ACM-Teagle Collegium on Student Learning-Final Conference
Diane Angell-Biology Department St. Olaf College

Summary and Context (1 and 2)
This research project focused on the role of metacognitive assignments in two different biology courses. Many students can and do perform strongly in our biology classes. Others consistently struggle to get through courses despite a strong initial interest in the sciences. Some of these students also happen to be financially needy students from groups typically underrepresented in the sciences. Despite strong efforts, informal observations seem to indicate that biology often loses these students to other majors in the first several semesters of their biology courses. In order to target students that may often be less prepared for their science courses, I worked with two non-majors biology "Bridge" classes (during August of 2009 and 2010) designed for incoming SSS (Student Support Services) students to give them a head start on their academics as they enter St. Olaf as freshman. SSS is a TRiO U. S. Department of Education funded program that provides support for students throughout their college years. Each of the sections of this August Bridge class were taught by faculty other than myself in the Biology Department and had roughly 40 students. I also worked with two large (70 students per section) second semester biology majors courses taught during the spring of 2010. I taught one of these classes and the other was taught by a colleague. Both the Bridge classes and the second semester biology majors classes often include a set of students that are being considered for "Biologists for the Future" scholarships through a the National Science Foundation S-STEM grant. In addition to promoting retention for all students in the biology major we are especially interested in the retention of students typically underrepresented in the sciences.

Each of the four classes was divided in half and each half was emailed an "exam preparation assignment" several days before exams that they would then email back. Half of the class received metacognitively enriched assignments with questions geared towards getting students to think about and reflect on their own learning (Is there material from your lecture notes and/or textbook that you feel like you did not understand? Describe those topics. Why do you think you had trouble with these topics? Where did you lose points on your last exam?). The other half of the class had assignments geared towards students defining terms they had encountered in their text or lecture. No formal explanations or coaching were given concerning metacognition to either group. For three of the four classes the students did not know me personally, since I was working with classes that I was not teaching. Exam grade data was collected for each group to evaluate the effects of the assignments on exam performance.

Three of the four classes filled out a forty question version of the Motivated Strategies for Learning Questionnaire (MSLQ) at the start and end of the class. The MSLQ was developed at the University of Michigan by Profs. Pintrich, Smith, Garcia and McKeachie. This survey helped me evaluate whether students are specifically gaining metacognitive skills from the metacognitive assignments relative to the group simply assigned to define terms.

Conclusions and Evidence (4)
Metacognitively Enriched Pre-Assignments and Exam Grades
Several patterns are consistent among the classes that have been tabulated so far, despite the fact that final statistical analyses have not been completed. Students receiving metacognitively

enriched assignments before each exam had slightly higher exam grades. Although the increases are very small and unlikely to be statistically significant, each of the 3 classes analyzed so far showed the same pattern. Such small effects are perhaps not surprising given the fact that no direct instruction in metacognition was ever given. I never talked about the role metacognition may play in increasing student learning. Students were simply assigned questions to fill out that required the use of metacognition. They also received no feedback on their metacognitive efforts, a situation that would be unlikely if a faculty member were actually incorporating metacognition formally into an entire class. Again, although differences were very small, students receiving metacognitive assignments before each of their exams did perform consistently better on exams.

MSLQ Survey
Since students filled out the MSLQ at the start of the classes and at the end, I can compare the responses of those receiving metacognitive assignments to those receiving standard assignments. Here I focus only on the 20 metacognitive questions out of the 40 questions on the short version of the survey. Pre and post data for the MSLQ for the summer bridge class showed all students gained in metacognitive ability during the month. For the biology majors class students that were assigned the metacognitive assignments showed small increases in their total metacognitive score (all metacognitive questions summed), while those assigned to define terms showed no increase.

Across the semester in the classes considered so far, students with higher metacognitive scores on the MSLQ had a slightly higher final grade. Given that students arriving at St. Olaf seem underprepared for college classes, the metacognitive scores at the start of the summer Bridge class were compared with metacognitive scores on the MSLQ at the start of our second semester biology major's course. The major's course is roughly half freshman in their spring semester and half sophomores. Despite the likely differences in experience between the two groups of students at the start of each of these classes their metacognitive scores were surprisingly similar. It is possible that students starting a new college experience are less likely to answer the metacognitive questions as honestly as the relatively confident second semester freshman and sophomores.

Future Analyses
In addition to the basic findings described above, there are other kinds of information I will be gathering. Both assignments asked students to estimate the grade they expected to get on the exam. I will explore whether students that received the metacognitive training are more accurate with their estimates than those simply asked to define terms. I would also like to consider whether weaker students gain more from the metacognitive assignment than stronger students.

Implications and Looking Ahead (5 and 6)
These data have continued to convince me that metacognition is valuable. Although the effects of metacognitive assignments only had a small effect on exam grades it was surprisingly consistent. Moreover, in this study, students simply completed an assignment that asked them questions geared toward making them be more metacognitive about their learning. Students were forced to use metacognition without actually understanding what they were doing. Clearly talking to students about the research literature associated with metacognition would make any assignment much more motivating and actually increase their effort and effectiveness in using

metacognition. Feedback on my part on their metacognitive efforts would also be helpful. Some students thought deeply about the assignment while others clearly did not.

Since I was aware that I had used metacognitive strategies abundantly as a student myself, I have always talked to students with a metacognitive mindset in the past, coaching them to think about what information they did and did not understand deeply. With the research and reading I have done so far, I can now be more focused and purposeful in those efforts. I was pleased to discover some specific papers on metacognition in the sciences and so am enthusiastic about the power of metacognition in student learning.

Bibliography/ Key Resources (7)
Allan, J. and Clarke, K. 2007. Nurturing supportive learning environments in higher education through
      the teaching of study skills:To embed or not to embed. *International Journal of Teaching and Learning in Higher Education* 19(1): 64-76.
Kruger, J. and Dunning, D. 1991. Unskilled and unaware of it: How difficulties in recognizing one's
      own incompetence lead to inflated self-assessments. *Journal of Personality and Social Psychology* 77(6): 1121-1134.
Nietfeld, J. L., Cao, L. and Osborne, J. 2005. Metacognitive monitoring accuracy and student
      performance in the postsecondary classroom. *The Journal of Experimental Education* 74(1):7-28.
Zohar, A. and Peled, B. 2008. The effects of explicit teaching of metastrategic knowledge on low-and
      high-achieving students. *Learning and Instruction* 18:337-353. (science specific)