

## **CHEM 122 Redesign Team Report 2013**

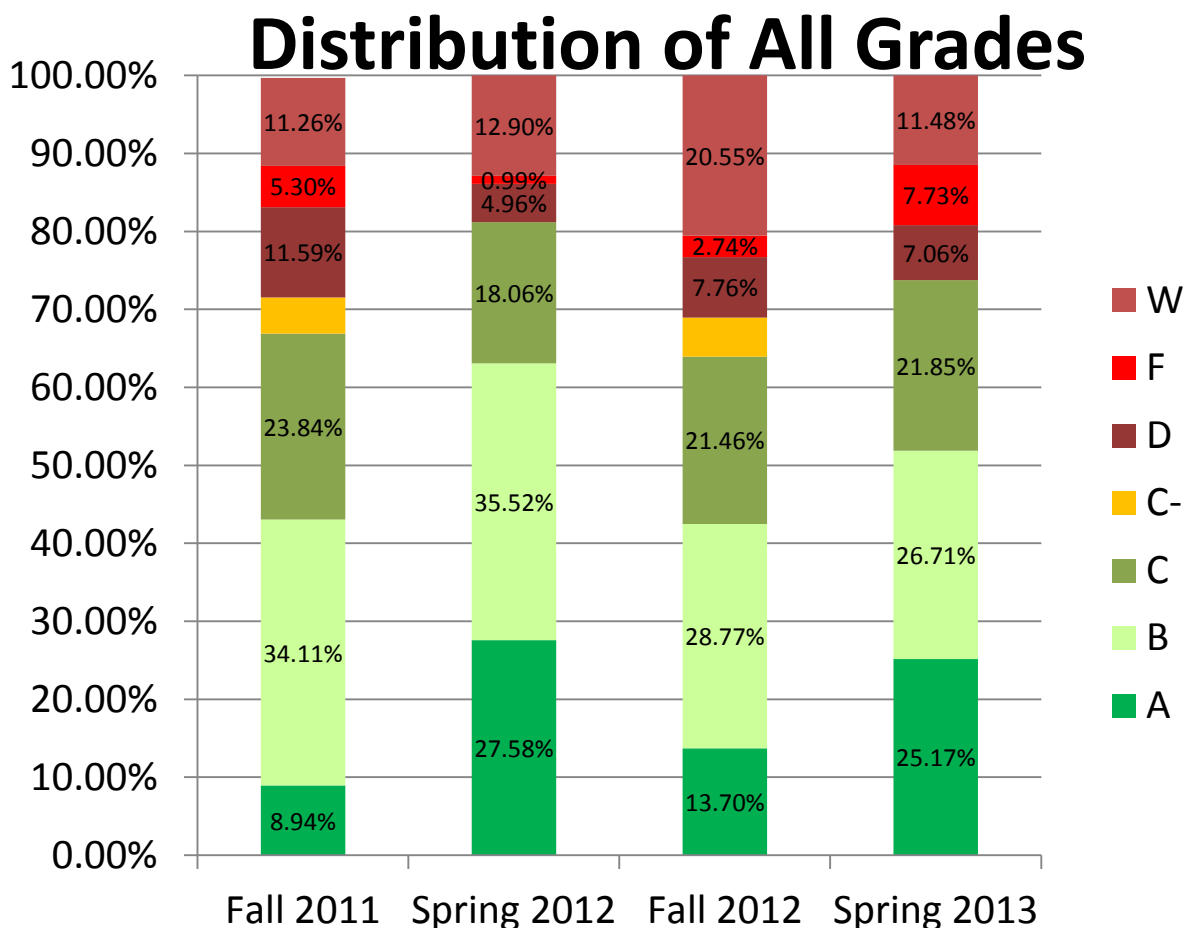
### **Team members:**

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### **Summary**

The CHEM 122 Redesign project started in the summer of 2012, and implemented in one section of the fall semester of 2012, and expanded into all sections of the spring semester of 2013 and thereafter. Data presented in this report were collected from these two semesters. Although there is not significant change of students' performance in terms of course grades since the implementation of the reform, more significant improvements of the reformed classes have been observed in concept gains, especially the concepts covered in the CHEM 122 Course Learning Outcomes.



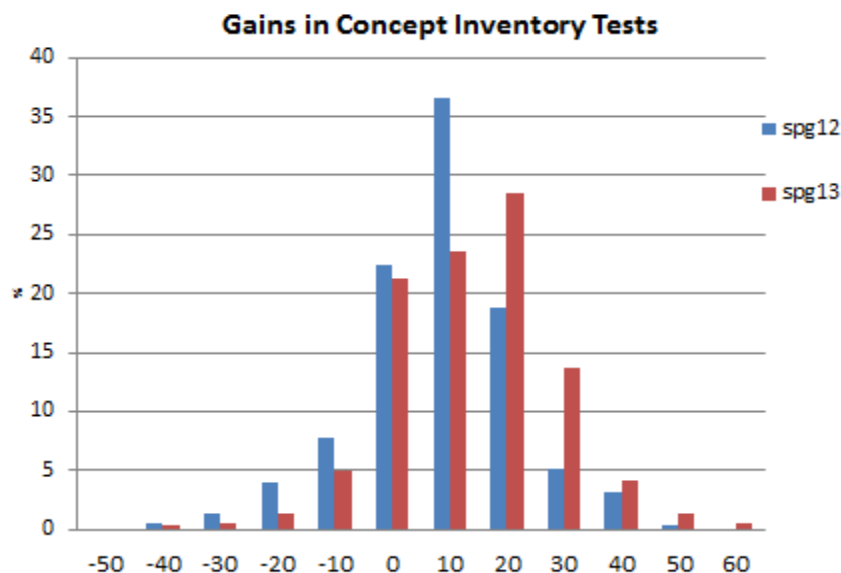
**Figure 1.** Passing (green variants) and D/W/F (red/orange variants) data for CHEM122 students who received a grade at the end of the term, excluding drops, audits, CR, I, and NC. The D/W/F rate is defined as 'Failure rate' for the remainder of this report.

**Background information:**

- Fall 2011: one year prior to the reform
- Spring 2012: one semester prior to the reform
- Fall 2012: first semester implementation of the reformed course. Only one section (section 4) was selected (about 35 students). Sections 1 and 2 were taught traditionally. Section 3 was a fully online course, primarily delivered using video lecture.
- Spring 2013: The second semester of implementation. All sections were taught as reformed courses.

## Analysis:

1. There is a significant difference between the fall and the spring semesters from all categories of grades. Students normally enter the sequence in the fall (for CHEM 121) and move on to CHEM 122 in the spring semester. Therefore, the Spring semester is the on-cycle semester for CHEM 122. It is expected to observe different performance in CHEM 122 between the fall and spring due to students' background. In general, we have seen higher failure rates in the Fall semester than in the Spring semester. The percentage of students receiving A and B are also higher in the spring semester.
2. A noticeable difference between the Fall 2011 and Fall 2012 for the percentages of students receiving A's (13.7% vs 8.9%) could be a sign of the effect of the reformed approach. However, the fall 2011 semester still shows better performance in terms of Failure rate, B's, and C's. Because of the small number of students in the test group (35), the Fall 2012 group is dominated by the population of students taught using a traditional approach.
3. The spring semesters are more troublesome for the interpretation. Although the plain numbers from the grade data indicate a worse performance in 2013, the differences are not statistically significant. Unfortunately, we don't have the data from the same pre-test to compare students' entrance scores between the two semesters. (The average of the pre-test from the spring of 2012 is 53% whereas that from the spring of 2013 is 37.39%. The two tests have about 85% common questions.)
4. Another factor that cannot be ignored is the variation of grading scale by different instructors. The practice of grade assignment by different instructors can affect the distribution of passing and failure rates.



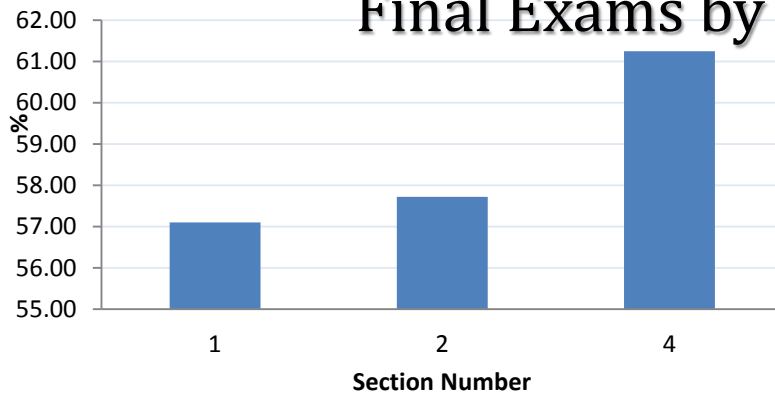
**Figure 2.** Conceptual Gains between Spring '12 and Spring '13. The conceptual gains were calculated as the post-test score – pre-test score. These are not normalized gains.

**Analysis:**

Because of the Fall-Spring differences in students, we will compare Spring 2012 to Spring 2013. Although the overall grade distributions appear similar (or perhaps even a bit worse in Spring 2013 than Spring 2012), analysis of gains on the pre- and post- concept inventory shows a significant shift to greater gain. The average student gain shifts to ~+20% in Spring 2013 from ~10% in Spring 2012. This suggests that students taking the redesigned course show a greater conceptual gain over the semester.

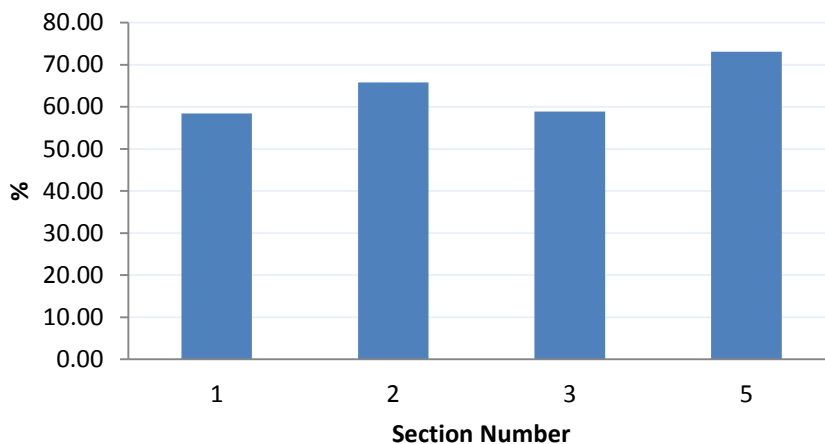
This comparison shows a different trend than what is revealed in Figure 1 where fewer students received A and B, more students received CDWF in spring 2013. Although the reformed classes did not demonstrate learning advantages in grades, students from these classes demonstrate greater conceptual gains. The better learning in the concepts is believed to help students' performance in the advanced courses later in the program.

## Fall12 Final Exam Final Exams by Sections



Fall12	final exam
1	57.10
2	57.72
4	61.25
Spring13	
1	58.44
2	65.77
3	58.85
5	73.11

## Spring 13 Final Exam



### Analysis

In Fall 2012 and Spring 2013, identical final exams were given. The redesign pilot section had the highest exam average (despite having a lower pre-concept test average) of the 3 sections taught. In Spring 2013, all sections were taught with the redesign, and showed improved final exam scores than the control groups in the Fall. Again, this could be due to the Fall-Spring section difference, and although a common final exam was given in Spring 2012, it was not the same one used in Fall 2012 and Spring 2013.

Although the differences among sections are small, the general trend is clear. In the Fall of 2012, the control group (section 1 and 2) consistently had lower averages than the test section (4). In the spring of 2013, all sections are test groups and their averages are similar, except for section 5 which is a BA/MD section. The two sections with the highest averages were taught by the same instructor. The sections range in size from 23 students to 250 students, and there was no obvious relationship of average final exam score and class size.

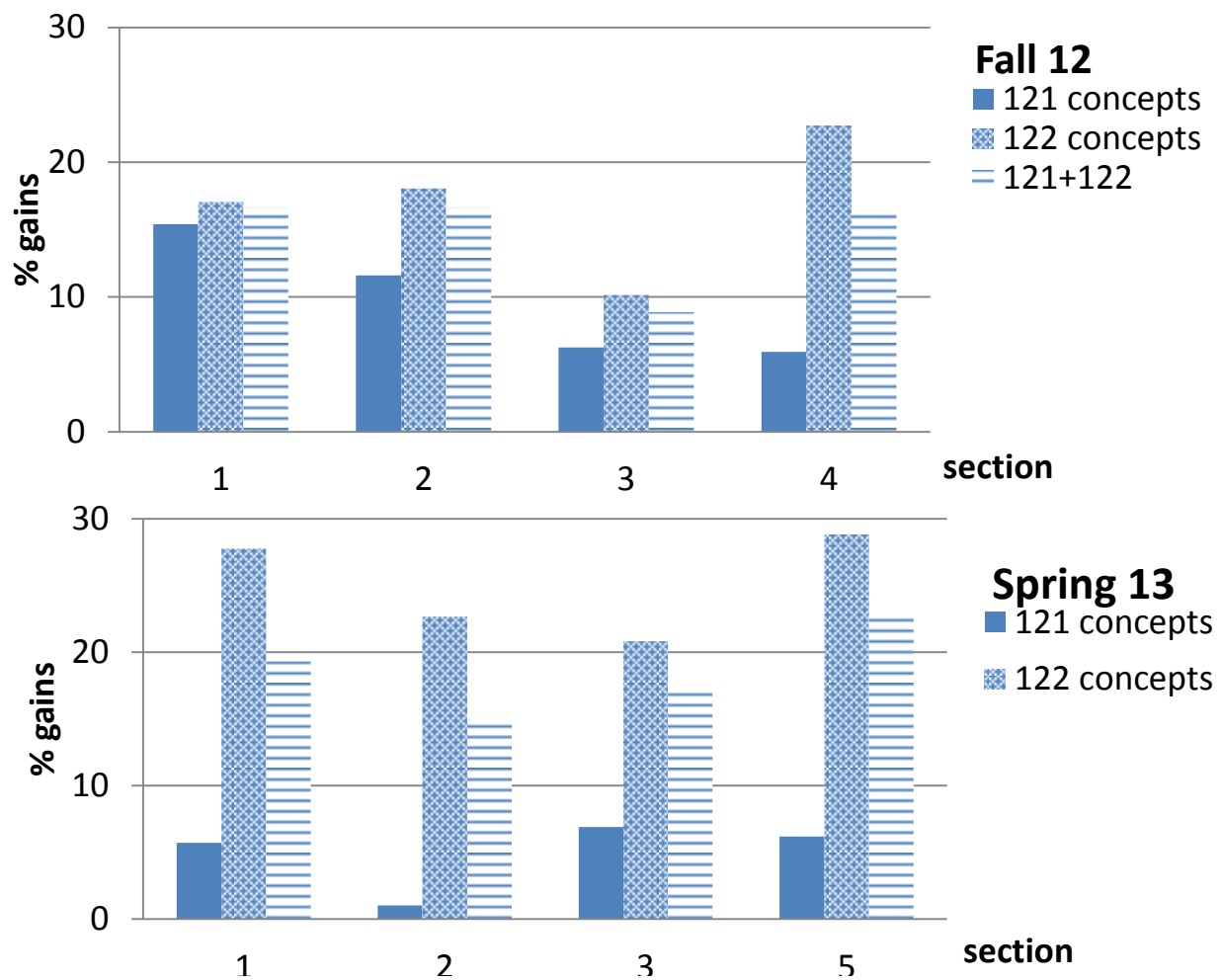


Figure 3 Normalized conceptual gains by section and with 121 questions separated from 122 questions.

**Background:**

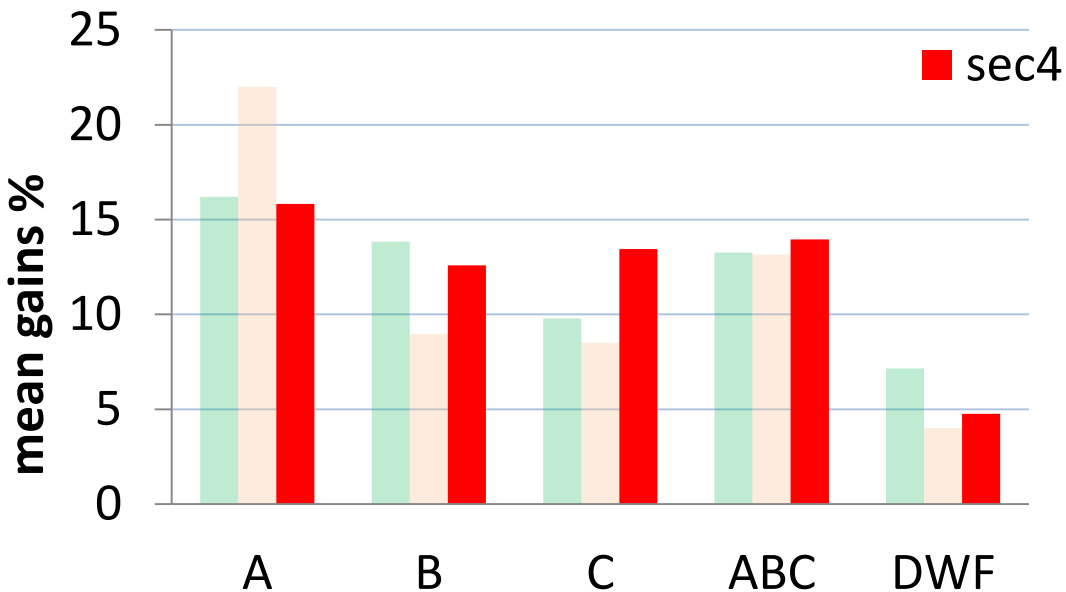
The averages of 121 and 122 questions were calculated separately in this analysis to reveal the conceptual gains in each set of questions. In general, the 122 concepts build on 121 concepts.

The normalized gains was calculated as  $(\text{post score} - \text{pre score}) / (100 - \text{pre score}) \times 100\%$ .

**Analysis:**

All redesigned sections show significant improvement in CHEM 122 concepts, ranging from 21 to 29%. The control sections had gains of about 16%. Interestingly, the control sections show a better gain on CHEM 121 material than the redesign sections, but this may be a function of the Fall-Spring difference rather than the redesign.

## Concept Gains by Grade



### Background:

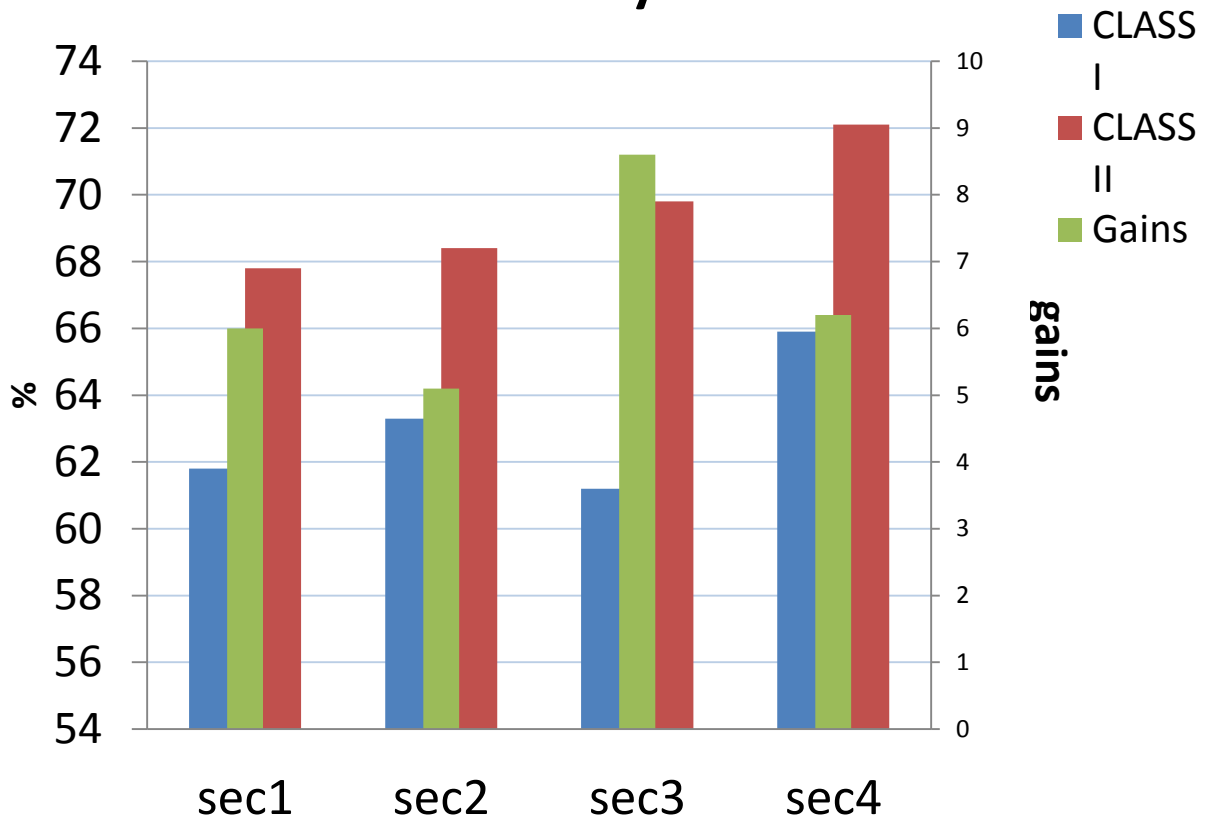
The performance gains for Fall 2012 were calculated as the absolute gains defined. The test section is plotted in red.

### Analysis:

The averaged gains of ABC students are significantly higher than those of DWF students by at least 5%.

The control sections show gains in proportional to the grades. The A students show higher gains than the B students, etc. However, from the test section, the averaged gain of C students is higher than B students; all grades show similar averaged gains. It is believed that the reformed approach provides a more balanced attention to all grade groups of students.

## CLASS I & II by Sections



### Background

The Colorado Learning Attitude in Science Survey (CLASS) was given to all students on week 3 and week 16 of the fall semester of 2012. Section 4 is the test section for the reformed course. The gains were calculated as the absolute gains.

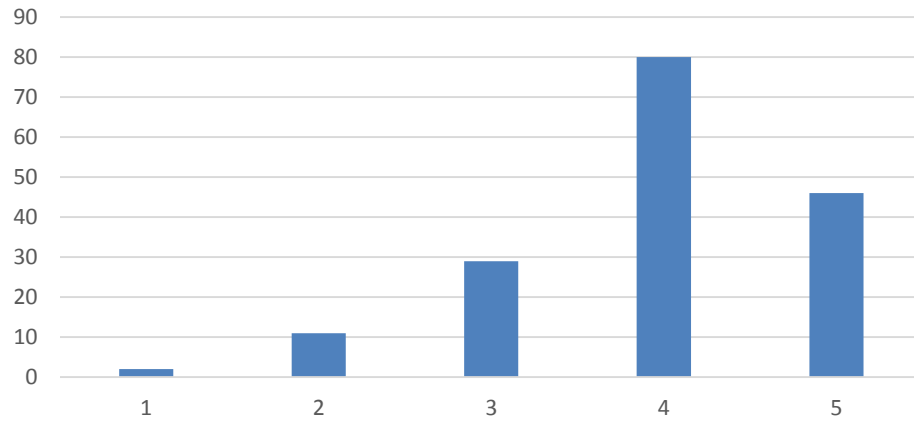
### Analysis

In Fall 2012, all sections showed gains on the Colorado Attitudes to Science Survey, with the pilot section (section 4) starting out the most positive and ending the most positive, with the 2<sup>nd</sup> largest gain. Interestingly, the largest gain was observed in the online section – section 3.

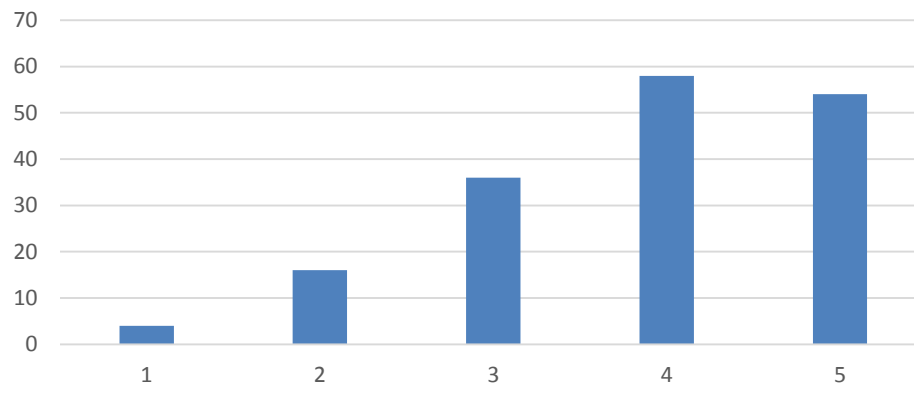
Although the pre and post CLASS was not complete in Spring 2013, the instructor of the largest redesign section (N = 250) collected results of a mid-semester survey in which students rated the effectiveness of particular components of the redesign for their learning. Results of these are shown below, with total number of students on the y-axis.

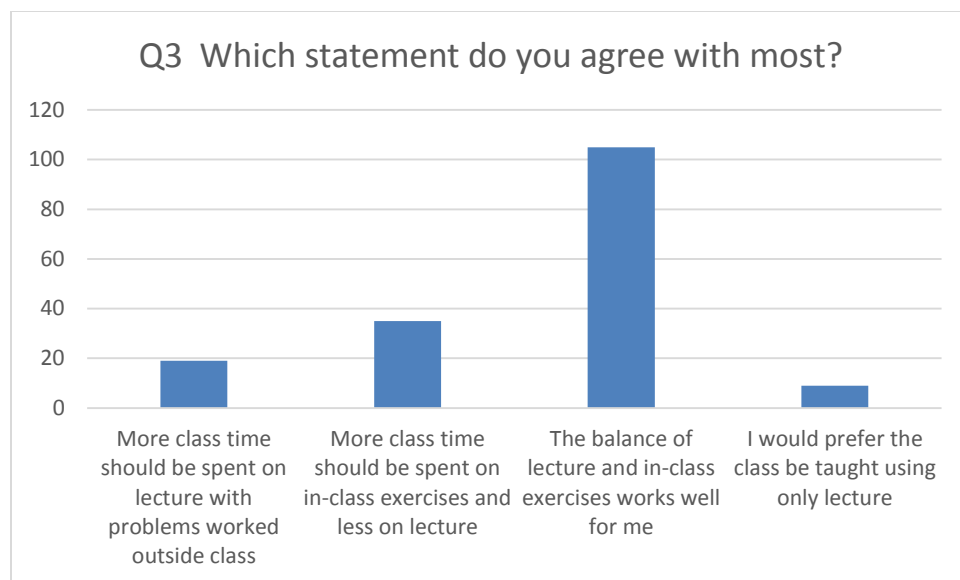


Q1: How well do the reading assignments and quizzes prepare you for class? (1- 5 where 1 = not at all and 5 = very much)



Q2 How effective are in-class exercises in helping you learn the material? (1-5 where 1= not at all and 5 = very much)





## Conclusion

The course redesign project was successfully scaled up from a single pilot section in Fall 2012 to all sections (4 sections total, 3 different instructors, of which one was not a member of the redesign team) in Spring 2013. The redesign materials were used in classes as small as 23 and as large as 250. Although course grades data does not yet reflect significant differences between student outcomes in the redesigned classes and in traditional classes, we do see a significant gain in a chemical concept inventory given pre- and post-class. With multiple instructors with different grading policies and many components, course grades can be difficult to compare, and as such, we are encouraged by the improved gain on the concept inventory. In addition, students respond well to the redesign (improvement in the CLASS attitudes to science survey, Fall 2012), and rate the components of the redesign as having a net positive effect on their learning (mid semester survey in 250 student CHEM 122 section, Spring 2013). We are continuing to analyze the course materials that corresponded to significant concept gains to recommend their use, and will work to improve course materials in areas that still show poor concept learning. Thus, the redesign will continue as an iterative process, and will benefit from discussions with new faculty teaching the courses and using the materials.

## General Raw Data for Pre, Post, Final, and Gains data, Spring and Fall

Spring 13						
mean (final exam)		pre	post	#	%	gains%
81.713	A	45.4054	60.9841	114	25.17	28.54
65.531	B	36.4565	45.8095	121	26.71	14.72
54.7938	C	36.1847	43.6325	99	21.85	11.67
48.5938	D	33.913	37.8333	32	7.06	5.93
39	F	29.6825	38.75	35	7.73	12.9
	W			52	11.48	
				453		
67.3459	ABC	39.3489	50.142	334	73.73	17.8
56.3062	DWF	35.5181	42.4251	119	26.27	10.71
Fall 12						
mean (final exam)		pre	post	#	%	gains%
75.75	A	34.7475	52.6263	33	18.13	27.4
59.2241	B	28.6667	37.9444	60	32.97	13.01
52.625	C	28.8333	38	40	21.98	12.88
45	D	26.0606	31.2121	22	12.09	6.97
35	F	27.7778	31.1111	6	3.3	4.62
	W			21	11.54	
				182		
62.5331	ABC	30.7492	42.8569	133	73.08	17.48
52.2831	DWF	27.8535	35.7189	49	26.92	10.9