



# Lab assistants, video production and growing pains:

## Restructuring general chemistry labs to improve cost recovery without diminishing the student experience

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### Abstract:

The economic realities of the past few years have put considerable pressure on any program that offers 3-hour, 1-credit lab courses. To address this problem, we have taken a number of steps to restructure our general chemistry lab offerings to improve the overall cost recovery and revenue generation within our department without compromising the high quality lab experience that our students have enjoyed. This has included some advanced planning in facilities design, the implementation of undergraduate General Chemistry Laboratory Assistants (GCLAs), and the production of pre-lab procedure and technique videos to spread the faculty's effort over a larger population of students. In addition to maintaining service to students enrolled in the class, the GCLA positions have proven to be extremely valuable experience for students hired to fill these positions.

### Introduction:

A quality laboratory experience is essential to a true appreciation of chemistry, but offering a traditional laboratory experience requires a significant investment of faculty time. With the Minnesota state budget situation of the last few biennia, departments across campus have been challenged to come up with creative ways to offer the classes necessary to support their majors as well as general education requirements in a way that is more fiscally sustainable.

### Student Credit Hours per Full Time Equivalent:

During previous administrations on campus, departments were assessed by comparing the number of credits the department generated to the faculty load, a ratio of student credit hours (SCH) to full time equivalents (FTE). The target number for SCH/FTE was 600. For disciplines that do not have 1-credit labs, this is the equivalent of teaching four 3-credit lecture courses each semester, each with an enrollment of 25 students. This is a quite manageable class load and allows for very low enrollment upper division classes to be offered if the enrollment of other classes is brought up to 30-35 or more.

In science classes, the traditional 3-hour lab significantly impacted SCH/FTE because it only generates 1 credit per student. For an average chemistry faculty member, a semester load might be two lecture classes and two lab classes. Lab classroom size limits enrollment in a lab class to 24 students. To achieve the 600 SCH/FTE target, the average chemistry faculty's two lecture classes would have to have an average enrollment of 42 students. While this is not an unreasonable target for lower division and general education classes, it offers no flexibility to offer the low enrollment upper division classes required by our majors. As an example, our typical Physical Chemistry or Inorganic Chemistry class has an enrollment of 10 or less. If the faculty teaching this low enrollment upper division class was also teaching a General Chemistry lab, the fourth class in his or her load would have to have an enrollment of nearly 80.

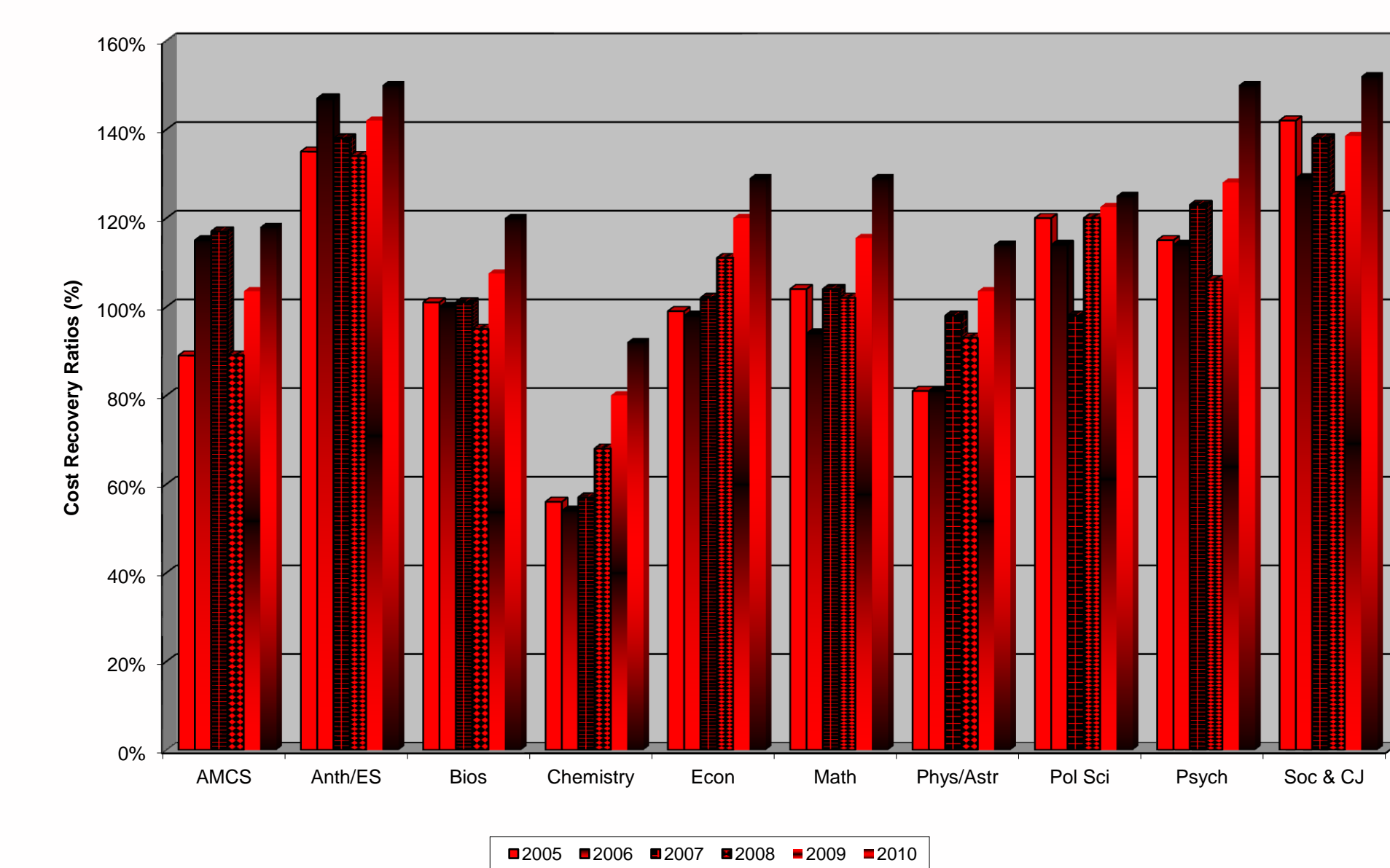
Historically, the Department of Chemistry has had a low SCH/FTE, often in the 400-500 range as a department. This has always been a concern, but it was understood that some departments on campus would always have a lower SCH/FTE due to the type of classes offered.

### Cost-Recovery Ratio:

With a new University President and the harsh realities of recent economic times, a different metric was chosen to assess the sustainability of academic departments. Cost-Recovery Ratio (CRR) is a slightly more straightforward metric; it is the amount of student tuition revenue generated by an academic department divided by the university's direct cost for that department, expressed as a percent. A self-supporting department is one that has a 100% CRR. CRR is easier to understand, but because it involves faculty salaries and other operating budget items, the numbers that are used to calculate CRR are a little more difficult to compile. Using the same assumptions as above, a faculty member teaching two 42-student lectures and two 24-student labs would have a CRR of approximately 103%. It is important to note that SCH/FTE and CRR are not significantly different metrics, they simply process the data slightly differently. The SCH/FTE target of 600 corresponds to approximately 100% CRR.

The CRR calculated for the Department of Chemistry was 56% for the period 2005-2007. In 2008, the CRR was brought up to 68%, but even with this improvement the department was still lagging behind the 100+% target. This led to the Department receiving special scrutiny during the 2008-2009 academic year as the 2010-2012 budget was being prepared. Changes obviously had to be made, and the changes had to be substantial.

College of Social and Natural Sciences Cost Recovery Ratios

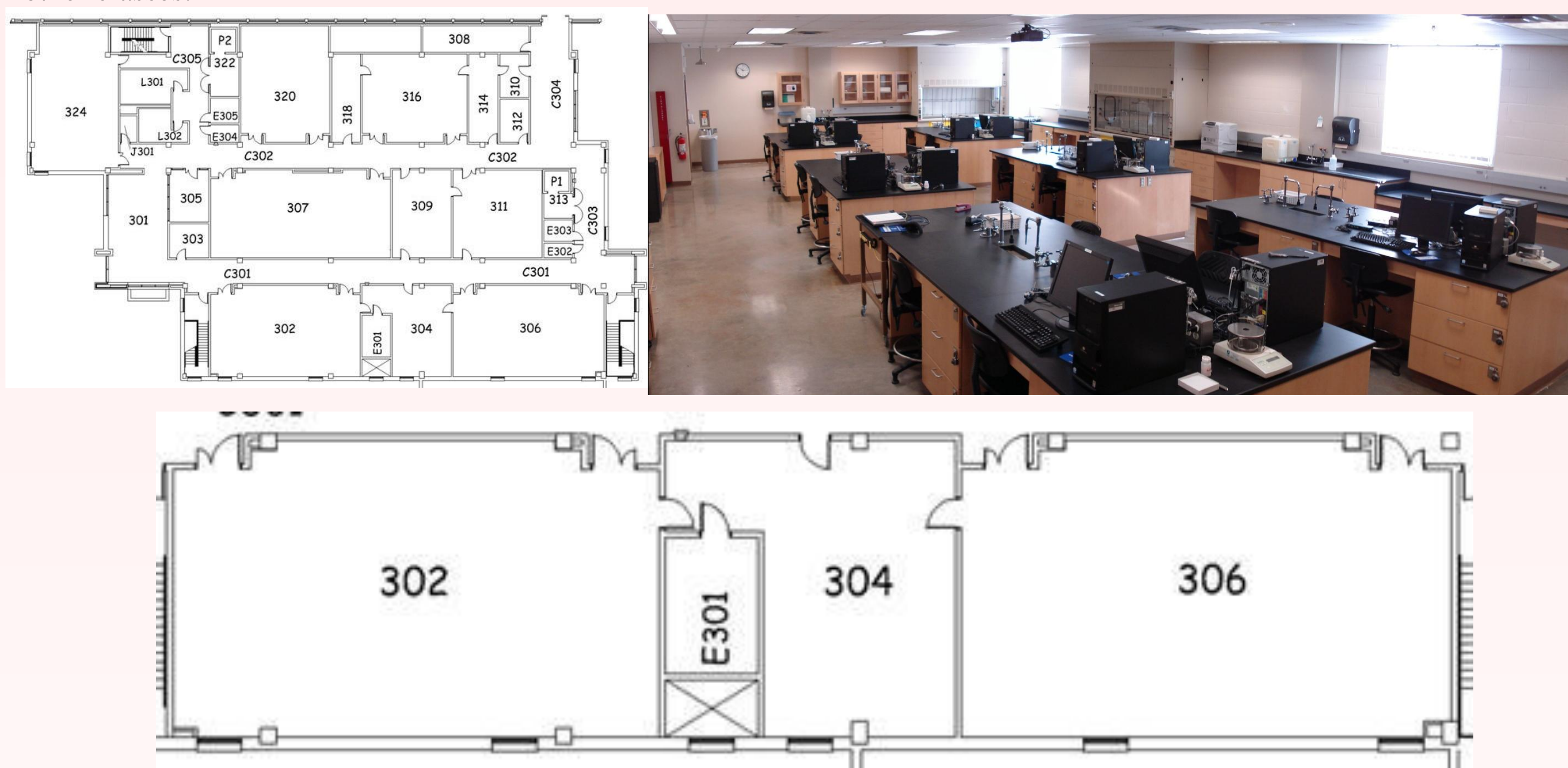


One factor in our favor is that as a whole, the College of Social and Natural Sciences (CSNS) has always had a positive SCH/FTE or CRR. For comparison:

College	2005-2007	2008
Arts and Humanities	92%	99%
Business and Industry	82%	85%
Education and Human Services	73%	85%
Social and Natural Sciences	105%	104%

### New Building Design:

In anticipation of changes to come, some design considerations were included in the new Science Laboratory Building that was completed in 2007. The most significant aspect of this design for the General Chemistry Laboratories is that there are 2 identical lab rooms with a common prep area that were intended to be used for General Chemistry as well as other classes.



The original intent of these identical rooms was to allow some additional flexibility in scheduling a variety of classes, but because these two lab rooms (each with a capacity of 24 students) are in close physical proximity, it is possible to run simultaneous labs during a single lab time period, allowing enrollment of up to 48 students per lab section. By scheduling General Chemistry labs in a continuous block, these two lab rooms are continuously occupied for 9-12 hours of the lab week (better facilities utilization) while still allowing significant flexibility during the remainder of the week.

### General Chemistry Laboratory Assistants (GCLAs):

Although offering lab in two room simultaneously allows a single faculty member to enroll twice as many students, there are some significant drawbacks to this system. The most pressing of these are:

1. Unsupervised students pose a safety hazard and a potential liability in case of accident
2. A single instructor splitting time between two rooms will result in longer wait times when students have questions or need assistance
3. Doubling the enrollment for a single faculty will double the grading load on that instructor

To address this potential deficiency, we decided to enlist undergraduates as General Chemistry Laboratory Assistants (GCLAs). Although this action was considered necessary, we were determined to use these GCLAs as supplements to the regular instructor and not replacements. This required a considered approach to the GCLA position description. The GCLAs duties are to:

1. Assist students with experimental set-up and design
2. Troubleshoot instrument, equipment and computer problems
3. Answer basic questions and serve as a liaison between students and the instructor
4. Serve as a positive role model for proper technique and safety in the lab
5. Attend a weekly GCLA meeting
6. Grade lab assignments using a detailed rubric provided by the instructor

To attract high-quality students to serve as GCLAs:

1. Students are selectively recruited from those who have completed (or are completing) the organic chemistry course sequence
2. Preference is given to chemistry majors and chemistry education/science education majors
3. The hourly pay rate (\$10/hour starting) is generous enough to emphasize the responsibilities of the position

In addition to the 3-hour lab period and 1-hour meeting each week, GCLAs are also responsible for grading lab assignments. This adds up to (on average) 4-5 hours per week over the 15-week semester. At \$10/hour, this is a cost of \$600-750 per GCLA per semester. For each two-room class, this means that the cost is approximately \$5000-7000 for a faculty instructor and \$1200-1500 for two GCLAs. If the total enrollment for the two-room class is 40 students (two full rooms would be 48 students), the cost recovery is approximately \$8000 for a CRR of 90-120%. For comparison, a one-room class of 20 students with one faculty instructor would have a CRR of 60-80%.

Although the financial arguments are compelling, the students' experience is paramount in evaluating the success of this program. Preliminary indications from course evaluations are extremely positive regarding the GCLAs. In addition to the positive outcome for students enrolled in the class, the GCLAs have noted a significant benefit in their own understanding of General Chemistry topics and their own thought processes when approaching their own classes. From the faculty perspective, the decrease in grading load has been critical to increasing class load without making the time commitment unmanageable and the preparation of a well-defined grading rubric has ensured consistency among the sections and lead to a more deliberate approach to assignment set-up and point assignment. Thus far, implementation of the two-room labs has been a positive experience for all parties involved.

### Pre-Lab Videos:

Another challenge presented by running two simultaneous is the format of a pre-lab lecture. In the past, lab began with a 5-20+ minute lecture during which the experimental techniques were explained or demonstrated and some of the underlying theory of the experiment was reviewed. With two separate rooms, it would no longer be possible to have pre-lab lectures in the lab. One option that is used by some faculty is to schedule a separate lecture room for a pre-lab lecture. To ease scheduling problems, I chose a different approach.

A consistent problem with some students is their lack of preparation before they arrive at lab. Using a pre-lab lecture at the beginning of lab only serves to enable this lack of preparation. To address this and the scheduling difficulties, pre-lab videos have been produced to take the place of an in-person pre-lab lecture.

Advantages of Pre-Lab Videos:

1. Students can watch the pre-lab according to their own schedule
2. Students can be required to take a quiz based upon the pre-lab video to encourage preparation
3. Students can utilize the full 3-hour lab period for experimental work, data collection and analysis rather than waiting for the pre-lab lecture to be finished
4. Since there are computers at each lab station, students can re-view videos while in lab to answer some of their own questions and gain a higher level of independence.



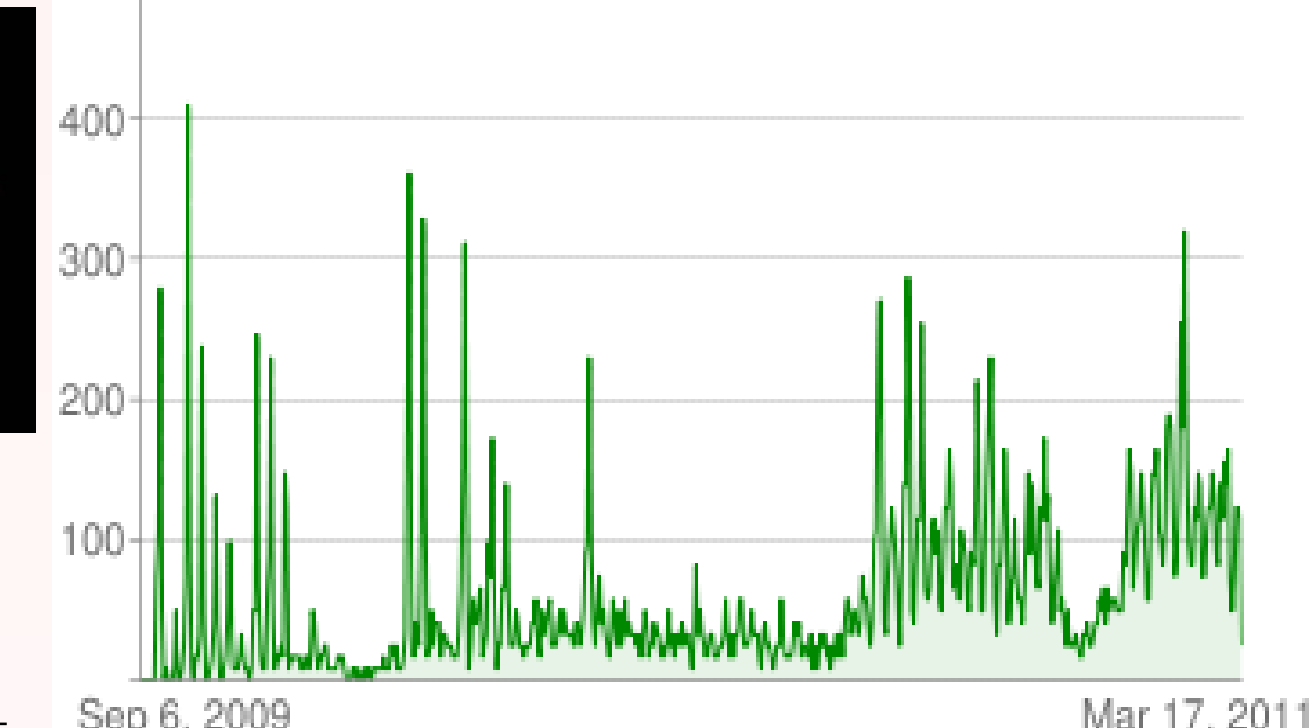
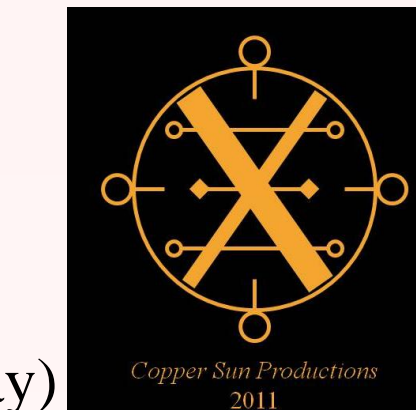
Since the first videos were uploaded, there have been

9/6/2009 → 3/17/2011 32346 views (58 views/day)

8/21/2010 → 3/17/2011 19212 views (92 views/day)

Views by region:

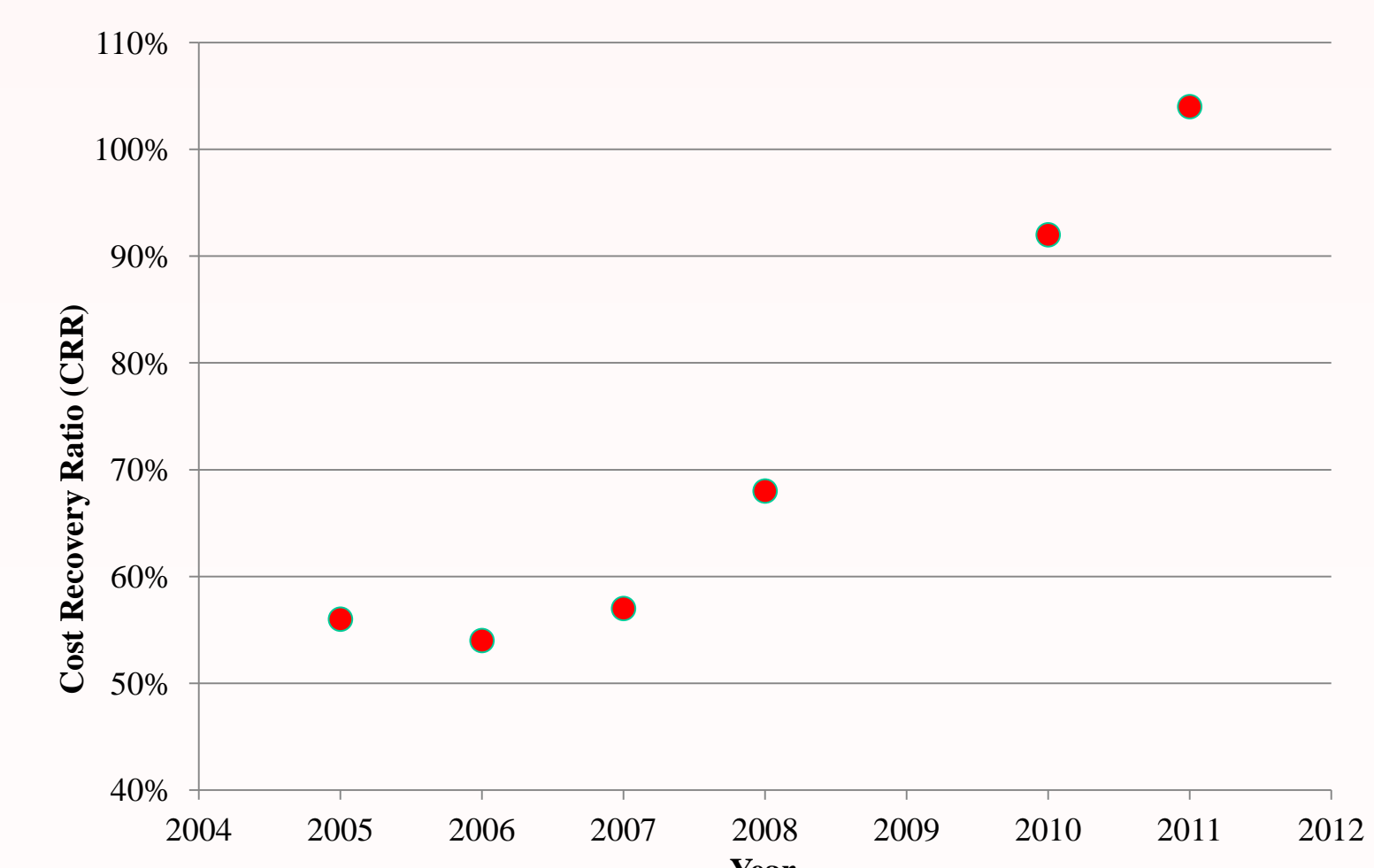
USA = 20325, Asia = 3923, Africa = 569, Europe = 3238, Middle East = 869, South America = 481



YouTube.com views per day of videos on www.youtube.com/user/drdbodwin

### CRR Implications:

Doubling up the General Chemistry labs has offered significant cost savings. In 2010, the CRR for the Department of Chemistry increased to 92%, due almost exclusively to changes in the General Chemistry labs. Another consequence of the change in General Chemistry labs is that a notable amount of faculty time has been liberated for other activities. With some strategic changes in our liberal studies/general education course offerings, we have been able to use this open time to offer other higher cost recovery classes. The estimated/projected CRR for 2011 is 104%.



### Evaluation:

Every aspect of these changes has been positive. Our department's CRR has improved, our General Chemistry students are getting a complete and positive lab experience, the GCLAs have reaped the rewards of their experience, and the faculty time commitment/grading load has been managed and perhaps even slightly decreased. These changes have forced us to evaluate our class planning and room usage and make more considered decisions about schedules and workload. We are also better able to compensate for faculty sabbaticals and leaves without resorting to adjunct or fixed term replacements.

Given the success we have enjoyed with these changes, it is difficult to identify negatives. One potential problem is that faculty will not have as close a connection to the lab students, but that is more a function of the individual instructor than the system. Another departmental issue is that the faculty time liberated by doubling up the labs must be used in a way that improves the overall CRR for the department. This could be a significant problem, but some careful and deliberate strategic planning of our entire Liberal Arts and Sciences Curriculum menu will make this change work to our advantage. Production of pre-lab videos can take significant time, but these videos are persistent and can be used multiple times so the time investment can be amortized over multiple semesters.

It is unlikely that we could revert to the "old" system of General Chemistry Labs without some significant changes in the culture and economy, but with the success of the changes we have made so far there is no reason to consider reverting.

### Acknowledgements:

The changes that have been implemented in the General Chemistry Laboratory program at MSUM would not have been possible without the dedication of all faculty and the excellent undergraduates who have served as GCLAs. We also appreciate the cooperation and understanding of the MSUM Administration as we transition through these challenging times.

