

78

**IPESL Grant Application**  
(Initiative to Promote Excellence in Student Learning)  
Minnesota State University, Mankato

**PROPOSAL COVER PAGE**

Title of Project: Integrating Critical Thinking with Audience Response Systems

Name: Brian Groh

Are you full-time faculty in 2006-2007?  
(fixed-term faculty are not eligible to apply)

Yes

Do you plan to return to MSU in 2007-2008?

Yes

e-mail: brian.groh@mnsu.edu

Campus Address: 242 N Trafton Science Center

Campus Phone: 5921

College: Science, Engineering and Technology

Department: Chemistry and Geology

Spring Semester Schedule:

List times when available to participate in Learning Communities and workshops.

Mondays: 12-2

Tuesdays: 8-10; 12-2

Wednesdays: 12-3

Thursdays: 9-12

Fridays: 12-4

Brian Groh  
Signature of Applicant

Brian Groh  
Signature of Department Chair/Director/Supervisor

John J. [Signature] 11/27/06  
Signature of College Dean/Vice President

## **Integrating Critical Thinking with Audience Response Systems**

### **Purpose of project**

Organic chemistry is a course, serving approximately 200 students annually, that is rich in abstract and difficult to master content and is currently taught primarily through lecturing. This combination of extensive content and lecture often results in overwhelmed students who tend to tune out early during the lecture. I am proposing to incorporate interactive question and discussion breaks that integrate critical thinking. The key to successfully encouraging student participation, and engagement while incorporating critical thinking, such that all students will participate, employs an audience response system (ARS) to poll students and facilitate follow up discussion. Questions that require careful analysis and evaluation of possible answers will be developed. Students will be encouraged to work together to arrive at solutions to the problems. Instant feedback by displaying the class distribution of scores from ARS polling will facilitate critical analysis and discussion of the wrong responses as well as the correct one. Students will actively participate in this discussion and analysis. As a result of this process I expect students to show an improvement in polling and standardized exam scores as they develop critical thinking skills. Critical thinking herein involves the solving of complex problems, such as analysis and evaluation of multiple possible solutions to a problem (eg. correct synthetic sequence of reactions to solve a multi-step synthesis or the determination of a compound's structure based upon spectral data). Students will follow fundamental rules and concepts of organic chemistry to draw inferences, and evaluate potential solutions to these and similar problems.

### **Project description and how enhances critical thinking**

The use of question/discussion breaks in conjunction with ARS will enhance student participation. Unlike many of the publisher supplied ARS questions, those developed under this proposal will require critical thinking. Critical thinking will be enhanced in at least two ways. First is through the use of questions requiring critical thinking such as applying systematic nomenclature rules to the naming of a compound, multistep synthesis or spectral data interpretation. Multiple solutions may be presented but only one correct answer is possible. For example, a multistep synthesis may be carried out with identical reagents applied in differing sequences to give very different products. Careful analysis of the reagents and sequence of addition will reveal the correct answer. By displaying the polling response distribution it will be possible to identify problems in understanding the concepts and allow further discussion of the wrong as well as the correct answers. Second, a follow-up question similar to the first will be presented that should test and reinforce students' critical thinking skills over the concept previously discussed. Students who understood the reasoning behind the previous question should score well on the follow up question. Use of ARS and awarding points for participation and correct answers will help to ensure high participation rates and increased interest. All chapters covered in this course will have question sets developed that will be used in many but not every lecture. These may be used in conjunction with appropriate publisher provided questions to create a comprehensive experience in the question/discussion sessions.

### **Assessment of project**

At the end of the semester students will be required, as in the past, to take a standardized exam written by the American Chemical Society. I will compare scores from this exam with data from national scores as well as data on select questions from previous standardized exams I have given. Based on these data I will make comparisons of past classes with the current class to determine whether there is a difference in student performance. In particular I would expect students to

demonstrate a better grasp of concepts, such as multistep organic synthesis and spectral interpretation. I will also analyze student scores during the semester looking for an improvement in overall correct scores recorded by the ARS polling. Finally, students will be asked to complete a survey on their perceptions of their critical thinking skills and their class participation.

#### **Project dissemination**

I will submit a paper to a regional or national meeting of the American Chemical Society and possibly to *the Journal of Chemical Education* describing the results. I also expect to present this work at a university seminar series as part of the grant. I am part of a group of three faculty from our college who meet to discuss best practices using ARS and anticipate sharing my work with them. This project will impact organic chemistry which serves approximately 200 students annually for whom critical thinking is a fundamental skill needed to successfully complete this and advanced chemistry courses.

#### **Department and university goals**

This project will address department goal 7 - *The department will continue its commitment to the improvement of teaching effectiveness and curriculum enhancement.* This project also helps meet the university strategic priority of enhancing academic excellence in undergraduate studies.