STEM Faculty Learning Community
College of Natural Sciences and Mathematics
F11 Cohort Final Report

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Faculty Learning Community F12 Second Semester Report: Effecting Change

In response to the Highly Valued Degree Initiative (HVDI), a faculty development task force was developed that identified low completion rate courses in STEM disciplines as a primary area to be addressed. In addition to working at the student level, this committee suggested improvements at the level of instruction. The task force recognized that faculty in STEM receive relatively little formal training in teaching, particularly in researching and evaluating teaching and learning. They also recognized that faculty in STEM are rarely rewarded for conducting such research or implementing new student-centered pedagogical methods in their classrooms. The STEM Faculty Learning Community (FLC) project emerged from a campus need to have faculty in the College of Science and Mathematics (CNSM) engage in research and evaluation of their own courses, particularly those with low completion rates. The STEM FLC was designed by Dr. Terre Allen (Director, Faculty Center for Professional Development) and Dr. Kelly Young (Associate Professor, Department of Biological Sciences) to encourage faculty to make sustainable changes in their teaching, and to foster a culture of teaching excellence throughout the college.

The first goal of the STEM FLC was to transform the teaching and learning culture in CNSM to one where our active scientists/mathematicians are also active teachers, equipped with the latest pedagogical tools to focus on enhancing student learning. However, a secondary goal was to reduce faculty preparation for teaching time by providing faculty with background research they need regarding best pedagogical practices in STEM and peer coaches to provide a network of guidance and support. The two-semester structure of the FLC was as follows:

Semester 1: Faculty participant in the online component of the FLC researching pedagogies of engagement and developing an implementation and evaluation plan.
Semester 2: Faculty pilot & evaluate course changes (through coaching).

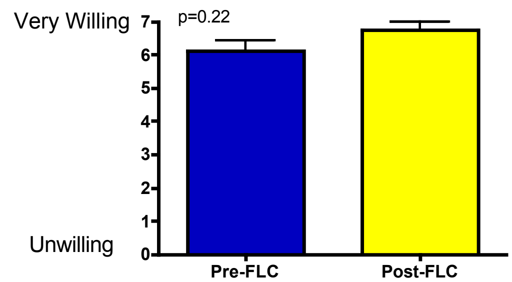
During the first semester, CNSM faculty members were asked to research pedagogical literature, identify new pedagogies of engagement, and discuss ideas and concerns with FLC peers while completing guided online learning modules. During the second semester, FLC participants incorporated reforms, evaluated the impact of those changes on student learning, grades, and retention, and reported their findings. To best appeal to the working scientists and mathematicians that make up the faculty of the CNSM, FLC participants were encouraged to form hypotheses about the potential effect of the change, to design the implementations as an experiment using "control" and "experimental" groups, analyze their data, and reflect on results. This report contains the second semester reports from those classroom changes conducted by the F11 FLC participants, and presented as hypothesis, analysis, and reflection (discussion).

Overall, CSULB's HVDI investment in STEM education and the CNSM FLC has been highly successful. Faculty participants were provided with the tools needed to provide innovative and engaged learning experiences in STEM, and they intrepidly put them to use. F11 participants report direct impact on student achievement as a result of feasible changes. Others report positive gains in student responsiveness and engagement in the difficult STEM content material. Most faculty participants also report a renewed connection with other faculty members in their College and a rekindled excitement for teaching. While the members in the FLC were previously interested in promoting student learning, many report that it was inspiring to know that there was an actual community within the CNSM with a shared interest in and devotion to teaching. Presenting the goal of increasing student learning and retention as area to be explored inspired these faculty members to problem solve like the STEM professionals that they are: they researched literature, consulted professionals, formed hypotheses, and have made thoughtful and meaningful conclusions from their results. The data presented here demonstrate that a STEM-focused FLC makes a powerful difference in faculty participants, that our faculty are willing and eager to enact change, and that these changes can positively impact student learning at CSULB.

Post-FLC Survey Analysis

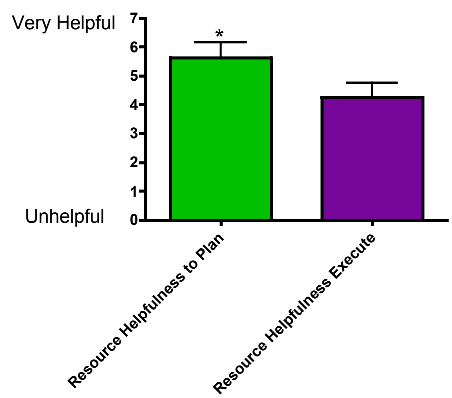
In addition to asking for formal results from each faculty member (included at the end of this report), I constructed a post-FLC survey for participants and analyzed response data. *The overall picture of faculty in CNSM is one of engaged faculty members, who see themselves as professionals that teach, eager to try new things to improve student learning.*

Figure 1
How willing were you to change?



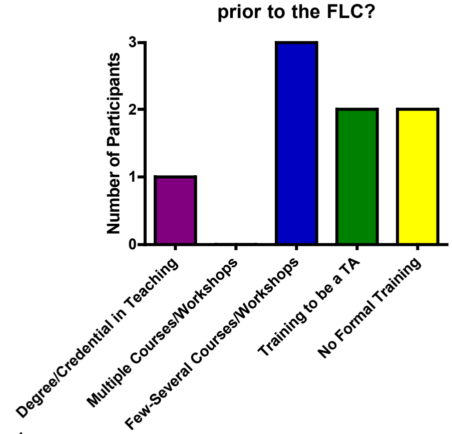
Faculty members recruited for the F11 cohort were very willing to change to improve student learning, with participation in the FLC continuing that interest (p>0.05; Figure 1). While this enthusiasm to engage in something new to improve student learning reflects the hand-selected nature of the group, this high level was also reported in our S12 cohort (see S12 first semester report). This suggests that a critical number of faculty members in CNSM are eager to try new ideas to help increase student retention and understanding.

Figure 2
FLC Resources were Helpful to Plan and Execute Course Changes



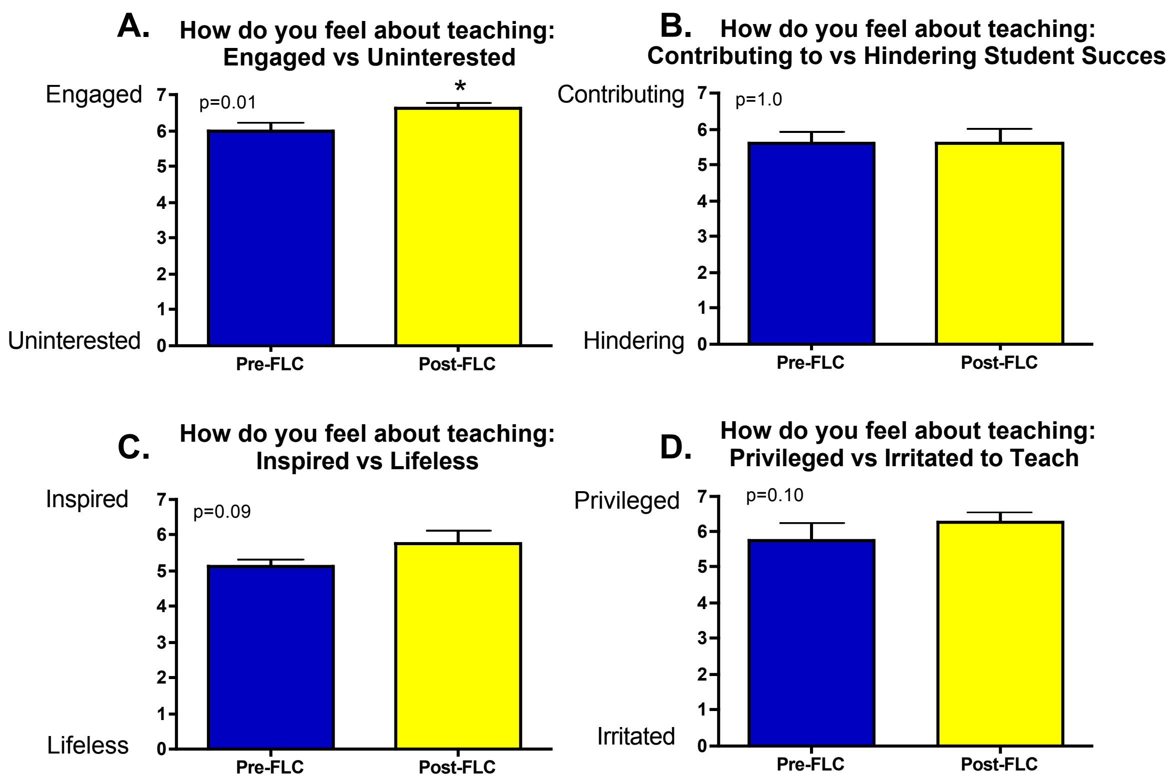
When faculty members are engaged in the online component of the FLC and planned their course changes, they appreciated the resources provided by the FLC. During the F11 semester, 100% of participants (n=8) reported that the FLC was helpful to refine teaching. These resources were found to be helpful during the planning stages of course change, and less useful during the execution of class change (Figure 2). Given that the FLC was one of only a few teaching courses/workshops to which STEM faculty members had been exposed (Figure 3), these STEM-specific resources were a critical piece of the FLC. Of the F11 participants, two had received no formal training, two had received training only to be a teachers assistant in graduate school, and three had taken 1-3 courses or workshops on teaching (Figure 3). The lack of formal training in seven of the eight participants is something that can be combated by the FLC, which harnesses the enthusiasm of CNSM faculty members to teach. We intend to allow faculty continued access to these resources, even after completion of the course change. Faculty members indicated that the changes made this semester inspired further plans to refine the course, and these resources may prove helpful in future semesters. In addition, faculty may continue to refine different courses in different semesters, so having permanent access to these resources is key.

Figure 3
Formal training in teaching prior to the FLC?



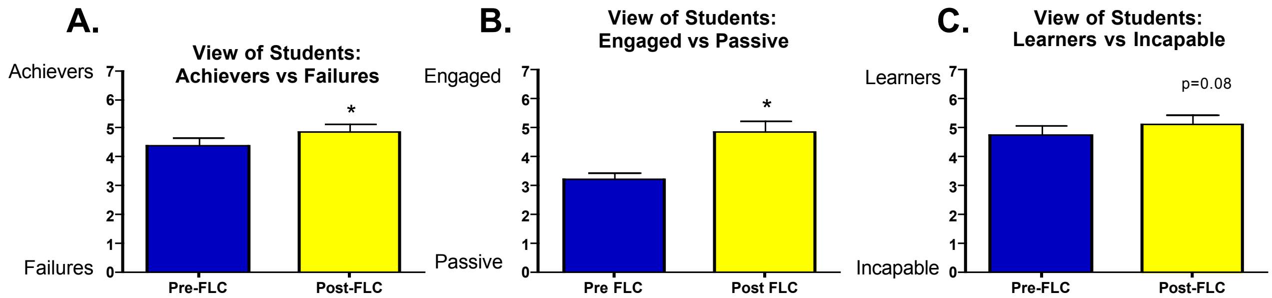
Participation in the FLC affected more than the structure of the classes taught by participants, involvement in the FLC changed faculty member's perception of themselves, their students, and their interaction with their students. Faculty members in the F11 FLC cohort came into the FLC with a high regard for teaching. The participants were highly engaged in teaching prior to the FLC, but participation in the FLC significantly increased this engagement ($p<0.05$; Figure 4a). STEM faculty members participating in the FLC also felt that they were contributing to student success, a perception that continued following the FLC ($p>0.05$; Figure 4b). Participation in the FLC fostered a trend towards increasing their feeling of being inspired to teach, although this feeling was high prior to the FLC ($p>0.05$; Figure 4c). Finally, STEM faculty participants in the F11 FLC place teaching as a high priority in their lives, as they indicated that they were "privileged to teach" both prior to and following participation in the FLC ($p>0.05$; Figure 4d).

Figure 4
How STEM Faculty View Teaching



In addition to changes in how faculty viewed themselves, participation in the FLC changed how faculty viewed their students (Figure 5). Following completion of the FLC, faculty members were more likely to view their students as "achievers" ($p<0.05$; Figure 5a). Students were also viewed as more engaged than in previous semesters ($p<0.05$; Figure 5b). Importantly, CNSM

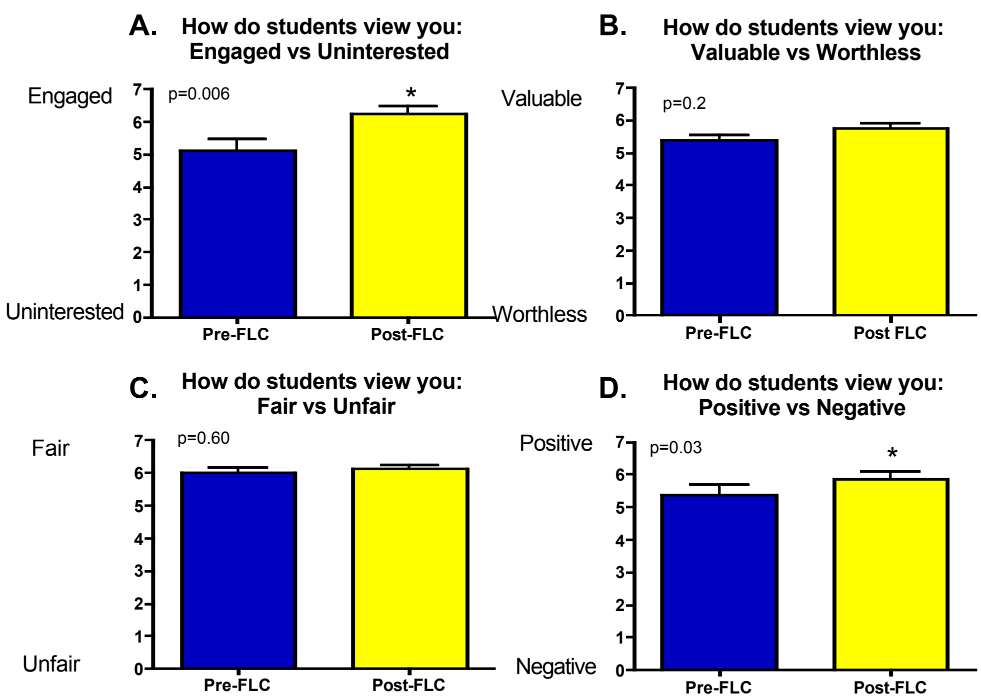
Figure 5 Faculty View of Students



faculty members view their students as "learners" and not as "incapable" regardless of participation in the FLC ($p>0.05$; Figure 5c).

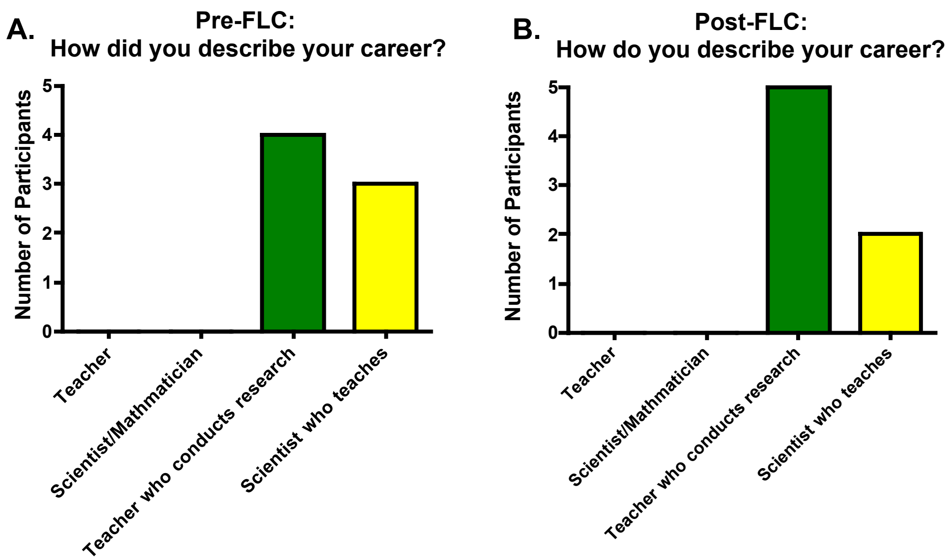
Faculty perception of how students *viewed them* also changed with participation in the FLC (Figure 6). While these are opinions of faculty members, engaged teaching means a focus on student response, so it is likely that FLC participants could identify a potential shift in how students responded to the new teaching style. Participating in the FLC significantly increased how faculty thought students viewed their engagement in the classroom (Figure 6a). Faculty also thought students perceived them as trending towards valuable (Figure 6b) and fair (Figure 6c), although participation in the FLC did not alter their perception ($p>0.05$ for both analyses). A change that did occur following completion of the FLC was the scale of positive to negative; faculty thought that students saw them in a more positive than a more negative light following completion of the FLC ($p<0.05$; Figure 6d).

Figure 6
Perception of how students view
STEM faculty pre and post FLC



STEM faculty at CSULB view themselves as professionals working in their fields who have a mission to teach (Figure 7a). Following participation in the FLC, CNSM faculty predominantly self-identified as individuals who were “Teachers who conduct research in science/mathematics”, or to a lesser extent, “Scientists/ Mathematicians who teach” (Figure 7b). No faculty members identified as a teacher or a scientist alone. This combination of teacher/working professional is critical to inspire excellent teaching, and to provide excellent training for our students.

Figure 7
How STEM Faculty View their Career



Summary of Reports, Full Reports Follow:

In Organic Chemistry (**Chem 322B**), **Dr. Stuart Berryhill** replaced one third of the lectures to devote time to learning groups where students problem solve in class with instructor interaction. Participation in the learning groups decreased low scores on a National American Chemical Society standardized exam as compared to previous semesters, and increased the average score on the exam. In addition, 77% of students found the learning group activities useful, 81% thought that this activity should be used in the future, and Dr. Berryhill reports that he is "encouraged" with the response and "glad he participated in the FLC".

Dr. Ashley Carter effected changes in his Biostatistics (**BIOL 260**) Laboratory, training five graduate students and himself in TBL- team based learning techniques learned in the FLC. Prior to introducing the material, Dr. Carter asked prepared students in the laboratories to work on quizzes by themselves and then together as groups. Overall, students found the TBL to be "somewhat" to "very useful," although they thought that traditional assignments (non TBL) would have allowed them to learn the material in a more effective way. Scores on exams in S12 trended towards an increase as compared to previous semesters, with the main effect of TBL to help the weakest students move from a D to a C grade, and an increase in Dr. Carter's overall teaching evaluation scores. Dr. Carter also discussed several issues that arose using TBL at CSULB, (such as class attendance, level of engagement, participation) which may not be an issue at other institutions. His results and discussion would be useful for others CNSM faculty members working with student groups engaged in problem solving exercises.

Dr. Jen-Mei Chang made experimental changes to her teaching technique and class design that improved grades and retention rate in both Calculus III (**MATH 224**) and Introduction to Linear Algebra (**MATH 247**). Dr. Chang created an online question-and-answer board via the website *Piazza*, and changed easier in-class quizzes to more challenging take home problem sets. The goal was to increase interaction among students and to encourage them to work for solutions themselves, rather than just receive an emailed final answer. These small changes had a large effect—with pass rates increasing by nearly 20% in MATH 247, a stunning achievement. Interestingly, students with the greatest use of Piazza (both contributions and views) earned the highest scores in the class. Dr. Chang found participation in the FLC to "rekindle" her passion for teaching and thought that it would have an "everlasting" positive impact on her desire to be a great educator.

Enacting a large number of both major and minor changes increased in **Dr. Shahab Derakhshan's** General Chemistry **(CHEM 111A)** course. Dr. Derakhshan provided students with a "recipe for success" that provided a framework on how to approach the class, including requesting frequent student/instructor interaction about the material over email or office hours. Not only did he design major changes for his section, but he also requested to become course coordinator so change could occur across all sections of 111A. These major changes included refining the material taught, designing and using activity sets, reconstructing laboratory sections, better analysis of exam answers, and working with TA and SI instructors. Minor changes included: revamping the syllabus, providing students with ultimate goals before starting each chapter, use of the early alert system, implementing additional office hours (an additional 10 hours a week to discuss graded exams), and including more interactive lecture props (models, youtube videos). These changes have resulted in an increase in a standardized exam score in chemistry that is almost 4% higher than in previous years, over 16% higher than the national average. In addition, scores on his own exams have increased in S12 as compared to previous semesters, with improvement on some questions up to 20%.

Dr. Thomas Gredig devised a method to harness the student love for social media, and converted it into a productive homework discussion board that mirrored problem solving in traditional homework for General Physics (**PHYS 100A)**. Creation and implementation of the "path to solution" discussion boards were predicated on the belief that students have an innate desire to learn. While Dr. Gredig's surveys of students indicate that the final grade, not understanding the material, was the most important student goal, students did realize a benefit from posting and reading solutions to homework problems. Students readily used the site with a total of 5045 views and 2060 comments for the 71 enrolled students. He also worked with *Dr. Jim Kissel* of Science Education to study the pattern of seeking help for homework problems, finding that students trust "expert" answers on cramster.com more than peer-to-peer solutions. Dr. Gredig's analysis of his data and ideas for future semesters can be applied across STEM classrooms that encourage students to seek the pathway of problem solving rather than merely naming the solution.

In Electricity and Magnetism (**PHYS 340A)**, **Dr Jiyeong Gu** made two major changes to her class that fostered student engagement and participation. By not providing power point copy of her notes, she encouraged students to take their own notes during class. They did just that, stopping to ask her for clarification, and becoming engaged in the lectures, which had not happened in previous semesters. She also reduced her lecture time to allow for three full periods of group problem solving, which also encouraged student interaction and critical thinking skills. These two changes resulted in midterm scores that were the highest ever on comparable exams from the last three times that she has taught the course. Dr. Gu plans to continue these changes, and follow-up with additional hands-on problem solving opportunities for students.

Using two different approaches for different courses, **Dr. Eric Haas-Stapleton** made major changes to both molecular cell biology (**BIOL 340)** and virology (**BIOL 416/516)**. For BIOL 340, Dr. Haas-Stapleton provided audio recordings of his lectures and PowerPoint slide sets so students could review the lecture as needed. In addition to adding short answer to multiple-choice exams, he also used several low-stakes quizzes to assess student learning. In particular, his use of iclickers+think/pair/share, where students only get the points when >75% of the class had the correct answer is a unique and effective method to encourage students to talk to neighbors to understand a question. While no change was noted in grades or retention rate, both students and Dr. Haas-Stapleton were more engaged with the material and the class in general. In BIOL 416/516, use of assigned group quizzes for team-based learning did have an effect on student success. Dr. Haas-Stapleton devised an effective method for creating balanced learning groups and assigning tasks within the groups. This is a method that can be applied to upper division courses across the CNSM. The learning group activities engaged students, increasing affect, and positively changed Dr. Haas-Stapleton's perspective on teaching.

Dr. Xuhui Li reformed the GE course Precalculus Algebra (**MATH 113**) by incorporating an online program (ALEKS) with self-paced mathematics tutorial/practice exercises, by making lectures more dynamic with multimedia, and by using learning groups during lecture to actively involve students in problem solving. As a result of these changes, midterm scores improved, in particular for those students who completed the entire ALEKS learning modules. The same increase was also observed in those students who participated in all of the in-class exercises and discussions. These changes are sustainable and he plans to encourage future students to fully partake of the opportunities for learning in the class to increase their scores. For Dr. Li, the FLC was "helpful" and he was encouraged by finding many other STEM faculty members in the CNSM who were "interested in and devoted to improving teaching and learning."

CNSM Faculty Learning Community Final Report

Introduction
Stuart R. Berryhill
Department of Chemistry and Biochemistry
Chemistry 322B Organic Chemistry (second semester of two semester sequence)
Course enrollment was 60 (4 students dropped and received a W)
Is this typically considered a low completion rate course? Yes

Hypothesis
The class was organized into four-student learning groups. About every third lecture roughly half the course meeting time (30 – 35 minutes) was devoted to solving two or three problems in the learning groups. The groups were asked for their answers, and the students discussed these answers after a group was chosen to put their answer on the board. I usually also gave some further comments about the problem and any incorrect approaches that I had observed while circulating among the groups. I have taught this course a number of times, and I tried to choose learning group problems that I thought would illustrate concepts that have typically have been difficult for many students in the course to master. During the last few learning group sessions I used problems from the study guide for the American Chemical Society standardized exam that I used for the final. The groups were polled for their answers, and I gave some further discussion about strategies for answering the types of problems they would encounter on the final.

Results
I used two approaches to assess the effectiveness of the learning group sessions. The first was a comparison of the class performance on the standardized final exam with that of the class I taught in Spring 2011, which did not use the learning groups. The faculty teaching the organic chemistry courses have used the ACS standardized exam for a number of years in Chemistry 320B, which is the organic sequence for chemistry majors. I used the exam as the final for the first time in the non-majors Chemistry 322B in Spring 2011.

Standardized exam results (70 question multiple choice):
81 students in Chem 322B Spring 2011 – scores 11-60 (average 37)
55 students in Chem 322B Spring 2012 – scores 22-59 (average 39)
The ACS reports a national average of 39.5 for scores reported to them for the version of the exam that was used.

The second method of assessment was a short, anonymous questionnaire given to the class at the end of the semester to get some feedback about the student response to the learning group sessions (43 questionnaires returned).

Question: Were the learning group activities useful to you?
Yes – 33, No – 10

Question: Do you think this type of activity should be continued in the future in Chem 322A/B?
Yes – 35, No – 8

Question: Were there certain topics for learning group problems that weren't discussed this semester that you wish had been covered?
Yes – 19, No – 19

For the no answers to the first two questions, several students included the comment that the time spent on the sessions had taken too much time away from the lectures. For the third question many of the "yes" responses also mentioned particular topics, but no specific topic was mentioned more than a few times.

Discussion

I plan to use the learning groups when I teach both Chem 322A and Chem 322B. The student response was positive, and I enjoyed the breaks from the traditional lecture format and got useful feedback from the students while interacting with the groups when they were discussing the problems. I don't think that the score comparison on the standardized exam with just one other class is perhaps very meaningful, but I was encouraged that with this class I didn't see some of the extremely low scores that I saw with the class a year ago.

I am glad that I participated in the FLC. I learned quite a bit about strategies for improving student engagement in courses by reading the materials posted during the fall semester. Some of the things that I read prompted interesting conversations with my colleagues, even those not participating in the FLC. It is easy to get discouraged when faced with lack of student interest or engagement when teaching a class. Spending time learning about teaching techniques and trying some new strategies was, and I hope continues to be, productive for me as an instructor.

CNSM Faculty Learning Community Final Report

Introduction
Name.
Ashley Carter
Department.
Biology

Name and number of class where development occurred:
Bio 260, Biostatistics

Number of students in the class:
167 initially enrolled, 156 grades given

Is this typically considered a low completion rate course?
I think so. Many students do struggle in this introductory course.
From 167 students starting course 140 received A/B/C grades (16% drop/fail rate).

Hypothesis

I decided to try the team based learning (TBL) activity described in the FLC course where students take individual quizzes followed immediately by the same quizzes in assigned groups. The goal of these activities is to foster group discussion and active learning via conversation among the students in the groups. I also added group activities using the same student groups.

The course has over 160 students in a large lecture hall with only 50 minutes available for lecture, so these activities were done in the 3-hour long TA-led labs that the students took concurrently. The TBL quizzes and activities were discussed in weekly TA meetings and I instructed TAs on how to perform the TBL activities, exposing the five graduate TA students to new teaching methods.

Lab grading in previous versions of this course came from 2 large individual quizzes (25% of total), 2 full lab period exams (50% of total) and weekly homework assignments written separately by each TA for their labs (25% of total). This semester the weekly assignments were removed, and the 10 individual and group TBL quiz scores were used for the 25% of the grade. In addition, the same quiz was used in all labs and written by the TAs and myself (each TA did one week per lab they were assigned, and I did the first and last quiz).

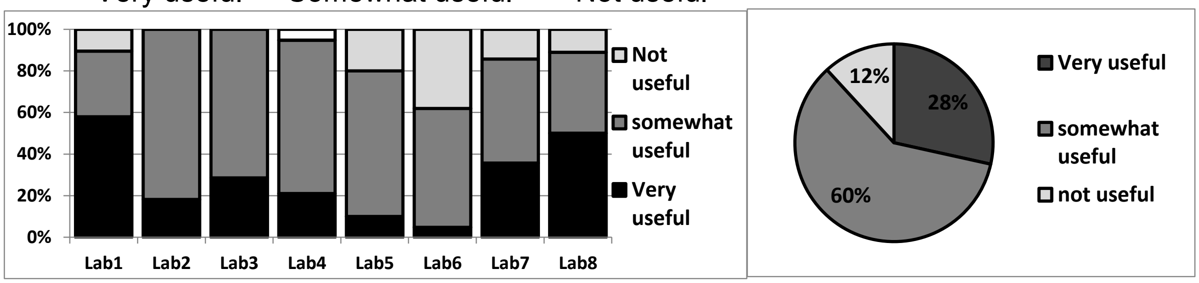
My hope was that the quizzes would increase lab preparation, increase interest and create the active learning aspect the FLC videos discussed. On the first week I attended all 8 labs and explained the purpose of the TBL activities to the students. During the penultimate week (their lab exam was during last week) I attended all 8 labs and had students complete TBL evaluation forms (see appendix A). Each TA was also asked to complete an evaluation form (see appendix B), 4 of the 5 TAs returned completed evaluations.

Results

Tallying the responses on the student evaluations (appendix A) gives the following data:

(1) Did you find the TBL quizzes to be a useful method to encourage you to prepare for the labs and learn the material? (circle one)

Very useful   Somewhat useful   Not useful

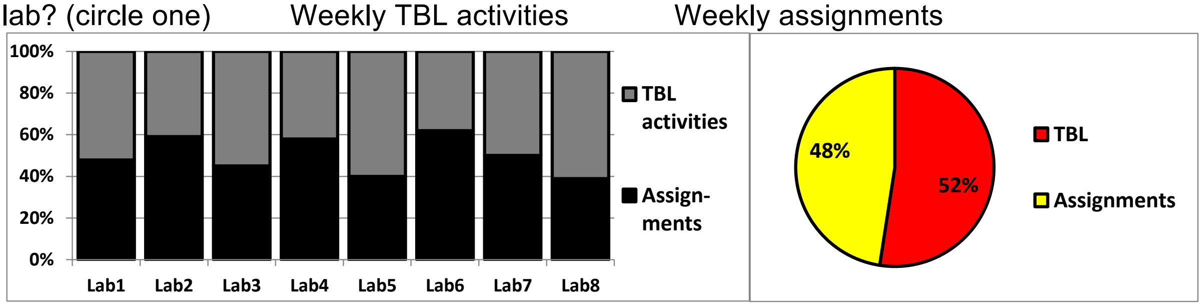


By lab section   Overall

The results of this question indicate that most students found the TBL activities either “somewhat” or “very” useful. I am unsure why 12% of students believed that having quizzes was not helpful for learning the material; perhaps they are expressing a feeling that it is unfair to test them on knowledge before they receive it in lab. A number of student evaluations did suggest that quizzes be done after lab or about the previous week's topic - contrary to the central purpose of the TBL design, but more consistent with after-the-lecture assessments that students are used to.

Note that Lab #6 was instructed by a TA teaching this course for the first time which may account for lower scores than for the other labs that were taught by TAs with at least 2 semesters of prior experience.

(2) If you could choose, would you prefer the weekly individual and group TBL quizzes used this semester or weekly assignments from your TAs without quizzes to start each lab? (circle one)   Weekly TBL activities   Weekly assignments

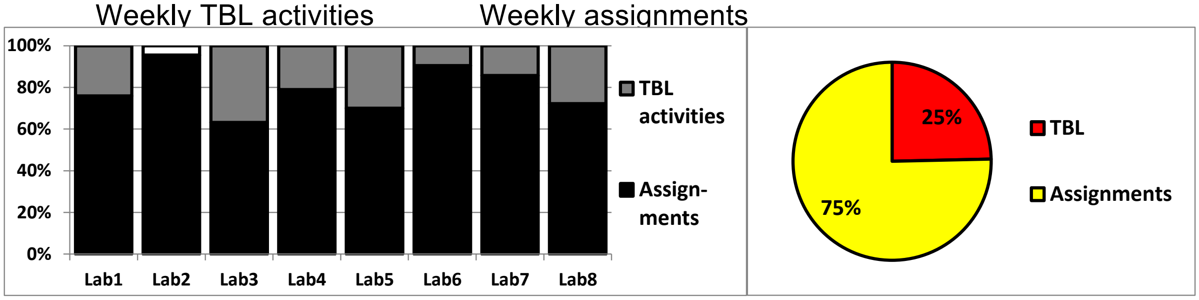


By lab section   Overall

The results of this question indicate that student opinions of their preference for TBL quizzes versus assignments were split, with roughly half preferring each method.

(3) Being honest, which of the two types of activities described in question (2) do you think would have helped you learn the material the best? (circle one)

Weekly TBL activities   Weekly assignments



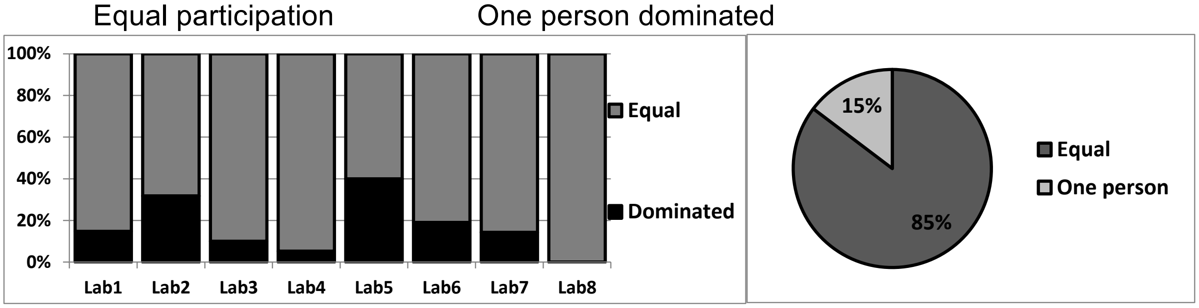
By lab section   Overall

These results indicate that students believe they would have learned more with traditional assignment than with the TBL quizzes.

Combining this with the responses on question 2 this seems to indicate that at least 25% of the class feels that although they would learn more with assignments they would prefer to have the TBL activities. This tension between what students prefer to do (and are therefore easily willing to do) and what they acknowledge aids their learning is something that I have a hard time addressing. For example, these data would imply that having students do assignments would assist their learning but would result in lower teaching evaluations than TBL activities if evaluations measure enjoyment instead of learning (which they may well do in today's customer model of education).

(4) Did you find that the members of your group participated fairly equally or did the same person do most of the work on each group quiz or activity?

Equal participation   One person dominated

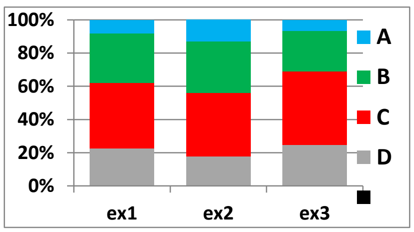


By lab section   Overall

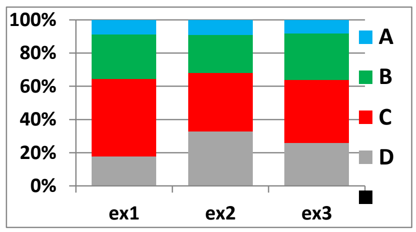
These results indicate that students generally believe that most group members contributed equally. This data seems to differ from that reported by 3 of the 4 TAs in their evaluations in which students specifically mentioned that some group members were not contributing equally, and that this was a serious issue. Years of experience have shown me that many students are very hesitant to criticize one another's participation, even anonymously, and the results of this question therefore underestimate the inequality that occurs with group assessment.

Analysis of lecture exam performance.

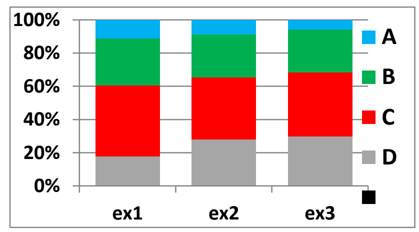
An analysis of the grade distributions suggests that there may be a slight effect of the TBL activities raising the grades of more poorly performing students. Since new exams are used each semester, the exam means fluctuate from exam to exam and year to year which makes direct comparison of raw scores meaningless. The standard grading for this courses uses a scaling based on the Z score to assign letter grades that effectively rescales the mean to 75% with a standard deviation of 10% (students with higher raw scores retain these values). Examining the number of A, B, C and D grades (F grades are typically due to exams so terrible they arise from the personal problems of a small number of students and can skew results, so these are omitted) that arise from scaling the grades for the spring 2010, 2011 and 2012 courses provides the following distributions.



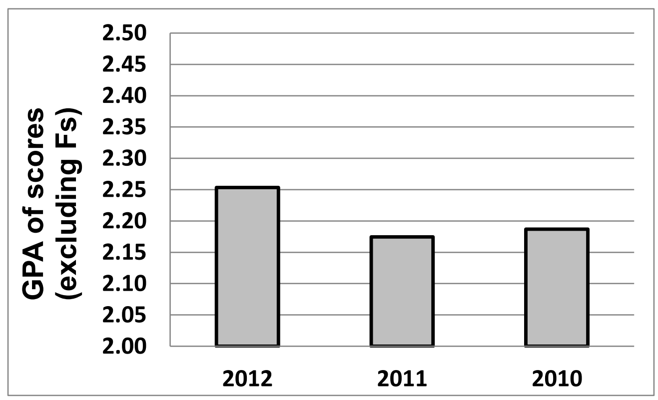
2012



2011



2010



The overall GPA was also calculated for the three semesters. While non significant, overall GPA in the course did trend towards an increase in 2012 as compared to other years (non significant; *3 unpaired heteroscedastic t tests*). However, this increase is consistent with the visual pattern showing fewer D grades in 2012 than in 2010 and 2011. Interestingly, the total number of A and B grades remain fairly level in the set of three figures above. These results are consistent with the TBL activities helping the weakest students; a process in which some students that would have previously performed so poorly as individuals relative to their peers, that they would have received D grades received C grades instead. Having group assessments prevents these extremely low scores, as the low performing students can rely on other group members to supply answers.

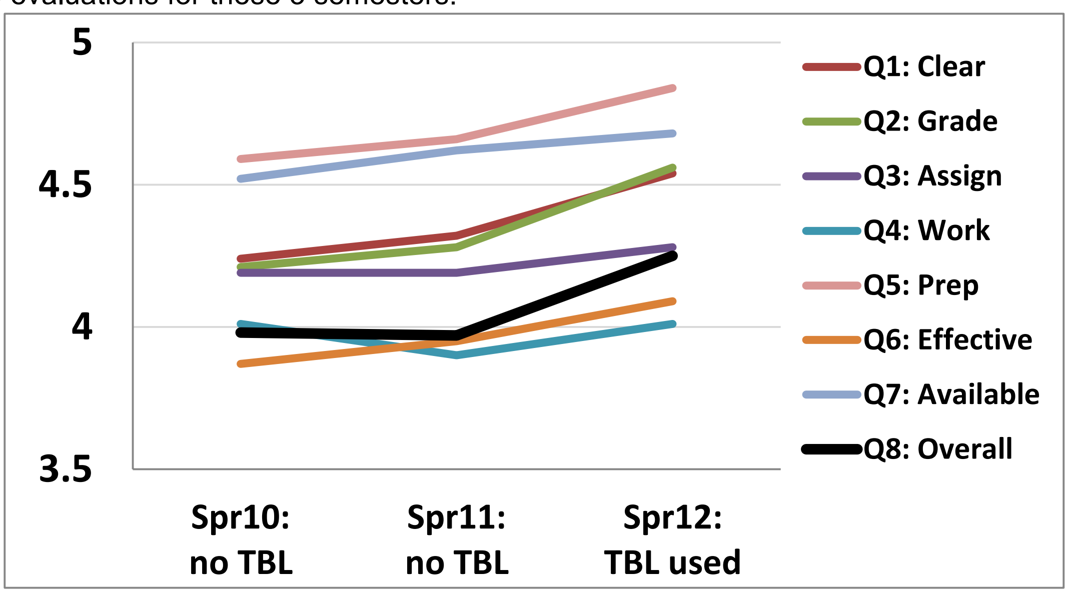
Anecdotally, I have performed a separate study testing an active learning activity in the biostatistics course and saw non-significant, but suggestive, evidence of a similar effect from that active learning activity. For that activity there was no apparent effect on the better students, but evidence consistent with a slight benefit to the weakest students.

Analysis of student evaluations.

An analysis of the student evaluation scores suggests that incorporation of the TBL activities have increased the scores on student evaluations. I have instructed this course in the springs of 2010, 2011 and this year with fairly similar enrollments and course structures (same number of exams and homework assignments and grading policies). The only concrete course change from the last two years to this year was the use of the TBL activities in lab instead of TA assignments.

Students assign scores on each of the following questions, 5 is positive, 1 is negative:
Q1: "The instructor provided clear and accurate information regarding course objectives, requirements, and grading procedures."
Q2: "The instructor's grading was consistent with stated criteria and procedures."
Q3: "The instructor provided assignments/activities that were useful for learning and understanding the subject."
Q4: "The instructor's expectations concerning work to be done in the course were reasonable."
Q5: "The instructor was well prepared for classes."
Q6: "The instructor was effective in presenting subject content and materials in the class."
Q7: "The instructor was available during posted office office hours for conferences about the course."
Q8: "Rate the overall effectiveness of this instructor in this course."

The figure below shows the teaching evaluations cores for the 8 questions used on CSULB evaluations for these 3 semesters.



The scores for every question show an increase from the previous offerings, consistent with a more positive impression of the course by the students.

Discussion

Looking at the analyses described in the results section I think that the use of the TBL activities may have resulted in modest learning improvements in the weaker students and increased overall student satisfaction with the course experience as a whole.

I will consider these TBL activities for future semesters, but with several changes.
- Using shorter quizzes and a mechanism to move the quizzes along more rapidly since the most common student complaint was the time required. I think the TAs are used to being polite and waiting until everyone says they are ready, but that this extra time was excessive. Adding strict time limits will move things along, and reduce student complaints about the long timeframe of the quizzes.
- With shorter quizzes I will use a pool of questions and assign different ones to each lab to reduce the communication problem described in the evaluation by TA#4
- I will set a more severe penalty for missing a lab and failing to help the group. This is because of the following point that the TAs and I noted:

> In the videos about the TBL activities provided by the FLC, much was made of having stable and good sized groups from the very start of the semester, but nothing was really described about how to handle the real world of students. Many do not commit to classes until the 2nd or 3rd weeks and are constantly absent even if they do "commit". Some students at CSULB miss class often, even when their grades depend on attendance, this penalizes their group mates. I have the feeling that these techniques tend to be developed at institutions with higher attendance rates; perhaps some investigation into best practices for dealing with poorly motivated students would be useful.

- I will use some of the lab questions on the lecture exams to encourage review and the making of connections between the lab material and lecture material (a common problem students have).
- I will make it more clear to the TAs that they not alter the format. Near the end of the semester I discovered that one of the TAs was passing out printed sheets with the questions instead of projecting the quizzes and synchronizing the process as recommended by the FLC material.

Reading the TA comments and my own impressions of how this went has prompted some concerns about the ability of weaker students to parasitize stronger ones on TBL activities. Several TAs mentioned this and I know this is a common problem with activities like this although the individual grades help even this out. I would be curious to know what the solution is in a case in which half a group doesn't contribute. I asked student to evaluate one another's' contributions as suggested by the FLC resources; however, virtually all student responses indicated equal contribution, as did the overall evaluations did as well. However, several students complained individually to the TAs that contributions were actually unequal.

These comments may seem negative, but overall, I feel like participation in the FLC program has introduced me to several new techniques I plan to use in the future. I plan to spend the summer dividing my syllabus into two documents - the technical syllabus and a mission statement document per a recommendation of the FLC material. My next offering of one of my upper level elective courses will almost certainly be completely redesigned along TBL lines and will make use of the new classroom on campus.

Carter Appendix A: TBL evaluation given to students

Bio 260 Spring 2012: Team Based Learning (TBL) evaluation

As I described during the first week of class, this semester we changed the format of the Bio 260 labs to replace weekly assignments made by each TA with standardized TBL quizzes and activities you participated in. Part of the assessment of this change includes gathering feedback from you, the students. Please answer the questions below so that this course can be improved for future semesters.

Thanks,
Ashley Carter

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(1) Did you find the TBL quizzes to be a useful method to encourage you to prepare for the labs and learn the material? (circle one)

Very useful   Somewhat useful   Not useful

(2) If you could choose, would you prefer the weekly individual and group TBL quizzes used this semester or weekly assignments from your TAs without quizzes to start each lab? (circle one)

Weekly TBL activities   Weekly assignments

(3) Being honest, which of the two types of activities described in question (2) do you think would have helped you learn the material the best? (circle one)

Weekly TBL activities   Weekly assignments

(4) Did you find that the members of your group participated fairly equally or did the same person do most of the work on each group quiz or activity?

Equal participation   One person dominated

(5) What were the most useful aspects of the TBL activities this semester?

(6) What do you think can be done to improve TBL activities like the ones used in this class?

Carter Appendix B: Verbatim TA evaluations. (TA names have been replaced with numbers)

Team Based Learning (TBL) Evaluation - TA #1

(1) Please describe any problems or negative aspects of the TBL activities done in lab.

- *Uses up lab time*
- *I feel the students get a bit "worn out" by doing the quizzes and this might contribute to them zoning out once the quiz is done.*
- *It replaces graded assignments, meaning people might not look at the problems they need to solve on the exams until they get them*
- *I feel bad about quizzing them on something BEFORE they are taught it*

(2) Please describe any benefits or positive aspects of the TBL activities done in lab.

- *Gets students to prepare better for lab*
- *Gives students immediate feedback on their understanding*
- *Emphasizes certain important concepts and misconceptions*
- *Promotes discussion about the concepts*

(3) In your opinion was the performance on the lab quizzes and exams this semester better or worse than in previous semesters and how do you make this judgment?

- *I think it was about the same. I find it hard to do direct comparisons because I'm still trying to get a feel for how hard I should make the quizzes and exams, so I don't think the quizzes were necessarily of the same difficulty as previous semesters.*

(4) As a TA, do you prefer conducting the TBL activities or conducting the labs as they were performed in previous semesters?

- *I think it is about the same. The TBL activities require less grading time, but use up more time in class. Overall the TBL activities do take up less of my time as a TA.*

(5) Please provide any additional comments you may have about the TBL activities here.

- *I do think they were helpful*
- *Perhaps cutting them down to 5 questions would help prevent burnout*
- *Another option might be to just do the team quiz, but then the free-rider problem becomes more severe*
- *While the TBL quizzes are good for emphasizing concepts, they are not designed to teach how to perform the analyses which is what they need to do on the lab quizzes and exams*
- *Perhaps graded group lab analyses, or some form of team activity more heavily focused on using Minitab*
- *Maybe giving people the lab assignments to complete with their group at the end of the lab*

Team Based Learning (TBL) Evaluation - TA #2

(1) Please describe any problems or negative aspects of the TBL activities done in lab.

- *Several groups had students who were either shy, quiet or lazy and did not seem to participate in the group discussions on a regular basis.*
- *Many groups seemed to have one or two people who contributed to the TBL portion while others were passive*
- *With the TBL structure, it was difficult to have enough time to spend with the students helping them solve problems*

(2) Please describe any benefits or positive aspects of the TBL activities done in lab.

- *The students came to class with a proficient knowledge of what we were going to cover that day and were able to follow what we covered in the introduction much better.*
- *Sometimes the students used the exercises as intended and spent time meaningfully discussing the question and the content*
- *I LOVED not having to grade assignments every week.*

(3) In your opinion was the performance on the lab quizzes and exams this semester better or worse than in previous semesters and how do you make this judgment?

The students performed much differently on the exams this year compared to past years. There weren't really all that many middle of the road exams, unless the student was unable to finish the exam. There were students that did very well and students that did very poorly. The dedicated students did well regardless of the format. The poor students did even poorer than I remember. There were more questions on the exams that were either left completely blank or almost completely blank. The students that didn't put in the work were more clueless when it came to the exams than I expected them to be.

(4) As a TA, do you prefer conducting the TBL activities or conducting the labs as they were performed in previous semesters?

There are advantages and disadvantages of both. I would like to see a hybrid of the two. I do not care to spend hours and hours grading homework assignments every week. However, I don't want to leave the lower performing students behind completely either. I would like to try to do shorter quizzes (maybe 5 questions) then assign points to whether the students participate in the lab activity. I had lots of students leave immediately after the quiz on more than 1 occasion and they seemed to do the most poorly on the exams (although I guess they deserved low scores anyway).

(5) Please provide any additional comments you may have about the TBL activities here.

Doing the quizzes on the board seemed to be a little frustrating for the students because many students ended up waiting for a few who couldn't decide what they wanted to do for the individual quiz. Some students were very quick and others were not. Perhaps we could give the individual quizzes on paper then give the TBLs on powerpoint? I guess there may be no way to account for the differences in reading and thinking time among students even if the questions are on paper. Overall there seemed to be a lot of wasted time for certain students who waited for others to finish.

Team Based Learning (TBL) Evaluation - TA #3

(1) Please describe any problems or negative aspects of the TBL activities done in lab.

Not all group members participated equally in answer discussions for quizzes
Some students missed labs which impaired their group as a whole for the daily quiz
Not all students utilized their group members when they had a problem with the sampling activities/exercises

(2) Please describe any benefits or positive aspects of the TBL activities done in lab.

The quizzes forced the students to read the lab manual ahead of time---however I didn't notice an improvement in their understanding of the lab material or computer software ability
There was a lot of lively discussion during the group quizzes which I think benefitted students by developing their critical thinking skills

(3) In your opinion was the performance on the lab quizzes and exams this semester better or worse than in previous semesters and how do you make this judgment?

For one of my lab sections I think that the lab quizzes and exams were comparable to my previous semesters of teaching—the overall quality of work of the "A" students was very similar to those in previous semesters and the students who received D's or F's had similar quality of work to previous semesters as well. In addition, I did not see a %change in the number of students receiving any one grade—I still had a strong bi-modal curve in my grade distribution as in most of my previous semesters.
For the other lab section, I think that the overall performance of the class was worse than in previous semesters. The first quiz and lab exam went fairly well but the second quiz and second lab exams had F and D averages, respectively. This was based on their quality of work—many more of these students seemed increasingly confused on the lab material and computer software. However, this section still displayed a bi-modal grade distribution (but I had a higher % of students receiving C or lower grades).

(4) As a TA, do you prefer conducting the TBL activities or conducting the labs as they were performed in previous semesters?

I liked the group quizzes and think that it should be incorporated into lab again. However, I would not add in group quizzes in lieu of homework—on all my previous semester evaluations my students commented that the homework was very useful for their understanding of the material. Not having required homework assignments seemed to put these students at a disadvantage.
I think that assigning people to groups worked well versus having students pick their own groups. I think students "goofed around" less and that overall, people utilized their classmates more for minor problems/questions rather than bog me down the whole time with relative unimportant Minitab questions.

(5) Please provide any additional comments you may have about the TBL activities here.

No answer given

Team Based Learning (TBL) Evaluation - TA #4

(1) Please describe any problems or negative aspects of the TBL activities done in lab.

I had one student in my lab (Mondays 5-8pm) who was receiving answers to the TBL quiz from a student in the earlier lab (Mondays 2-5pm). I know this for a fact because a saw a boy in my earlier lab talk to the girl in my lab. It's not that hard to figure out that the quizzes in all lab sections are the same because you post the answers on your website.

TBL quizzes will benefit the weaker students who rely on the smarter student. I had one group where there was a really smart student grouped up with 3 not-so-smart students. For the individual quiz, the smart student would get a perfect score, whereas her 3 group members would average 30%. So, for the group quizzes, every member of the group would then get a perfect score because the 3 not-so-smart group members would just tell the smart member to do the group quiz by herself. I considered the group quizzes to be too large of a percentage of the overall lab grade; this opinion is based upon the fact that the variance of my exams and major quizzes would be small.

If I were to guess, most of the student evaluations for the TBL activities state that they hated the TBL quizzes.

The activities were not helpful at all. For example, the first activity was about accuracy and precision; it was where the students measured various corks. I know that your ideal situation is where the group members would debate on the size of the corks. But in reality, no one cares. The students just want to get the activity over with since they and I know that the activity seems pointless.

(2) Please describe any benefits or positive aspects of the TBL activities done in lab.

There are no positive aspects of the TBL activities. You probably thought that they might seem successful due to the fact that Yale and medical and pharmacy schools do group work; group activities at these schools are indeed a great learning tool. However, the big difference is that the students at these schools are at nearly at the same level, academically. Whereas, in CSULB, you get a wide range of academic abilities because there are some really smart students who can't afford to go to top schools, so they choose to go to CSULB instead. And, there are many not-so-smart students, which you will not see at places like Yale or medical and pharmacy schools.

(3) In your opinion was the performance on the lab quizzes and exams this semester better or worse than in previous semesters and how do you make this judgment?

This is my fourth semester teaching Biostatistics. After performing a one-way ANOVA on my grades, I can conclude that the performance of my lab quizzes and exams was not statistically significant. Meaning, the students overall seems to perform the same in all of my semesters. My grade distribution throughout 4 semesters is approximately 20% A's, 30% B's, 30% C's, and 20% D/F (These grades are the COURSE grade [not just my lab grade]).

(4) As a TA, do you prefer conducting the TBL activities or conducting the labs as they were performed in previous semesters?

I prefer to conduct the labs as they were performed in previous semesters. However, it depends on the TA. Some TA's don't know how to teach, so maybe the TBL activities might teach the students better than the TA. I, on the other hand, like to teach the way I want to. My class always scores higher than the average, and I would like to think that it is because of me.

(5) Please provide any additional comments you may have about the TBL activities here.

If you do group quizzes next semester, you should try to have different quizzes for each lab section, so students do not copy from an earlier lab (which is spread out over 4 days!). Either that or "make them believe" that the quizzes between the lab sections are different.

Jen-Mei Chang CNSM Faculty Learning Community Final Report Fa'11 – Sp'12

This report is organized by Jen-Mei Chang in the Department of Mathematics and Statistics at California State University, Long Beach, in response to my participation in the CNSM Faculty Learning Community during the fall 2011 – spring 2012 period.

Background Information
The courses where I applied the training received from the Faculty Learning Community are *MATH 224: Calculus III* (39 enrolled) *an MATH 247: Introduction to Linear Algebra* (38 enrolled). Both courses are extremely diverse in student demographic and majors (e.g., 15 distinct majors in MATH 224 and 9 distinct majors in MATH 247). MATH 247 is not typically labeled as a low-completion-rate course while MATH 224 is. In particular, the average deviation of pass rates in MATH 224 across all sections is nearly 45% in the past 3 years with the lowest of 41.9% observed in Fall 201 (Merryfield, 2012).

Changes Implemented
Two noticeable changes I implemented in spring 201 include
1. Use of discussion platform (Piazza) to allow collaborative learning and instant instructor-to-student and peer-to-peer feedback
2. Use of challenging take-home quizzes to reinforce conceptual and procedural learning.

Minor changes were also made to selective lessons to better orchestrate difficult ideas. Students from previous semesters expressed to me that graded assignments can help them stay o task and prevent them from falling behind with the material. Therefore, I designed ten weekly take-home quizzes (for both classes) to highlight what I consider as the most important concepts during the week's lessons and encourage students to work collaboratively in arriving at solutions. These take-home quizzes are more challenging than the recommended homework problems from the textbook and emphasize the process of explanation instead of merely steps of computation. The hope was that (1) students become more comfortable sharing ideas and learn from each other's way of thinking; and (2) students become aware of my expectations of their accomplishment.

The use of Piazza facilitates the constant communication between the students and me. On the first day of class, students were told not to email me with their class-related questions; instead, they should post questions directly on Piazza to solicit help from their fellow classmates. The goal of incorporating this tool was to alleviate the instructor's effort to repetitive questions and allow students to form learning community among themselves. My hypothesis was that students learn better from each other and are more likely to stay engaged when they study in groups.

Observations
Piazza was used more frequently in MATH 224 while more students from MATH 247 attended office hours. Either way, I felt that students were having fun when they studied math and attended classes. In fact, only out of 3 people in my MATH 24 dropped while the rest of the class attended lectures religiously. The usage of Piazza in MATH 224 declined as the semester progresses and I suspect that it boils down to two reasons: (1) students have (via Piazza and in-class activity) formed study groups and prefer to study face-to-face; and (2) other classes have

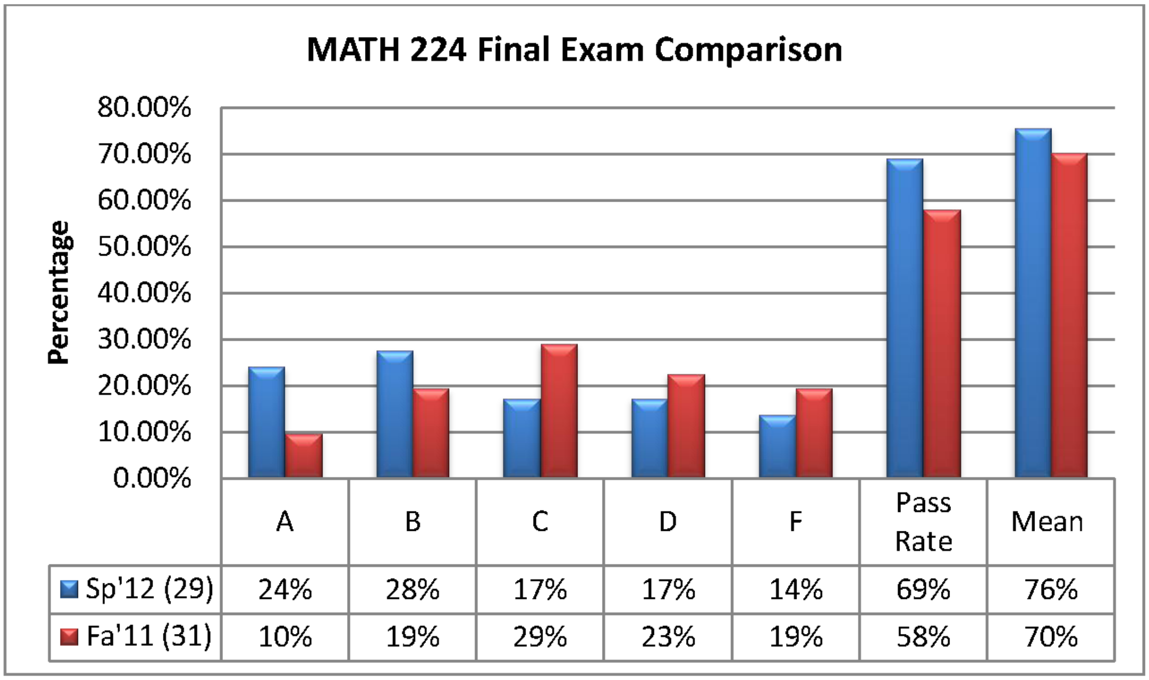


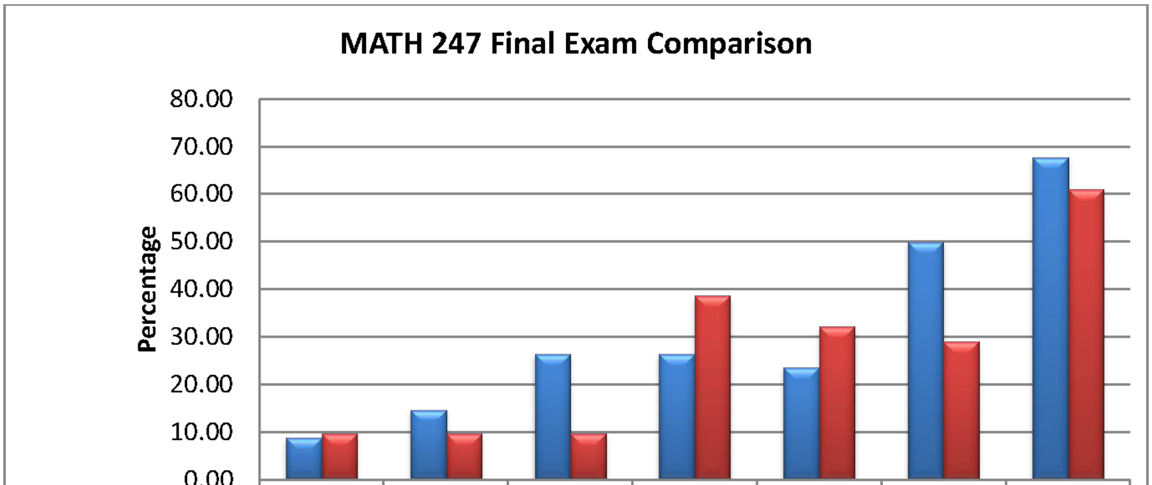
Figure 1. comparison of the final exam grade distribution for MATH 224: Calculus III between spring 2012 and fall 2011. Notice the higher percentage of A's and B's, overall mean scores, and the pass rate in spring 2012.

become more demanding hence the time dedicated to their math course is sacrificed. To ensure consistent involvement in the online collaborative learning environment, students will need to be held responsible in some way, such as points awarded or penalized. I am planning on talking to others more about how to actually implement this in the future in order to fully capitalize the benefit of the tool.

Take-home quizzes worked great. Nearly all students in both classes indicated in the self-administrated midterm and end-of-semester evaluations that take-home quizzes facilitate and further solidify their learning of new materials. These practice problems allow them to apply new concepts in novel settings and really force them to understand the definitions and results that lead up to the answers. The time it takes to design a single take-home quiz ranges between 3 minutes to an hour, which in my opinion, is not very time-consuming and since the problems can be reused again, the effort will not be duplicated. In return, though not exclusively so, these short but meaningful take-home problems attribute to higher exam grades in both classes.

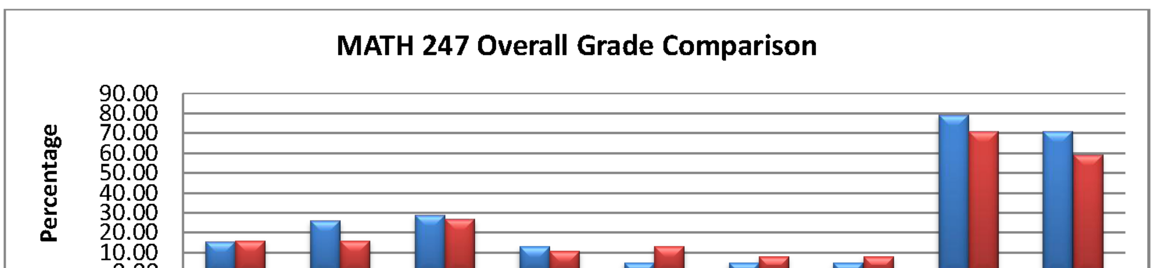
When ideas are reinforced through meaningful exercises throughout the semester, the trickle-down effect becomes pronounced in students' performances o final exams, see e.g., **Figure 1** and **Figure 2** where the overall mean scores for both classes are about 6 percentage points higher. Furthermore, not only the pass rates o the final exam for both classes are higher, it is nearly 20% higher in MATH 247.

Overall, the two proposed strategies helped improving students' exam scores (all mean exam scores are higher in spring 201 in both classes). However, as the retention rate in MATH 247 was improved, as illustrated in **Figure 3** it does not seem to be effective in lowering attribution rate in MATH 224, as shown in **Figure 4** My suspicion is that Calculus relies heavily on



	A	B	C	D	F	Pass Rate	Mean
Sp'12 (34)	8.82	14.71	26.47	26.47	23.53	50.00	67.66
Fa'11 (31)	9.68	9.68	9.68	38.71	32.26	29.03	61.10

Figure 2. comparison of the final exam grade distribution for MATH 247: Introduction to Linear Algebra between spring 2012 and fall 2011. Notice the higher percentage of B's and C's, overall mean scores, and the pass rate in spring 2012.

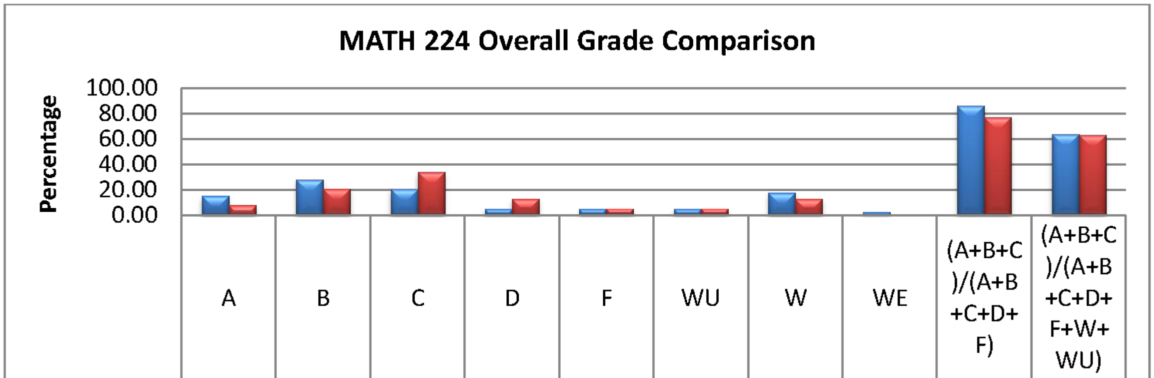


	A	B	C	D	F	WU	W	(A+B+C) /(A+B+C +D+F)	(A+B+C) /(A+B+C +D+F+ W+WU)
Sp'12 (38)	15.79	26.32	28.95	13.16	5.26	5.26	5.26	79.41	71.05
Fa'11 (37)	16.22	16.22	27.03	10.81	13.51	8.11	8.11	70.97	59.46

Figure 3. A comparison of the overall grade distribution for MATH 247: Introduction to Linear Algebra between spring 2012 and fall 2011. Attention should be drawn to the higher retention rate and the higher percentage of B's and C's in spring 2012.

computations and procedures, and therefore more graded assignments will need to be given on regular basis in order to force students to stay o task. I have already thought of a way to try this out in the future.

Moreover, being the third semester of a four-semester Calculus sequence, there is a huge variation in terms of what information students retained from their prior Calculus experiences. Students have already established work ethic and study habit when they reach Calculus III that are not easily altered. Nevertheless, students indicated that they are very open to my inquiry-based teaching/learning strategy and believed that they will benefit a lot more in the long run in developing problem-solving skills.



	A	B	C	D	F	WU	W	WE	(A+B+C)/(A+B+C+D+F)	(A+B+C)/(A+B+C+D+F+W+WU)
Sp'12 (39)	15.38	28.21	20.51	5.13	5.13	5.13	17.95	2.56	86.21	64.10
Fa'11 (38)	7.89	21.05	34.21	13.16	5.26	5.26	13.16	0.00	77.42	63.16

Figure 4. comparison of the overall grade distribution for MATH 224: Calculus III between spring 201 and fall 2011. Attention should be drawn to the higher percentage of A's and B's in spring 2012 and the comparable pass rate shared between the two semesters.

Discussion

have been experimenting different teaching strategies on a regular basis in different level of classes ever since I started teaching. I am not so afraid of something not working since I learn the best from mistakes; instead, I am more worried about the time commitment for a new paradigm shift. This semester, I kept everything else more or less unchanged and invested the time to write those challenging take-home quizzes. Maintaining the online discussion forum, namely Piazza, was minimal effort o my part. The exam scores collected in both classes were indicative in the positive impact these two approaches have on the students' understanding of course materials. I am certainly more encouraged to try something more large-scale in the future, such as completely flipping a classroom.

FLC provided me with structural guidelines in framing my pedagogical ideas and common language in communicating with others about those ideas. My involvement with the CNSM FLC rekindled my passion for education and initiated my desire to become a greater educator. It is n doubt that the impact it has o me will be everlasting. I am certainly thankful for the opportunity and appreciate the efforts devoted by the organizers for making this possible. I can only hope that more faculty members can benefit from this enlightened experience.

My two cents for others to try new ideas in their own classroom would be to solicit constant student feedback and to have a careful design of assessment. Students are the ones why we do this in the first place and they will also be the ones who can tell us whether something is working or not. One of the most important things I have realized from my experiences is to really listen to students – whether it is their misconception of concepts or suggestions for how to improve their own learning experience.

Shahab Derakhshan

Chemistry 111A

Overview:

CHEM 111A is the first half of a two-semester general chemistry course. It covers most of the fundamental aspects of chemistry including atoms and elements, electronic structure and periodic properties of atoms, chemical formula and nomenclature of molecules, chemical bonds in molecules, chemical reactions and stoichiometry, thermo-chemistry, properties of gases, liquids (solutions) and solids. I have taught this course twice, once in Fall 2010 and once in Spring 2012. In spring 2012 I had two lectures of Chem 111A and I also was the course coordinator. In the first section I will describe the nature of course as well as my previous experience then I will discuss the changes I made and finally I will explain the results of the changes based on the latest assessment.

Pedagogical Approach and Method:

Student Learning Outcomes: In this class students master a number of concepts critical for understanding chemistry: Measurement, accuracy and precision, significant figures, unit conversions, elements, compounds, homogenous and heterogeneous mixtures, physical and chemical changes, atomic models, sub-atomic particles, isotopes, atomic numbers, atomic mass, mole, molar mass, molecular compounds, ionic compounds, chemical formula, nomenclature, empirical formula, molecular formula, chemical equations, chemical reactions, stoichiometry, limiting and excess reactant, theoretical yield, percent yield, solutions, molarity, dilution, neutralization reaction, titration, combustion reaction, double displacement reactions, solubility, electrolyte and non-electrolyte solutes, single displacement reaction, activity series, oxidation reduction reactions, thermochemistry, system surrounding and universe, energy flow, endothermic and exothermic reactions, heat capacity, specific heat capacity, molar heat capacity, heat transfer, work and energy, calorimetry, enthalpy, Hess's law, electromagnetic radiation, wave characteristic, photoelectric effect, emission spectra, Bohr's model, de Broglie equation, quantum mechanics, orbitals, quantum numbers, energy shells and sub-shells, electronic configuration of atoms, shielding penetration and effective nuclear charge, periodic table, diamagnetism and paramagnetism, periodic trends in atoms, atomic and ionic size, ionization energy, electron gain enthalpy and electron affinity, metallic character, chemical bonding, Lewis structure, ionic bond, lattice energy, Born-Haber cycle, covalent bond, octet rule, single double or triple bond, electronegativity, polar and non-polar bonds, bond dipole moment, , formal charge, resonance structures, bond energy, bond length, VSEPR model, molecular geometry, polar and non-polar molecules, sigma and pi bonds, valence bond theory, hybridization, molecular orbital theory, LCAO approach, bonding, non-bonding and antibonding molecular orbitals, bond order, paramagnetic molecules, pressure in gassoeus state, Boyle's law, Charles' law, Avogadro's law, ideal gas law, molar volume of gasses, gas density, STP condition, Dalton's law of partial pressure, kinetic molecular theory, average speed, effusion and diffusion, real gasses, intermolecular forces, gasses liquids and solids, dispersion forces, dipole-dipole attraction, hydrogen bonding, ion-dipole interactions, vaporization, vapor pressure and imf, boiling point, Causius-Claperion equation, melting point, phase changes, phase diagrams.

Method: My primary method of instruction was based on power point slides and extensive in-place writing on transparency projector. I used iclickers in class to get feedback on understanding level of class about the taught subject. This enabled me to go back and explain the material again when it was needed. I used the “Mastering Chemistry” website for online assignment/quizzes. I also used beachboard as the primary communication tool with students and also as a resource for course documents (syllabus, course note slides, practice tests, etc.) and assessment (grade center).

The slides were posted on beachboard before the lecture so that the students could download and study them before coming to the class. There were numerous blanks in the posted slides and those empty spots were filled as the lecture was progressing. This way I was able to keep them interested and engaged in discussions. I used a great deal of in-class writing in conjunction to the power point presentations to encourage the students to follow the material step by step. This way they had more time to think about the material. The students were expected to understand the concepts that were presented in lectures and apply them in online homework quizzes, and exams.
Throughout my previous interactions with unsuccessful lower division chemistry class students, I had learned that their main complaint was the large amount of material required and that it was too much to master in a short period. They were telling me that at some point of the semester they were unable to follow the connections within and between content, and they decided to memorize the material instead. Such an idea unfortunately passes around and is adopted by other students, and the result is that a large fraction of students think that memorizing material is a common practice in a chemistry classes. Accordingly, as my first challenge, I chose to change this false belief.

The very first commitment that I made to my students was that I would teach this class in such a way that they could succeed the course with almost no need for rote memorization. In the first day of my lectures I gave them a ***recipe for success*** and told them that if they commit to this agreement, they will have a very high chance of getting a good grade. The recipe for success was simply defined as trying to *understand* each concept and relate concepts together to build up the big picture. For each chapter I gave the ultimate goal first and ask them to follow me in the journey towards that goal. This was only possible with numerous after class discussions as well as a lot of practice. Therefore, I asked them to come and see me in my office as soon as they felt that they couldn’t make the connection to the final step. Using “Mastering Chemistry” provided a large number of questions in different levels of difficulty for each chapter and gave my students ample amount of time to think about them. Although their work was graded for points, I gave them the option to come and check their answers with me during the office hours. During their visit I was asking them some related questions, which would give me a chance to detect their weakness and clear those up. For the entire semester, they were expected to complete over 650 multiple choice and short answer questions in online quizzes.

Assessment:

During the lectures we did iclicker-based in-class quizzes, which I found to be very efficient tools for immediate assessment. We also performed online homework using Mastering Chemistry for each chapter. By checking the average score of the class and comparing those and class performance on some selected individual questions with those of national level, I was able to monitor their progress.

Before the final, I administered three in-class exams. Before each test I provided a practice exam without a key. Students discussed the practice test with their TAs during the lab section. After discussions I posted the key on the beachboard.

I started using the ACS standardized test for Chemistry 111A final exam (Form 2005) as an additional way to assess overall learning outcomes in Fall 2010. This semester, I was enthused as

I noticed that my students performed much better than the national level. The average score for an entire pool of 4524 individuals from the following 39 schools was 40.35/70 (~57.6%) and for my class was 48.3/70 (~69%).

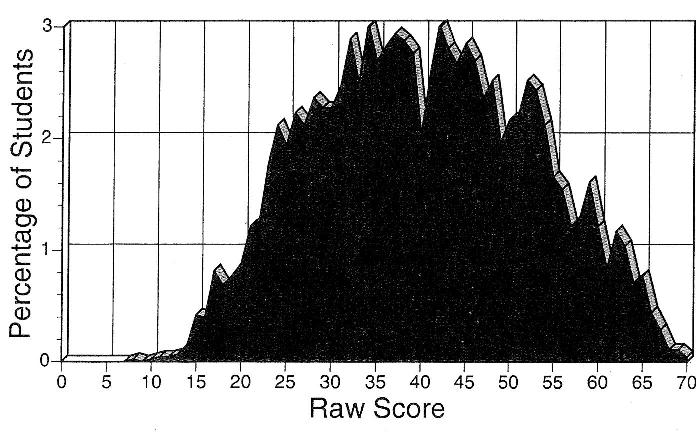
SCHOOLS SUPPLYING DATA FOR NORMS AND ITEM STATISTICS

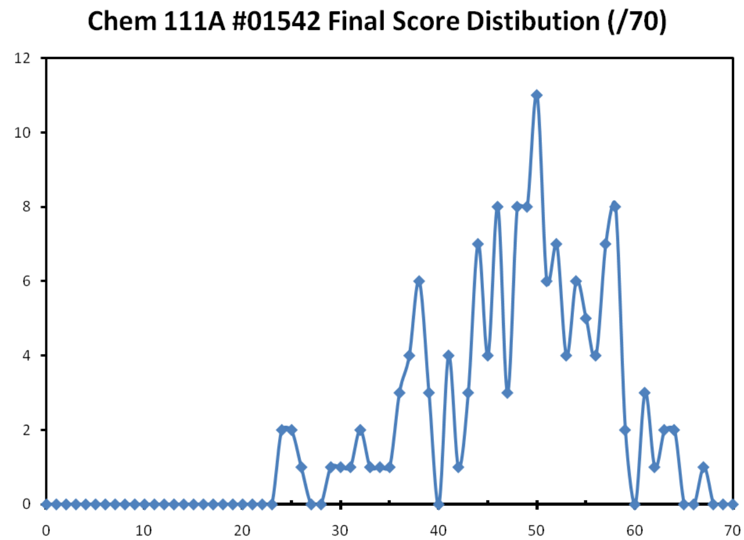
University of Akron / *Akron, OH*
University of Alaska - Anchorage / *Anchorage, AK*
Amarillo College / *Amarillo, TX*
Bethel College / *North Newton, KS*
Carson-Newman University / *Jefferson City, TN*
Central Michigan University / *Mount Pleasant, MI*
Community College of Baltimore County / *Baltimore, MD*
Colby College / *Waterville, ME*
Florida Southern University / *Lakeland, FL*
Front Range Community College / *Westminster, CO*
Iowa State University / *Ames, IA*
Jefferson Community College / *Watertown, NY*
Harrisburg Area Community College / *Lancaster, PA*
Lebanon Valley College / *Annville, PA*
Lincoln Land Community College / *Springfield, IL*
University of Massachusetts - Boston / *Boston, MA*
Messiah College / *Grantham, PA*
Middle Tennessee State University / *Murfreesboro, TN*
University of Missouri – St. Louis / *St. Louis, MO*
Monmouth University / *West Long Branch, NJ*
Moravian College / *Bethlehem, PA*
University of Nebraska – Omaha / *Omaha, NE*
Northern Idaho College / *Coeur d'Alene, ID*
Northeastern State University / *Tahlequah, OK*
New Jersey Institute of Technology / *Newark, NJ*
Ohlone Community College / *Freemont, CA*
Old Dominion University / *Norfolk, VA*
Pacific Lutheran University / *Tacoma, WA*
Pima Community College / *Tucson, AZ*
University of San Diego / *San Diego, CA*
Santa Barbara City College / *Santa Barbara, CA*
St. Ambrose College / *Davenport, IA*
Seminole Community College / *Sanford, FL*
College of Southern Idaho / *Twin Falls, ID*
Southwestern University / *Georgetown, TX*
Spring Hill College / *Mobile, AL*
Stephen F. Austin University / *Nacogdoches, TX*
Waldorf College / *Forest City, IA*
University of Wisconsin – LaCrosse / *LaCrosse, WI*

American Chemical Society Division of Chemical Education
Composite Norms – General Chemistry First Term Form 2005
(Revised, July 2007)

Score	Percentile	Score	Percentile	Score	Percentile
70	100	45	63	20	4
69	100	44	61	19	3
68	100	43	58	18	2
67	100	42	55	17	2
66	99	41	52	16	1
65	99	40	50	15	1
64	98	39	48	14	0
63	97	38	45	13	0
62	96	37	42	12	0
61	95	36	39	11	0
60	94	35	36	10	0
59	92	34	33	9	0
58	91	33	31	8	0
57	90	32	28	7	0
56	88	31	25	6	0
55	87	30	23	5	0
54	85	29	21	4	0
53	83	28	18	3	0
52	80	27	16	2	0
51	78	26	14	1	0
50	76	25	12	Mean	40.35
49	73	24	10	Std. deviation	12.26
48	71	23	8	Median	39.53
47	69	22	6	KR-21 reliability	0.90
46	66	21	5	Std error/meas	3.89

Based on the scores of 4524 students in 39 colleges.





The overall grade distribution and GPA for the class:

Grade	Range	Frequency
A	88-100	20
B	77-88	62
C	66-77	42
D	55-60	16
F	<55	5
GPA	2.524	

I scanned the scantrons again and obtained the statistics on an itemized base. First I focused on the questions with lowest response:

(a) Over 40% of the class had the wrong answer to 21 questions out of the 70 possible:

1) There was a question about the concept of phase transition from liquid to gas, boiling, with 84% wrong answers (question #9).

2) There was a question on significant figures (question #4) (combined addition and division) with 78% wrong answers. (This subject is not covered in lectures and is discussed only in lab activity sessions).

3) A question on concept of resonance structures of an organic molecule (question #64) with 67% wrong answers.

4) A question on periodic trends in atomic properties (question #54), with 65% wrong answers.

5) A question on concept of ΔH_f (question #37), with 65% wrong answers.

6) Another question on periodic trends in atomic properties (question #58), with 63% wrong answers.

7) A question on identification of polar molecules along with prediction of the molecular geometry, (question #60), with 63% wrong answers.

8) A question on calculation of average atomic mass (question #53), knowing the abundances of two isotopes, with 55% wrong answers.

9) A question on quantum numbers and orbitals (question #46), with 54% wrong answers.

10) A question on relation between lattice energy and solubility (question #61), with 53% wrong answers.

11) A question on mass measurement (question #70), with 53% wrong answers.

12) A question on electronic transition energy, Bohr's model (question #49), with 52% wrong answers.

13) A question on identification of oxidation states (question #11), with 49% wrong answers.

14) A question on molecular geometry (question #62), with 47% wrong answers.

15) A question on ΔH of reaction (question #40), with 46% wrong answers.

16) A question on concept of mixture (question #8), with 46% wrong answers.

17) A question on limiting reactant (question #20), with 46% wrong answers.

18) A question on ionic concentration in a solution from two compounds with a common ion, (question #27) with 44% wrong answers.

19) A question on effusion rate of a gas, (question #33) with 44% wrong answers.

20) A question on nomenclature of an oxo-acid (question #2), with 43% wrong answers.

21) Another question on ΔH of reaction, with 42% wrong answers (question #42).

There were 30 questions in test for which, at least 80% of the overall population were able to answer, correctly. These questions cover materials such as nomenclature, writing chemical formula, density, writing and balancing chemical equations, stoichiometry and quantitative analysis of the reaction products, percent yield, mass percent of element in a compound, identification of the reaction types, concentration and dilution in solutions, titration, gas law, electronic configurations in atoms, identification of covalent and ionic compounds, Lewis dot model, identification of σ and π bonds in molecules and hybridization.

Clearly there is a strong correlation between this observation and the difficulty level of the subject materials. We spend a great deal of time on elementary and fundamental concepts such as chemical reactions, mole, and concentration to prepare them to the next classes. Most of the laboratory activities are designed based on these materials, for which students get additional support. There are materials such as Quantum mechanical model and thermochemistry that are considered as the most difficult part of the curriculum. Due to the time constraints we spend only two weeks on these two chapters. I think this is an area that should be considered for improvement. Designing an extra activity on Quantum mechanical models followed by periodic trends in atomic properties would benefit student learning in this area. An interesting point is that there is a lab on calorimetry so students do some extra activity on calculating the heat capacity of their known and unknown metals. The only thermochemistry question from the test that they successfully answered (76% correct answers), was exactly on the same topic. My other suggestion to the Freshmen Chemistry Committee was to move chapter 12 (colligative properties of solutions), which is more relevant to the second semester chemistry, to Chemistry 111B. Having an extra week of instruction by moving chapter 12 to Chem 111B, would improve the quality of the lectures in weaker areas.

For Spring 2012 I was appointed as course coordinator and I requested the department chair to give me two lecture sections so that I could implement the suggested changes more easily. Most of the following changes were also adopted by other instructor, Dr. Lee-Lin, and we managed to have a uniform set up for all four sections on Chem 111A.

a. Minor changes

1) I started with the syllabus and tried to revise it so that its tone sounded more friendly and encouraging. I tried to change the (false) idea that Chemistry 111A is designed to fail students. In my first lecture I told them every single person *can* potentially earn an “A” if they follow the *recipe for success* agreement on the syllabus. I also elaborated more on student learning outcomes. In addition, I used the SLO section as a very nice study guide for students.

2) Teaching in the HSCI 100 lecture hall enabled me to use the whiteboard and projector simultaneously. This allowed me to eliminate using the transparency projector for in-place-writing and spend more time on board. I believe a nice blend of powerpoint slides with more frequent use of the board was a more effective method to engage students.

3) We started using the early alert system on beachboard to send automatic warnings to the students who performed poorly in first homework online quiz and also to those who didn’t perform well on the first exam. Different versions of messages were designed and sent to the different target groups. Depending on their grades, students were asked to change their study habits or consult with CNSM advising center.

4) We didn’t return their first exam. Therefore, meeting in office was the only way for them to review their tests. During the two weeks after the first exam I had over 20 hours of extra meeting with students. They came in groups of ~5 to meet with me to go over the test with them. Some had deficiency in math skills, some didn’t read the problems properly, some were lacking time management skills, and some had difficulty with the concepts. Depending on the type of problem, I gave them personal advice.

5) I booked HSCI 100 each Friday at noon and I had a Q & A session as an additional instructional hour. This weekly session was particularly beneficial for those students who had schedule conflicts with my office hours.

6) To engage students during lecture, I showed several youtube videos during some lectures on concepts such as mixture vs. compound, titration, periodic table, etc.

7) Also to engage students, I took some models to show the molecular geometries in accordance with the hybridization and the structural deviations due to the presence of lone pairs.

b. Major changes

1) Based on my suggestion, the freshmen chemistry committee agreed to move chapter 12 to Chem 111B. Accordingly we had one extra week of lectures and one extra lab session.

2) As the course coordinator, I reconstructed the lab sections by bringing more active learning techniques to the course. For all lecture sections I proposed an identical schedule and therefore we were able to run all the activities uniformly.

3) I designed activity sets for each chapter of the textbook. These problem sets were covered during the pre-lab sessions. I wrote a detailed key for the activity sets and I sent them to TAs so they knew how to explain the problems to students with the same approach. Students were expected to work on these problems and come to the activity sessions well prepared. To enforce this I assigned some performance points, and gave the TAs jurisdiction to assign these points to the students based on their engagement in discussion during the activity sessions. I was regularly checking these sessions, especially in the first few weeks of the semester, to make sure that they were being properly conducted. I had several instructional/ corrective meetings with TAs who were not leading these sessions with the expected quality.

4) Before each test I provided the students with a review exam, and discussed the problems during the activity sessions. Because we were so thorough with the process of problem solving, "Review exam" days took the entire three hours lab session, so no experiments were assigned for those days. Detailed keys were also provided to the TAs.

5) After each test I ran an itemized analysis and identified the questions that the class had a hard time with. Before the final exam I prepared an additional review exam (a second review for the final exam) based on those challenging questions. This additional review took place during the laboratory session that was previously devoted to material in chapter 12.

6) Online quizzes are now done in a single format with exact same questions for all laboratories.

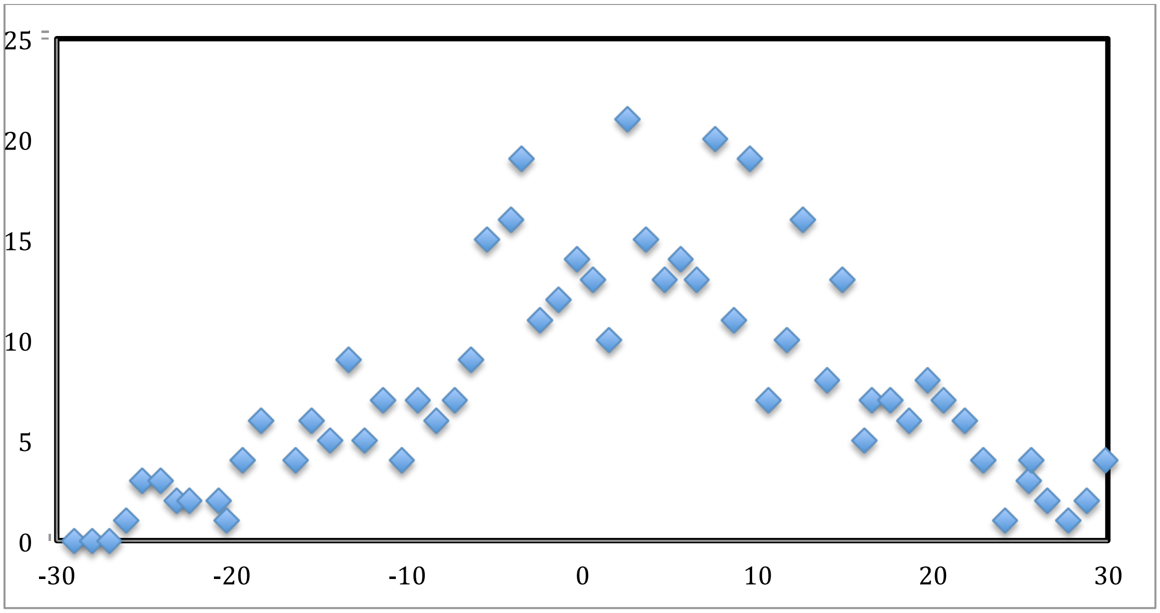
7) I had a meeting with SI coordinators to introduce the changes to them so that they could train the SI leaders accordingly.

Assessment

The first test was identical for all students enrolled in Chem 111A. We performed itemized analysis and identified the weak areas. We have put together this score with the Chemistry Placement Test (CPT) score and noticed some strong correlations.

In a group of 452 students from four different lecture sections whose first exam score varied from the CPT score by 30% the following results were obtained:

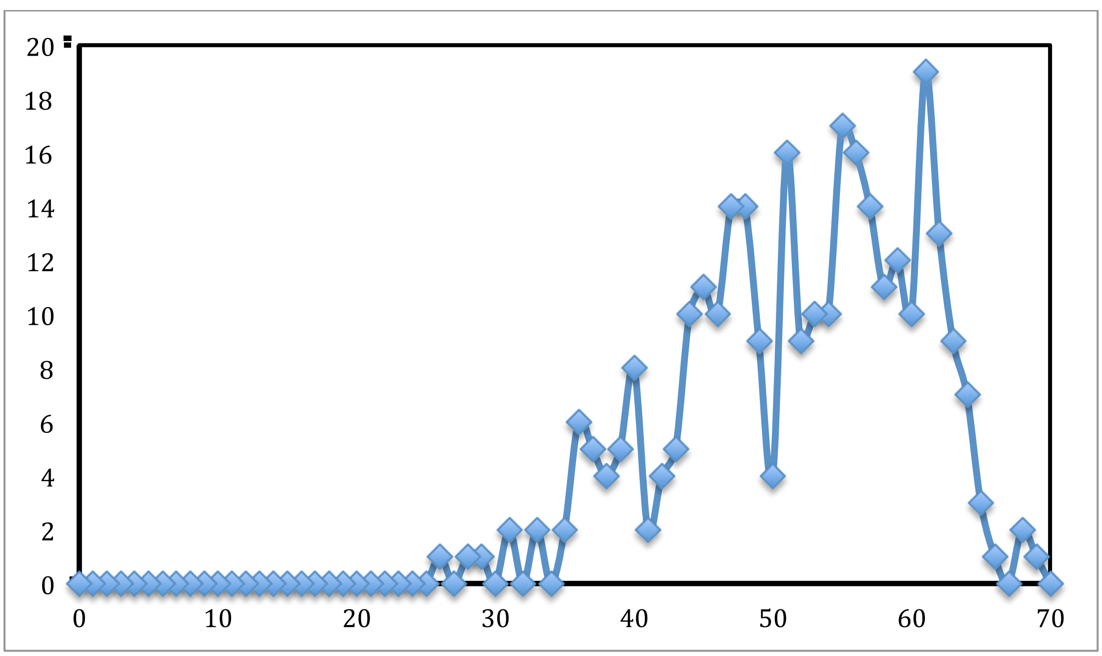
1) 270 students had a better final score compared to their CPT score.
2) 168 students had a worse final score compared to their CPT score.
3) 269 students had a final score, which was different from the CPT by ±10%.



Exam1 – CPT for a group of 452

The peak of the distribution of the (Exam1 score – CPT score) appears around 3, which is also indicative of the strong correlation between the scores with slightly higher Exam1 score compared to the CPT.

For the final exam we gave the same Form 2005 ACS test. I currently have detailed information on section 03C and 04D, which I taught. The class average for two sections based on 299 students who took the test was 73.7%, which is 16.1% above the national average (57.6%) and 3.7% above my previous class in Fall 2010. I also performed an itemized analysis and compared the class response to the questions with those of Fall 2010.



Grades Distribution for Final Exam, Chem 111A Sections 03C and 04D, Spring 2012

Question #	% wrong Fall 2010	% wrong Spring 2012
9	84	67
4	78	44
64	67	67
54	65	65
37	65	48
58	63	66
60	63	48
53	55	35
46	54	52
61	53	48
70	53	50
49	52	32
11	49	23
62	47	35
40	46	43
8	46	26
20	46	37
27	44	51
33	44	44
2	43	30
42	42	35

The number of questions with more than 40% wrong answers is down to 13 questions from 21. In 13 identified questions we noticed an improvement of at least 5%. Most of these improvements can be related to the activity sets and more analytical practice that the latter group had compared to the previous one. Question 37, and 42 with 13% and 7% improvements, respectively, indicate the impact of an extra lecture on thermochemistry and question #49 with 20% improvement also reflects the impact of an extra lecture on quantum mechanics. One can also consider correlating improvements in some area to small changes, which were adapted this time:

1) In question 8 we noticed an improvement of 20%. When teaching the concept of mixture vs compound (related to this question) I also showed a youtube video, which might have positively affected the class performance in this area.

2) In question 62 we noticed an improvement of 12%, which may also relate to the structural models we used in class for the first time.

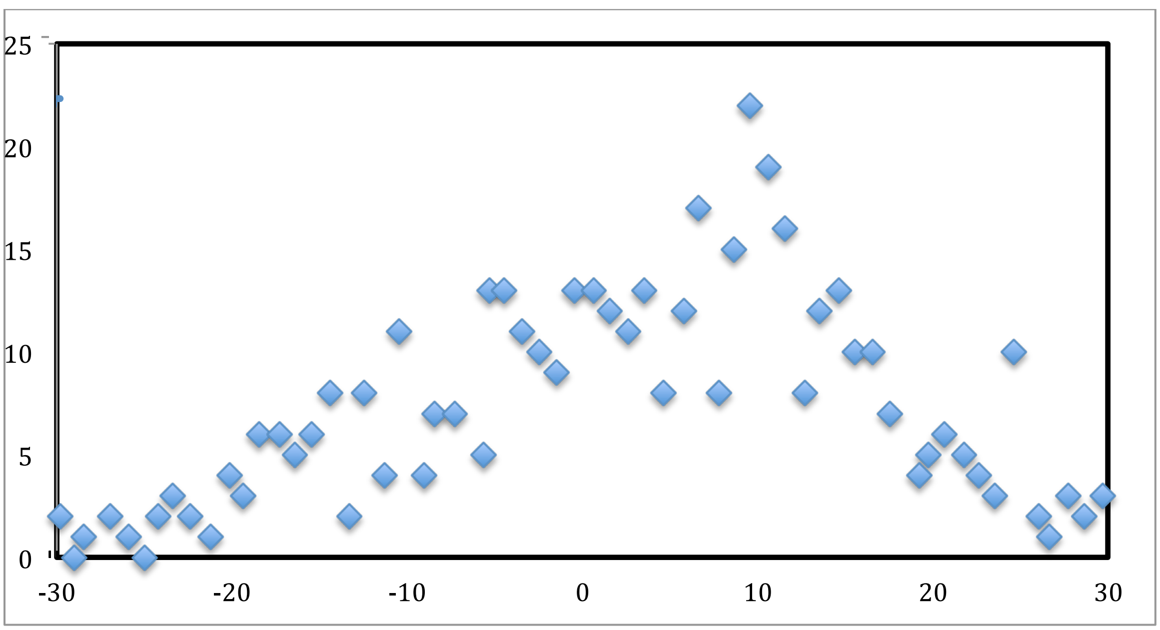
In seven questions, the change was less than 5% and in one question (#27) the number of wrong answers was increased by 7%. This particular problem is from chapter 12. In previous semesters we had some practice on the effect of concentration in colligative properties of solution (Chapter 12 material), but this did not occur this semester since chapter 12 material had been moved. This deficiency should be addressed by adding more concentration related problems in future activity sets.

Among 324 enrolled students in section 03C and 04D, 20 students dropped the course. 33 earned As, 135 students received Bs, 112 students earned Cs, 18 students earned Ds and 6 students earned Fs. Among the 6 who earned Fs, 3 students didn't attend the final exam. The overall passing rate was 86.4%. Among those who took the final exam 93% passed the class with the grade of C or higher. The overall GPA was 2.56.

Finally, for all four sections we compared the CPT scores with the final scores. In a group of 443 students whose Final score varied from the CPT score by 30% the following results were obtained:

4) 274 students had a better final score compared to their CPT score.
5) 156 students had a worse final score compared to their CPT score.
6) 234 students had a final score, which was different from the CPT by ±10%.

The peak of the distribution of the (Final score – CPT score) appears around 10, which is also indicative of the higher final score compared to the CPT.



(Final – CPT) score for a group of 443 students

CNSM Faculty Learning Community Final Report

Introduction

Thomas Gredig
Department of Physics & Astronomy
PHYS 100A (General Physics)
Number of Students: 71
Low Completion Course: Yes (requirement for several majors)

Hypothesis

An **online GROUP discussion forum** is used to engage students in homework. The forum allows students to work in a small ASSIGNED team (~3 students) to solve a problem through discussion. Near the bi-weekly deadline, the agreed-on solution is posted in a "showcase" available to all students, thereby creating peer-solutions. This tool is the missing link between the homework question and its answer; it provides training to the student on how to approach problems and work on the solution path. Students will be able to more easily solve the homework and do better on exams.

Results

The change was motivated by previous student feedback that there were a lack of step-by-step solutions and not enough training for word problems. Word problems take a lot of time to grade in large classes, and traditionally only the final result is checked in homework. However, in exams, the solution path is graded. In order to provide the students with more practice, group problems were provided that could be solved online in a discussion forum. Each group would solve one problem, but the entire class would provide step-by-step solutions of many problems that were then made available to all students.

Table 1: Statistics of Online Discussion Forum (PHYS 100A, Spring 2012)

Total of Enrolled Students	71
Total Views	5045
Total Likes	2568
Total Comments	2060
Comments per Student	**35**
Maximum Comments of Student	90
Standard Deviation of Comments	25
Forum Visits per Student	**86**
Standard Deviation of Views	61
Likes per Student	**48**

Generally, students have access to online tools and master uploading images and communicating online; i.e. the students are prepared to participate in online discussion forums. Specifically, a survey in the class found that 88% of students are fairly to extremely comfortable with facebook, 90% have their own internet access, 94% own a laptop, and 68% own a smartphone. In our discussion forum, students submitted 35 comments on average. Students could also "like" their peer's comments and generally solutions with many "likes" were more useful to read. The quality of the student comments was generally good to very good. A large quantity of data is available for each student in digital format.

A post-survey (Fig. 2) shows that **students tend to seek expert solutions** (cramster.com, ask.yahoo.com, tutors, professor) and not trust their peers. Peer-solution and expert-solutions, however, differ in the approach and the C-LASS attitude tests shows that the students did not become more expert-like during the course of the class; so, the expert solutions are not efficient learning material and do not engage the students sufficiently well. In the future, it will be important to demonstrate to students that group peer-solutions can be trusted and for students to find out whether a solution is correct.

Students who did well in the group online problems tended to also do well on the traditional homework problems that solely focus on the correct answer, see Fig. 1. However, no quantifiable change in better final test scores were found; seemingly, advanced students tended to receive more training with the newly introduced tool, and under-performing students tended to ignore the discussion forum as a tool to help them and were also less likely to come to class. It appears to be important to communicate the training advantages to the students well at the beginning of the class.

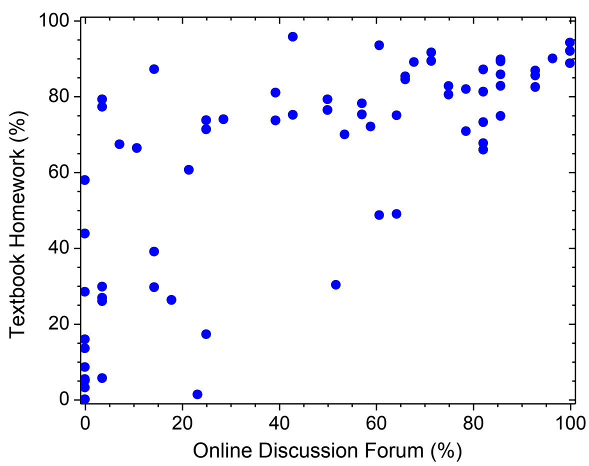
Discussion

The forum was developed based on open-source code (vanilla forums, php, mysql) and extended to be suitable for group discussions, team work, easy file/image upload and scientific equation support.

The discussion forum was aimed at giving students problems to be solved together with their peers. Groups were assigned and teams of 3 were made. The problems were sometimes open-ended, conceptual, and related to their majors to further motivate the class.

Several students mentioned the benefit of the conceptual problems—those that were more related to everyday life or to ideas without necessarily having computations. One student mentioned that this conceptual approach might be used to introduce concepts before a lecture. That is, students would reflect on the ideas or problems through the online discussion forum, followed by a more formal introduction of the concepts in some way during the lecture.

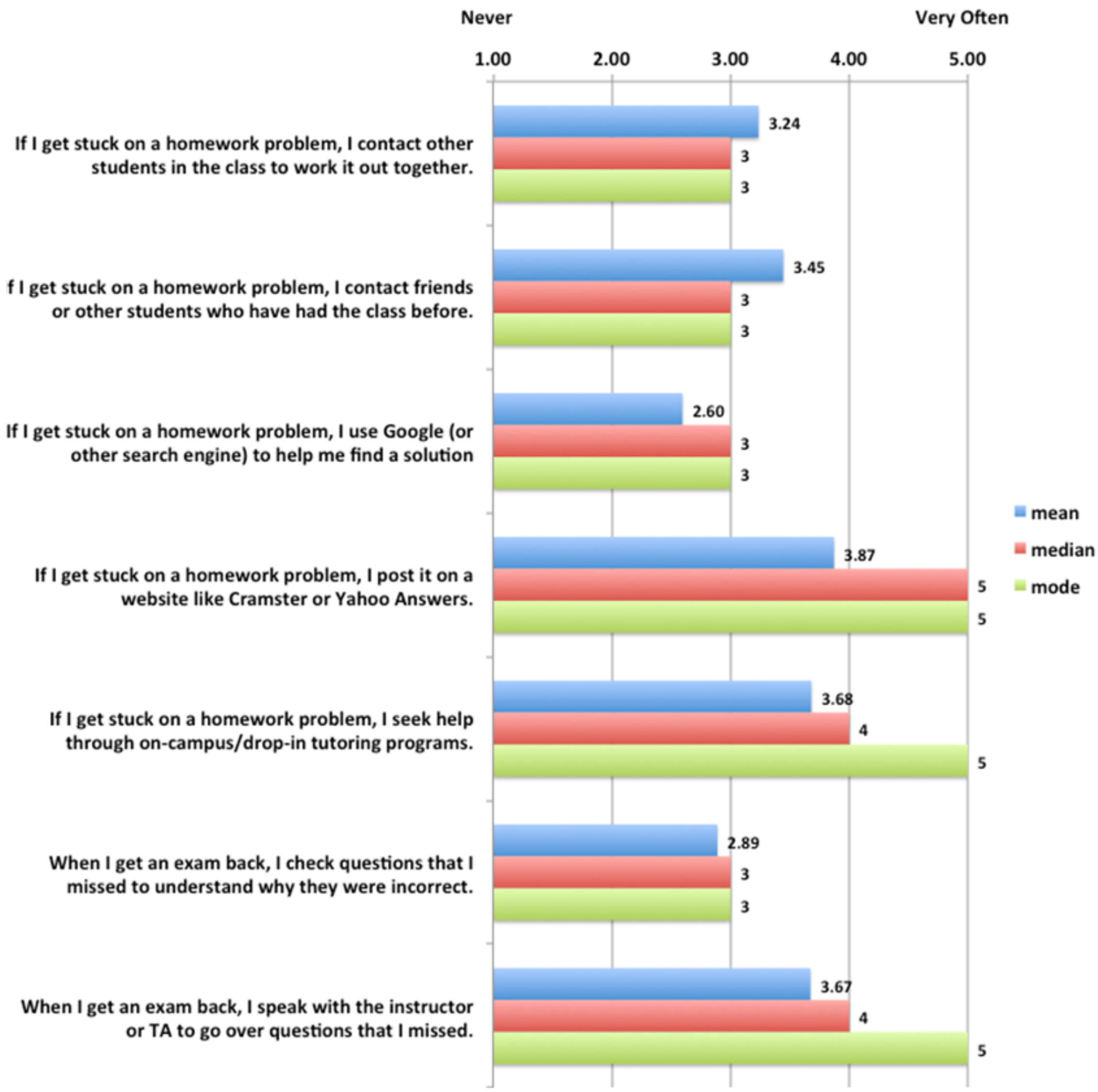
Figure 1: Correlation of traditional homework (result-based) and new group homework (solution-path-based) shows that students who participate in the solution-path learning do well in the results-based homework.



Students understood the potential value of looking at other groups to see how they solved problems. In some cases, students mentioned that it was good to see how others actually solved the problem in online discussion forum and indicated that they might be able to use that idea to help solve the other problems, like those in the textbook homework. But such opportunities to use online discussion forum as a stepping-stone to support textbook homework seemed not as common as assumed by design time. Compounding the problem, the deadlines were the same and students tended to solve the textbook problems first and then the online group problem. This appears to be an issue of communication and organization of the discussion forum.

I will integrate the online discussion forum into PHYS 100B (Summer 2012) and PHYS 152 (Fall 2012). The main changes are process related. Groups should be larger (~5 students), groups need to have the opportunity to meet in class and have alternating group roles assigned (director, solver, inquisitor, skeptic). Students are explicitly explained the impact of this learning process on their grade, and the role of the activity to practice the solution process. Students will also be informed that group solutions are trust-worthy and the answer is not as important as the solution-path.

Figure 2: Student survey in PHYS 100A shows that students tend to seek Expert solutions rather than Peer solutions. Data collected with help of Dr. Jim Kisiel. The green bar (mode) indicates the most common response.



Student end-of-semester surveys also showed that they – non-majors - were not interested in "learning" any of the subject, but solely focused on their grade (sometimes with a focus on achieving just a "C" grade). While students saw that the discussion could provide a "learning" effect, some students did not realize the connection to their grade and opted to focus elsewhere. I had wrongly assumed and relied on the student wanted to learn and did not clarify the connection to their final grade enough.

Conclusion

In summary, discussion forums provide a plethora of individual data and the possibility for instant feedback to the student. These forums lend themselves to early detection of need for remediation. A large amount of individual data was collected during the first implementation. Team work was introduced in the class. During the first (Spring 2012) implementation, some incorrect assumptions were made: (1) that students would like to study in groups and learn from peers – rather they trust experts and want quick, full solutions, and (2) that students want to learn – rather they want to pass the class (genuine focus on grade or passing solely). Therefore, the discussion forum was useful, mainly to students who did well elsewhere and provided more training to already successful students. However, there is the potential to make this tool the stepping stone to provide training for all levels in the cognitive learning domain (Bloom's taxonomy). Early indicators seem to support this: there is broad participation in the revised online discussion forum for the Summer 2012 class, 18,000+ views, and 955 comments by 65 students in the first week of class alone. This could effectively allow more advanced peers to set an example for their less motivated classmates and positively affect their training in the course.

CNSM Faculty Learning Community Final Report

Introduction

Name: Jiyeong Gu
Department: Department of Physics and Astronomy
Name and number of class where development occurred: PHYS340A Electricity and Magnetism I
Number of students in the class: 18
Is this typically considered a low completion rate course?: No

Hypothesis

Brief (few sentences) description of what it is that you tried and how you thought it might increase student learning/success/retention. If you tried several things, organize as best you can to be clear.

I tried two things for PHYS340A in Spring 2012.

(1) Lecture notes:
I made new lecture notes where I used my handwriting instead of Powerpoint. In this way I thought I would explain more details about the material and the problem solving process. Also, instead of uploading lecture notes before the class, I set the show time of the lecture notes to right after the class had ended. In this way, students had to take notes during class. I thought it might increase the student attention during the class hours. In previous semesters, I always uploaded the lecture notes in advance so students could come to the class with the copy.

(2) Group problem solving in-class:
I introduced group problem solving in class where three or four students solve exercise problems together as a group. I thought it would help student learning, and emphasize problem-solving skills. PHYS340A problems require extensive math work, so math skills are essential to understanding the physics concepts. Through group problem solving I thought they would teach each other and solve problems together that may have been difficult for some students to accomplish as individuals.

Results

Did it work? Briefly describe your results- ideally providing some figures to share.

(1) Lecture notes: I noticed that most of the students were taking notes during the class, and that they were following my lecture. In previous years when I posted the lecture notes before the class, and used the same power point slides for the class, not many students were taking notes and some of them didn't show up to class. This semester students who attended the class paid close attention to the lecture. It appears that not uploading the lecture notes before class made students pay more attention during the class time. Also, students asked numerous questions for each step while they were taking notes, something that occurred rarely in previous semesters.

(2) Group problem solving in-class: I could only try this three times during the semester due to the time constraint. Since it took almost the whole lecture time, I couldn't do it often. Therefore, it is hard to conclude whether it worked or not. However, it seemed like students were teaching each other and discussing problems and larger concepts, something which they hadn't done in previous semesters.

Discussion

Would you do this again? Why or why not?

I would like to do both trials again next time I teach the same class. In fact, I am planning on incorporating these new methods next semester when I teach the second part of Electricity and Magnetism, PHYS340B. I am especially interested in introducing more group problem solving in-class to see how it will improve students' problem solving skills.

Do you feel that you accomplished something by being a part of the FLC? If so—what?

Yes. I feel that I especially learned something in regard to the lecture notes. I have been using Power point slides for many semesters and I believed by providing the lecture note in advance I could help students save time by not writing during the class, so that they could pay better attention to the lecture. After the FLC where we discussed the pros and cons of posting lecture notes before the class, I wanted to test whether it would really save the time or make students less interested and focused. It turned out that students paid better attention while they are writing process line by line with me. Also, they asked many questions while they are doing it. It is hard to compare the exam grades directly because there are so many other factors affecting the grade however, the Spring 2012 PHYS340A class where I implemented these changes had the highest exam scores (for midterms and finals) out of my 4 semesters teaching of PHYS340A with similar level of difficulty in questions.

CNSM Faculty Learning Community Final Report

Introduction
Eric Haas-Stapleton, Ph.D.
Biological Sciences
BIOL 340: Molecular Cell Biology; n = 133 students; is a required course for most Biology Majors and is a low completion course (regardless of whom teaches it).
BIOL/MICR 416/516: Virology; n = 30 students, is not required and is not a low completion course.

Because there were different approaches and anticipated outcomes for each course, each is separated in this report.

BIOL 340 (Molecular Cell Biology)

Hypothesis (BIOL 340)
The goal of incorporating strategies learned in the FLC 2011-12 was to increase the successful completion rate for the course.
The approach included:

- Audio recordings of my lectures and PowerPoint slide sets used in class were posted to BeachBoard.
    - The aim of this approach was to provide students access to all course content, even if they were unable to attend each class session, and to provide students increased variety of resources for use in reviewing the material presented in class.
- A low stakes in-class quiz during the second week of class that included several multiple choice questions, fill in the blank questions and a short essay question (prior semesters had only multiple choice questions for quizzes). The fill in the blank and essay questions were scored by a hired grader (133 students in the class). Students not earning a passing grade on this quiz were sent an email informing them and providing suggestions for how they might improve learning (form learning groups, attend office hours, note-taking strategies, etc.). A similar email was sent after each midterm exam to students not passing the class.
    - The aim of this approach was to increase the awareness of students at risk for not passing the class with the anticipated outcome that they would take the recommended steps designed to aid in passing the course.
- Low-stakes iClicker quizzes during each class to assess learning (valued at 3 % of the total points for the course). If more than 25 % of students did not answer correctly, they were asked to briefly form Think-Pair-Share groups to discuss the question and then retake the iClicker quiz. Because points were awarded only on iClicker quizzes with more than 75 % of students answering correctly, students attending the class earned most of the available iClicker quiz points.
    - The aim of this approach was to encourage attendance and assess student learning "on the fly".
- Exams (n = 4) and quizzes (n = 8) included multiple choice, short answer and fill in the blank questions. All exams and 4 quizzes were in-class (the remaining quizzes were offered on BeachBoard). Prior semesters had only multiple choice questions on quizzes and exams.
    - The aim of this approach was to increase the writing component of the course.

- Greater efforts were made to diagram complex processes on the white board.

Results (BIOL 340)
While student attendance remained high throughout the semester, there was no difference in the proportion of students that did not successfully complete the course (Figure 1). Of note, in 2011 Spring (2011S) and 2009 Spring (2009S), the only assessments of student achievement in the class were multiple choice exams (n = 4) and quizzes (n = 8). The results demonstrate that all strategies employed to increase successful completion of the course were unsuccessful. Additionally, there was no difference over the years assessed in the grade distribution for students earning a passing grade in the class.

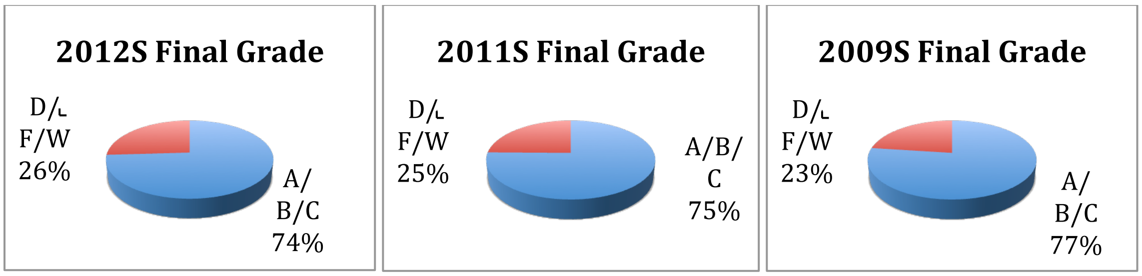


Figure 1. Distribution of students successfully completing BIOL340 (Molecular Cell Biology). A/B/C denotes the proportion of students earning a passing grade of A, B, or C. D/F/W corresponds to students earning a grade of D, F, or withdraw (W) and did not successfully complete the course.

Discussion (BIOL 340)
There was greater student engagement during the lectures (substantially more questions asked during and after class). This made the course more enjoyable for me and appeared to do the same for the students (increased affect). However, there was no difference in the proportion of students successfully completing the course before and after the strategies learned in the FLC. Because this was the principle aim, I will not be employing these approaches in subsequent course offerings. Further, because of the additional effort and cost (hiring a grader) of essay-based exams and the clear evidence that they do not increase student success in completing the course, I would recommend that other faculty teaching this course administer only multiple choice exams and quizzes.

<u>BIOL/MICR 416/516 (Virology)</u>

Hypothesis (BIOL/MICR 416/516)
The goal of incorporating strategies learned in the FLC 2011-12 was to stimulate a desire for learning outside of the classroom, diversify assessment of student achievement and positively impact student affect (attitudes, interests and value of learning).

The principle approach was to form learning groups for students to solve in-class problems. It included:

- Stimulated student interest for working in Learning Groups (LG) by assigning a very challenging in-class quiz. Upon its completion, I asked students if they wanted to work on it again as a group. They did (enthusiastically). This was the "buy-in" step.

- Diversified LGs formed by the instructor. To form these groups, I asked students to self identify as: graduate students, having an interest in professional school, an interest in graduate school, had a computer that was regularly brought to class, students majoring in Molecular Cell Biology, majoring in Microbiology, or were born somewhere other than Long Beach. At this point, everyone had self-identified to one category. The LG were next formed to contain a balanced distribution of students that self-identified for the categories. Next, each member of a group was assigned a Title with specific responsibilities for solving in-class problems. The Titles were: Coordinator, Analyst (with computer to do online research), Scribe (take notes of discussion), Listener (circulate among other groups to learn alternative ideas) and Announcer (verbally report the findings of the group to the class). As a reminder, each student was provided a physical card denoting the assigned Title and a list of the associated responsibilities. The Titles (and cards) were rotated among students in a particular group. To promote efficient interactions, students were not permitted to change groups.
- The LG was formed to work on group quizzes, solve in-class projects and prepare a written analysis of the scientific accuracies and faults of a recently-released popular movie that has a virus-based theme (Contagion).

Results (BIOL/MICR 416/516)
It is rare for students to unsuccessfully complete this course and it is usually taken by students having extensive prior training in molecular cell biology during their last semester at CSULB. Because completion rates and final grades are typically high for this course, a 13-question survey was employed to assess the impact of the new teaching/learning approaches incorporated into the class. While the results from only a few questions are included, upon request, I’m happy to provide the analysis of all student responses to questions and the survey instrument.

When asked if the students believed that in-class group activities helped them prepare for exams or encouraged learning beyond course requirements, 83 % and 85 %, respectively, agreed or strongly agreed (Figure 2).

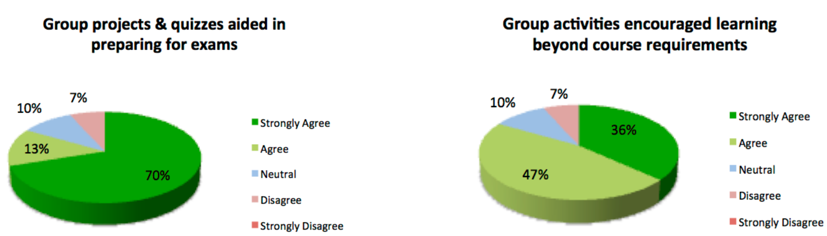


Figure 2. Survey assessment of student responses to the impact of group learning on preparing for exams and encouraging learning beyond course requirements.

Students were asked whether they believed student learning was better if in-class assignments and quizzes were based solely upon individual efforts, only on group efforts, or bases upon a balance of individual and group efforts. A greater proportion of students expressed a belief that a balance of individual and group efforts improved learning (Figure 3). Of note, in the space on the survey for written comments, many responded that the balanced approach encouraged student preparation for assignments, which reduced “loafing” during group discussions.

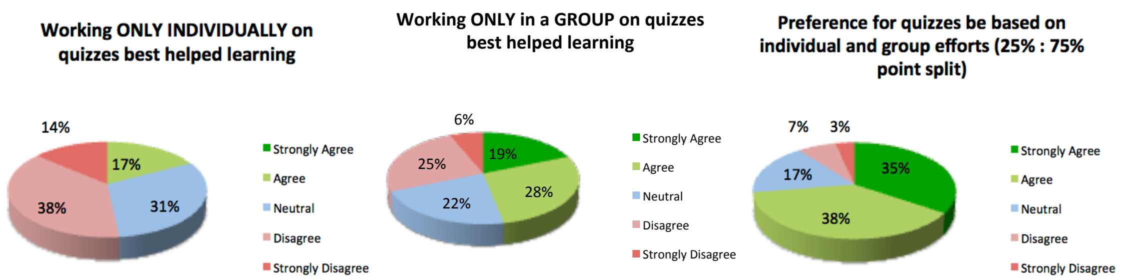


Figure 3. Survey assessment of student responses to preference for in-class assignments be based on only individual, only group, or a balance of individual and group efforts.

When asked if students thought that self-assembly into LG would have produced better learning, 62 % disagreed or strongly disagreed, suggesting that students preferred a balanced distribution of group composition over working with friends (Figure 4). Indeed, many students wrote on the survey that they greatly appreciated the effort made to form balanced LG. When asked if the movie analysis assignment promoted student learning beyond the course requirements, 93 % agreed or strongly agreed (Figure 4).

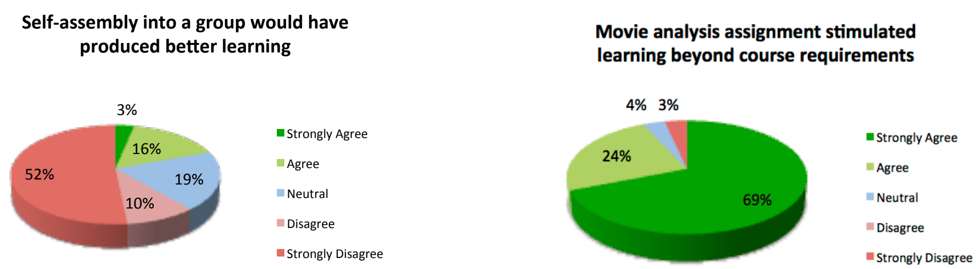


Figure 4. Survey assessment of whether movie analysis assignment promoted learning beyond the course requirement and if students believed self-assembly into groups (rather than instructor-assigned group composition) would produce better learning.

Discussion (BIOL/MICR 416/516)

Incorporating group learning activities appears to have positively impacted student affect and effectively diversified course assessment. Consequently, I will continue in subsequent course offerings to incorporate in-class group activities and will retain the movie assessment assignment. If other faculty have an interest in attempting this in their own classes, I strongly encourage them to form balanced LG and actively circulate among and engage with each group during the in-class projects.

Broader question: Do I feel that I accomplished something by being a part of the FLC?
Yes, I do believe that my training in the FLC has made a substantial positive impact on my teaching proficiency and outlook towards students. Previously, I considered teaching to be more of a chore. Now I view it as an exploration of how to best convey ideas related to my discipline. Additionally, my affect has improved as has my perspective of students as persons wanting to achieve and discover. Finally, I have found a community of faculty that are exceptional research scientists that also strive to be expert teachers. My goal is to further build the latter quality into my profession (by CSULB metrics, I'm already an effective researcher).

CNSM Faculty Learning Community Final Report

Introduction
Instructor: Xuhui Li
Department: Mathematics and Statistics
Course: Math 113 Precalculus Algebra, Section #2
Number of students enrolled in the section: 150

Math 113 is the very first General Education mathematics course required of most students in technical majors at CSULB. Each year about 1300 – 1600 students on campus take this course. The average passing (grade C or higher) rate across sections and semesters has been in the 60% ~ 70% range. Such a rate is worrisome to both instructors and students in the sense that (1) the mathematics content of this course overlaps extensively with secondary school Algebra 1 and Algebra 2. Supposedly, the students have already had a good foundation upon entering our campus or, in the case of one-third of the freshmen, after they finish pre-baccalaureate mathematics in the first year; also (2) for the majority of the students taking this course, it is a prerequisite for calculus courses. If they don't get a C or better, they have to repeat it.

New Strategies and Hypothesis
During the Spring 2012 semester I experimented with one new learning component and two enhanced teaching strategies in my Math 113 section with the hope to boost students' time on task, participation, active learning, and eventually, readiness for the next levels of mathematics study:

1. ALEKS online assessment and practice module: At the beginning of the semester students were required to take an initial diagnostic assessment with ALEKS to demonstrate how well they understood a variety of topics foundational to college algebra. Then they spent the first 6 weeks completing a series of online mathematics exercises in ALEKS to improve their knowledge and skills in each of their own weak areas. Those exercises were customized to individual student's specific needs, adaptive to students' progress, and totally self-paced. I was hoping that through the ALEKS activities my students would spend extra time outside class strengthening their mathematical foundations, which would make the students much better prepared for in-class learning and retention. Meanwhile, I anticipated the individualized and self-paced nature of the online module to allow sufficient flexibility and efficiency for all students.

2. Multimedia and dynamic presentations: During each class meeting, besides lecturing and writing detailed notes on whiteboard, I also used a computer and a projector to display some of the most important information onto the screen, including (1) pre-prepared PowerPoint slides that showed core concept definitions, theorems, and major steps in algebraic computations or derivations of formulas; (2) the symbolic, numerical, and graphical forms of algebraic functions and transformations created instantly with mathematics freeware such as GeoGebra; (3) texts, pictures, and videos that were relevant to the topic of the day, many of which are directly available on the internet. By paralleling the regular class notes on the whiteboard and utilizing intuitively more appealing media, I expected these visual-audio presentations to expand the dimensions of instructor-learner-content interactions, to more effectively highlight the most crucial information and ideas, and to draw more attention from the students and stimulate their

multiple senses, hence increasing both the quantity and quality of student understanding and retention.

3. In-class short exercises and peer discussions: During each class meeting I assigned more exercises for the students to work on than I did in previous semesters. For some of the exercises I asked the students to share and discuss solutions among themselves, or select two or three students and volunteer them to show work on the whiteboard. Two main rationales underlying this strategy included: (1) through in-class hands-on exercises students could more fully and spontaneously understand my examples and explanations, rather than passively taking notes and listening. This could in turn help to bridge the gap between learning in class and solving homework problems outside of class; (2) The peer or whole class discussions could make in-class learning more active, enjoyable, and productive. Students could learn different ideas and problem solving strategies from their peers. I could then summarize, compare, and relate the different solutions. In this way mathematics knowledge is built through collaborative efforts, and students could develop a stronger sense of ownership of their knowledge.

Results

The main sources of data includes student grades on the 3 midterm exams, the final exam, WebAssign online homework assignments, in-class participation credits, and student responses to an online survey.

Several two-sample *t*-tests were conducted on student grades and generated the following results:

1. Improved midterm exam performances across semesters:

I was teaching the same course one year ago in Spring 2011 without having the ALEKS component, multimedia presentations, or as many in-class exercises or peer discussions as in Spring 2012. For midterm Exam 1 and Exam 2, each was given at the same time point of each semester, and the questions have the same content coverage and difficulty level between the two semesters. Therefore it is reasonable to compare student performances on each of these two midterm exams between the two semesters, and use the differences found as a proxy for the effects of those new component and strategies.

On midterm Exam 1, the mean score of the Spring 2012 class was 72.5 ($n = 140$). At $\alpha = 0.05$ level, it is significantly higher than the mean score 67.4 of the Spring 2011 class ($n = 188$) ($p < 0.01$).

On midterm Exam 2, the mean score of the Spring 2012 class was 75.8 ($n = 135$). It was higher than the mean score 74.1 of the Spring 2011 class ($n = 186$). At $\alpha = 0.05$ level, the difference is not statistically significant between the two classes.

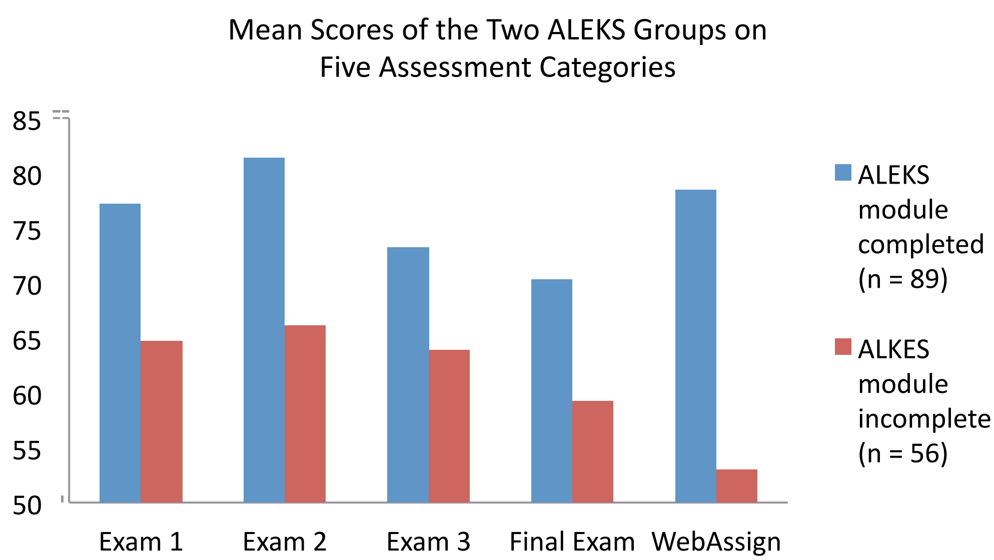
However, when I narrowed it down to a special subset of the Spring 2012 class, those who have completed the entire ALEKS module ($n = 86$), their mean score 81.4 on Exam 2 turned out to be significantly higher than the mean score 74.1 of the entire Spring 2011 class ($\alpha = 0.05$, $p < 0.05$).

I was not able to make a similar comparison for the 3rd midterm or the final exam because I was on paternity leave from the 10th week through the end of the semester. Those two exams were written by my substitute instructor so were somewhat different from the ones I used in Spring 2011.

2. Higher performances for those whole completed the ALEKS module:
Within the Spring 2012 class, those students who completed the entire ALEKS module scored significantly higher on all 3 midterms, the final exam, as well as the WebAssign online homework assignments, than those who didn't finish the ALKES module ($\alpha = 0.05$).

Below is a summary of the mean scores of the two groups of student on each assessment category:

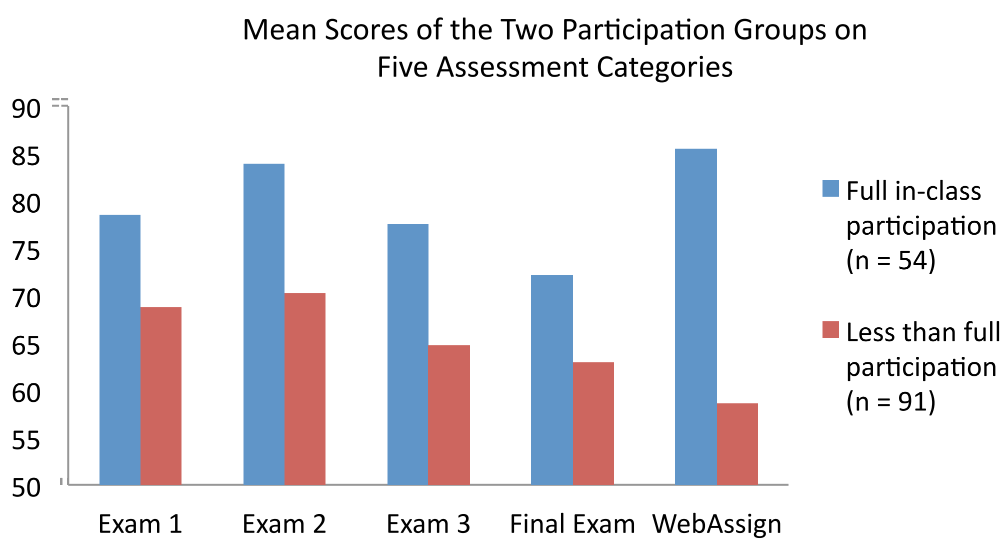
	Exam 1	Exam 2	Exam 3	Final Exam	WebAssign
ALEKS module completed ($n = 89$)	77.2	81.4	73.2	70.3	78.5
ALKES module incomplete ($n = 56$)	64.7	66.1	63.9	59.2	53.0
p value	< 0.01	< 0.01	< 0.05	< 0.01	< 0.01



3. Higher performances for those who had highest level of in-class participation:
Once a week, I collected student work after they finished the in-class exercises and discussions, and assigned grades as a measure of their in-class participation. A total of 7 in-class exercises were collected and graded. It turned out that those students who turned in all 7 exercises scored significantly higher on all 3 midterms, the final exam, as well as the WebAssign online homework assignments, than those who didn't turn in all 7 exercises ($\alpha = 0.05$).

Below is a summary of the mean scores of the two groups of student on each assessment category:

	Exam 1	Exam 2	Exam 3	Final Exam	WebAssign
Full in-class participation ($n = 54$)	78.5	83.9	77.5	72.1	85.5
Less than full participation ($n = 91$)	68.7	70.2	64.7	62.9	58.6
p value	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01



4. Students' moderately positive feelings on the new component and strategies:

Right before I started my paternity leave in the 10th week, I posted a short online survey for my students to complete. A total of 91 responses were received.

Below are two survey questions that are directly related to the new component and strategies I experimented in the class. The tables show the percentages of students who assigned a particular rating score to a particular item, as well as the mean rating score of each item.

(1) On a scale of 1 to 5, how would you rate the helpfulness of each of the following two aspects of the class to your learning (1 – least helpful; 5 – most helpful):

	1	2	3	4	5	**Mean Rating**
ALEKS assessment and practice module	11%	12%	20%	29%	28%	**3.5**
In-class exercises and discussions	8%	10%	23%	21%	38%	**3.7**

(2) In his lectures, Dr. Li used projector screen to present powerpoint slides or demonstrate numerical and graphical representations of functions. On a scale of 1 to 5, how would you rate the helpfulness of each of the following aspects of these presentations (<u>1 – least helpful; 5 – most helpful</u>):

	1	2	3	4	5	**Mean**
Highlighting definitions, formulas, and other important math facts via PowerPoint slides	2%	5%	11%	34%	48%	**4.2**
Visualizing abstract math concepts and procedures in multiple ways	6%	10%	20%	35%	31%	**3.9**
Relating information displayed on the screen to notes written on the whiteboard	7%	12%	20%	23%	38%	**3.7**
Assessing photos or videos related to the content from the internet	13%	14%	28%	24%	21%	**3.3**
Overall helpfulness	5%	6%	25%	31%	33%	**3.8**

Discussion

The results shown in the previous section suggest that student performance increased after the introduction of the ALEKS learning module as well as the visual presentations and more exercises and discussions in class. In particular, the completion of the entire ALEKS module and getting full credit on in-class participation were strongly associated with higher student performance. Of course these don't necessarily imply any simple causal relationship. Being fully devoted to ALKES and in-class participation are likely to be confounded with the same factor – student effort and persistence, which could be what is truly contributing to student success.

I would definitely use these approaches again when I next teach this course. The survey results reveal that there is still much space for improvement in each of the three experimental aspects. Below are some thoughts as future plans.

Both my students and myself are new to ALEKS. It takes time to get used to the design, structure, mechanism, and the technical aspects of ALEKS. Next time I would provide more detailed instructions to my students before they start, and somehow reduce the number of topics covered by the module so that it is more focused and students won't feel too overwhelmed. I would also emphasize more the importance of the module and intentionally make connections between topics taught in class and covered by ALEKS.

The use of visual presentation media during the spring wasn't as effective or smooth as I expected. I would be important to double-check all aspects of the technologies and get prepared for the occurrence of technical difficulties (both hardware and software) during presentations. I also plan to figure out better ways of integrating the presentations into the lectures so that I don't have to switch the projector and screen on and off too frequently.

Surveys showed that students always wanted more exercises in class. Although this is a very reasonable expectation, it's impossible to have a very large number of exercises or discussions due to time constraints. This means it will be very important to carefully select (or create) the best questions for exercises and discussions. Monitoring student work and conversations closely is also very crucial as we need to make sure that students are on task, collaborative, and productive.

Participating in the FLC in last fall was helpful to my experiments in Spring 2012. I got to learn many different ideas and strategies from reading articles and discussing with other FLC members. Although there are only a limited number of things I can try during each semester, through the FLC activities I have got to see two very encouraging phenomena: (1) there are many other colleagues in STEM fields who are interested in and devoted to improving teaching and learning; (2) many strategies have been experimented by others and proven to be somewhat successful in certain contexts. These lay two essential foundations for my own improvement and success in teaching: (1) a community of practitioners that are supportive and collaborative, and (2) good ideas and strategies that can be potentially transferred and adapted to our own campus.