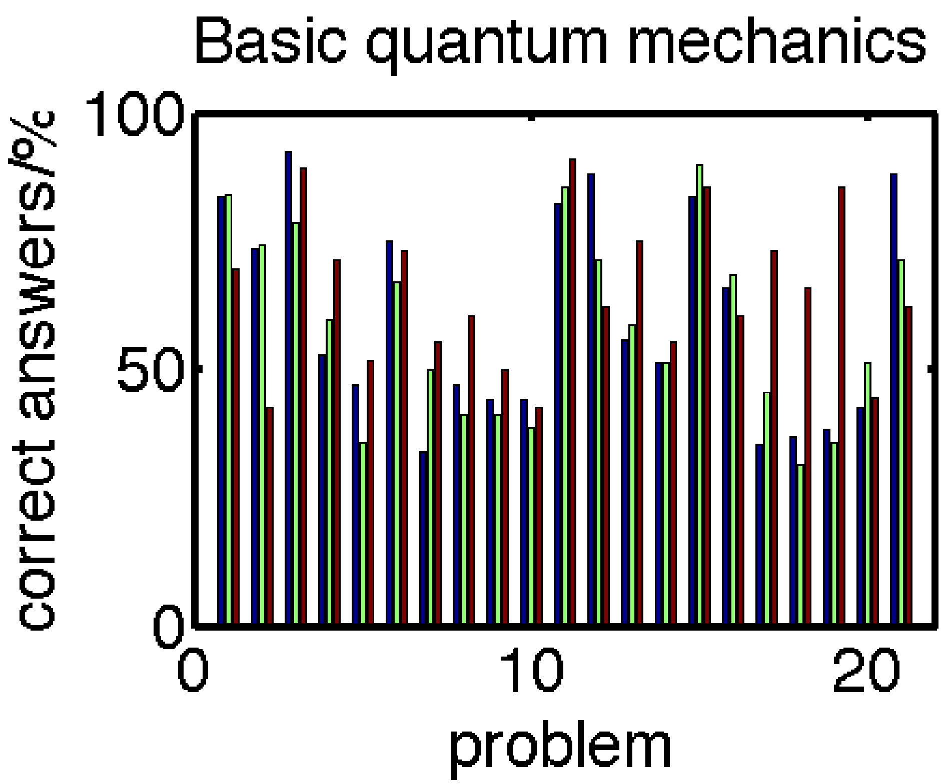


Figure 1: Percentage of correct answers per question of the section Basic quantum mechanics. Blue: fall 2013; green: spring 2014; red: spring 2015.

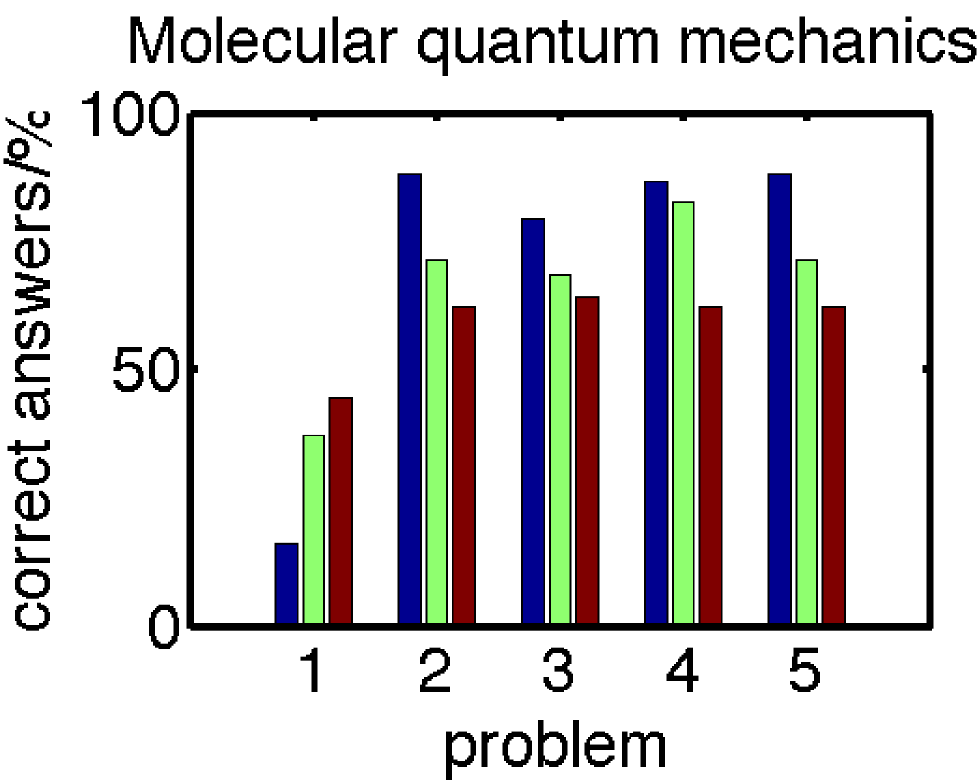


Figure 2: Percentage of correct answers per question of the section Molecular quantum mechanics. Blue: fall 2013; green: spring 2014; red: spring 2015.

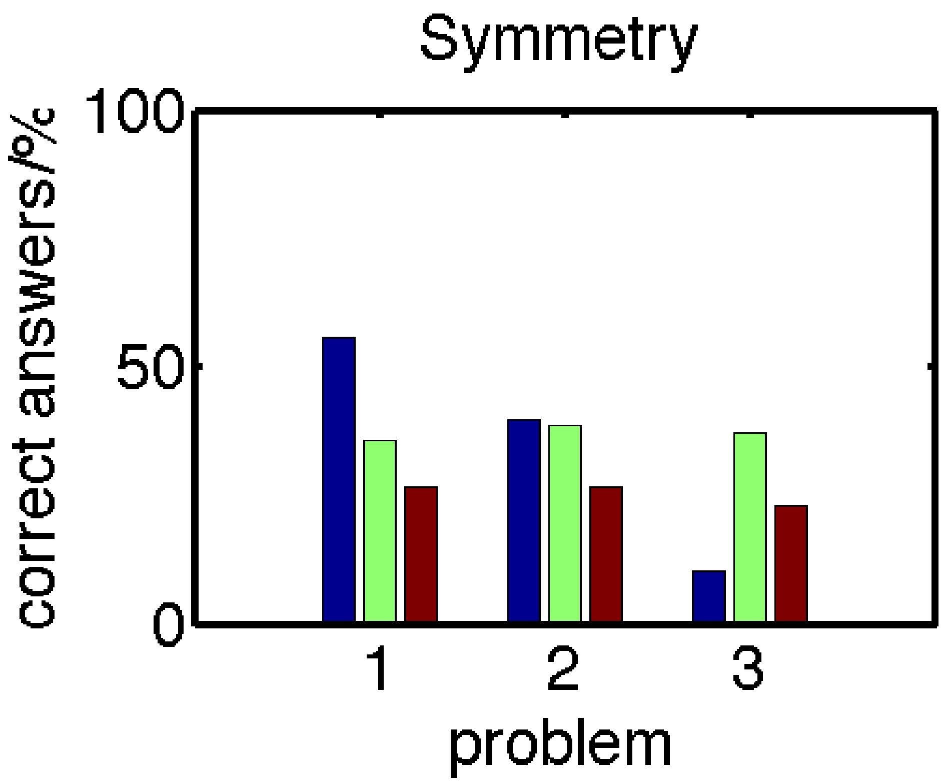


Figure 3: Symmetry

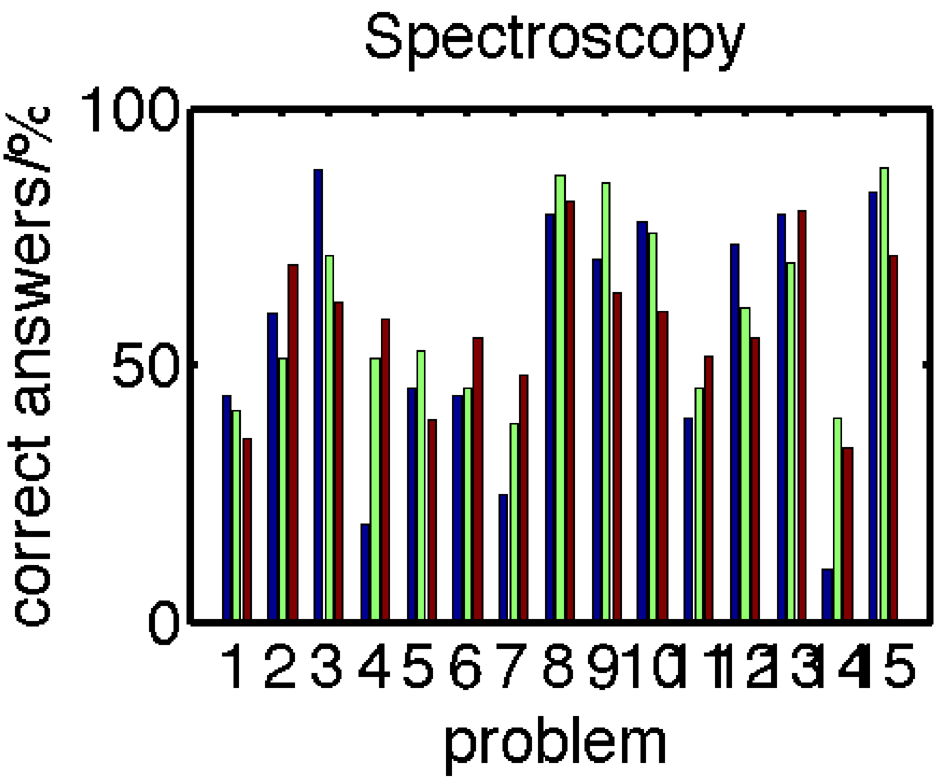


Figure 4: Percentage of correct answers per question of the section SPectroscopy. Blue: fall 2013; green: spring 2014; red: spring 2015.

Compared to the 377B classes, I spend very little time on molecular symmetry in the CHEM 371B class. Thus is it not surprising that the students were less successful in answering the symmetry questions.

5 Conclusion

Overall, the increased amount of homework problems and the fact that homework was not graded did not significantly change the final exam score. A slight improvement was observed, but there not is not enough data to allow for a valid statement.

For future classes, the data suggests that more exercises focusing on molecular QM, Symmetry and Spectroscopy should be given to improve the students performance in the final exam.

For Basic QM, an improvement in the students' performance was observed.

Ray Wilson, Biological Sciences

Engaging Students in the Classroom: A Report

Hypothesis
Certain readings from the FLC program inspired a test of enhancement methods for engaging students in the classroom; namely, by introducing more real-world applications of the lecture topics, by including a mixture of personal anecdotes having to do with subject materials, and by encouraging class attendance via attendance taking throughout the semester. My basic hypothesis is that those enhanced engagement methods, but in particular attendance at lecture, can produce demonstrable improvement of student final scores at the end of the course.

Methods
In both General Genetics (BIOL 370) and Marine Biology (BIOL 353) I posted for a time under the News feature of BeachBoard brief annotations with links to published articles related to lecture topics. In BIOL 353 I spent a significant amount of lecture time throughout the semester relating to the students my personal experiences over my 37 years in the field of Marine Biology. Finally, in BIOL 370 I took attendance periodically throughout the semester as an encouragement to attend class, but I did not do this for BIOL 353 being a much smaller class for which attendance was not at issue. The metric for success of the approaches was to be improvement, or lack thereof, in personal performance and total class performance in mastering the subject materials in the respective classes. Whereas the first two methods did not allow respective quantitative evaluations, class attendance data could be applied as a predictor for both personal and total class performance in BIOL 370. Also, for BIOL 370 I had two prior years of scoring data (2013, 2014) for comparison. For BIOL 353, 2015 being my first year of teaching the entire course, I had no good data for comparative evaluation for total class performance.

Attendance in BIOL 370 was taken 15 times. I announced the first week of class that I would be taking attendance periodically throughout the semester as part of a test of the effectiveness of attendance on student test scores as well as overall course grade, but that they would receive no credit (points) for attendance. Attendance was taken variously in three ways; by sign-in sheet, by roll call, and by notice of students being present or absent to pick up exams when brought to class for return and discussion; roll call was the most frequently applied method. Mean attendance for the 15 samples was determined for each student in BIOL 370 and a least squares linear regression of each student's total percentage score for the class against attendance was performed; e.g., 78% final grade versus 89% attendance, etc. Five outliers (of 92 students) were omitted from the regression because they served to drive results away from central tendencies. There was one student with 100% attendance but who regrettably failed the course with a very low score, and two others who had very low attendance on record but managed "C" grades, and two who had stopped attending class, and thus stopped taking exams, etc., producing a high correlation of low score with low attendance. The means of final scores for the BIOL 370 classes of 2015, 2014, and 2013 were compared using the one-way ANOVA under the null hypothesis that the mean scores did not differ significantly among years.

Findings
For neither class was there direct evidence that any students responded to my postings of real-world applications in those sciences. Had any done so, it would have remained difficult to

quantify success of that engagement method toward learning outcomes. My offerings of personal experiences and anecdotes in BIOL 353 (Marine Biology) definitely, I believe, enhanced "engagement" with the students as evidenced by questions and other signs of enhanced interest in the field of Marine Biology. Attendances were high even though I did not formally record it. There were no final grades lower than B-minus, including two A's (N=13), in BIOL 353, but that outcome was driven by completion of reading quizzes and writing assignments for laboratory. Test scores (mid-term and final) were not remarkably higher than those of other classes I've taught lacking much inclusion of personal experiences during lecture, for example, BIOL 419 (Ichthyology). Consequently, I cannot conclude that whatever engagement these methods might have produced, that there was any effect on ***exam*** scores.

Conversely, there was a demonstrable positive effect of lecture attendance on final scores in BIOL 370, although just barely. The regression of final score in percent against student attendance produced a significantly ($p = 0.046$) positive slope (Fig. 1). As can be seen, attendance was generally high, at least on the days when attendance was taken, with nearly half of the class having attendance scores over 90% (Figs 1 & 2). There was a wide range of final scores (65% to 95%) even among students with 100% attendance. However, no student with less than 100% attendance scored higher than the highest score in the 100% attendance class whereas there were students that scored lower than the lowest score in the 100% attendance class. The among-year (2015, 2014, and 2013) comparison of total scores did not show significantly higher scoring in the 2015 class versus the other two (Fig. 3). In fact, there was no difference in mean scores between 2015 and 2013, but scores from 2014 were significantly lower ($p < 0.01$) than either (Fig. 3).

Discussion

Clearly, a requirement for student engagement with a course and its offerings depends on the students' participation including attendance at lectures. At one quantitative level, students with high attendance as a group in BIOL 370 scored marginally higher than those with low attendance, although there was a wide range of scores in the high attendance classes. Whereas high attendance may have helped some students, it did not appear helpful to many others. The barely significant positive slope of the regression (Fig. 1) was no doubt enhanced by the top-performing (> 90% score) students in the class who also had 100% attendance.

The among-year comparison suggests that *attendance taking* may not be necessary to achieve high attendance if the results of the regression can be broadly interpreted. There was no demonstrable increase in scores in 2015 compared to 2013 (where attendance was not taken); so one might conclude evidence of similar attendance rates in the two years. If both 2013 and 2014 were significantly lower in scores than 2015, combined with the results of the regression, then we would have a hopeful indication that *attendance taking* might raise scores significantly *by encouraging attendance*. Still, drawing conclusions from comparisons among years is a risky exercise. For my section of BIOL 370 course materials offered in the three years were basically the same and the exams similar, but student graders were used for some exams and not others, etc. Thus, there is potential for introduction of variances in scores that might affect the outcome of a study such as this one. Consequently, agreement in final class scores between 2013 and 2015 does not mean that attendances were similar in the two years, nor does it mean that attendance taking lacks as an effectiveness tool to apply toward efforts in student engagement.

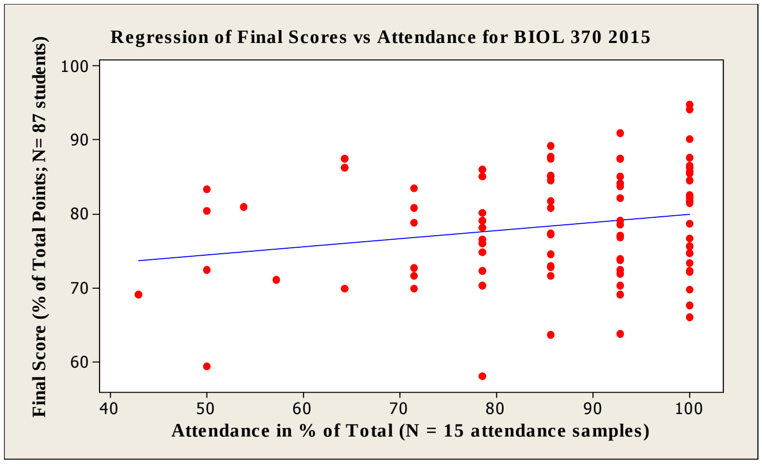


Figure 1 Least-squares regression of final score expressed as percentage versus attendance for BIOL 370 in 2015; slope of regression line is significant at $p = 0.046$.

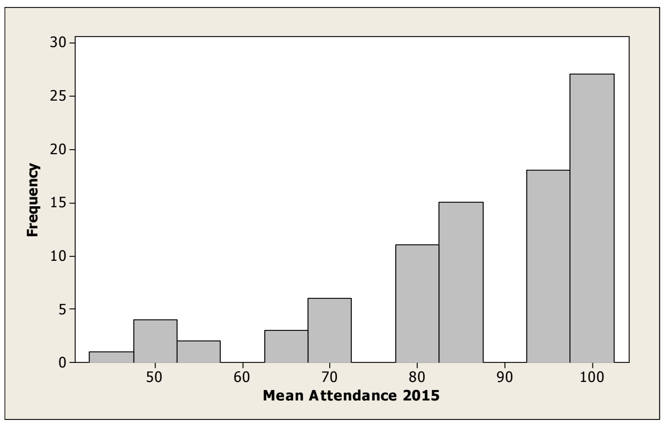


Figure 2 Frequency distribution of attendances on days taken (N=15) for BIOL 370 of 2015.

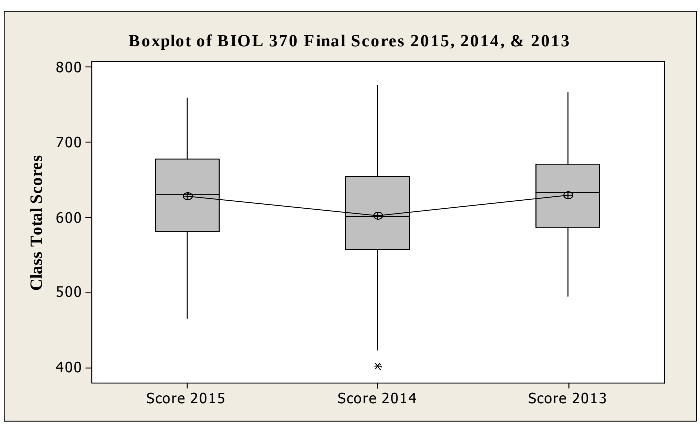


Figure 3 Boxplot for final scores in BIOL 370 in three consecutive years; attendance was taken only in 2015. Horizontal bars are the median scores; shaded areas are the interquartile range; asterisk indicates in 2014 indicates an outlier. One-way ANOVA on *mean* scores revealed Score 2014 significantly lower than that 2013 or 2015, $p < 0.01$.