

**IPESL Grant Report
(Initiative to Promote Excellence in Student Learning)**

**Project Title:
Integrating Critical Thinking with Audience Response Systems**

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Purpose of project

This project combines creation of interactive questions followed by discussion breaks that integrate critical thinking into lectures in organic chemistry. The key to interaction and successfully encouraging student participation while incorporating critical thinking, *such that all students will participate*, employs an audience response system (ARS) to poll students and help initiate follow-up discussions. This project required the authoring of a bank of questions that will be used this fall in organic chemistry.

Note that since this project is tied to a course offered only in the fall semester, no assessment data has yet been collected and analyzed and cannot be presented here.

Results and Discussion

A variety of general questions were created such that they could be used with the current text, but also be used in conjunction with other organic chemistry texts with little or no modification. Multiple choice questions were created for each chapter covered. These questions were designed to invoke critical thinking as much as possible. This is counterintuitive as the use of multiple choice questions would seem to circumvent critical thinking.

During a lecture, definitions and rules are introduced followed by one or more examples. Subsequent to this, multiple choice questions are displayed that require the use of the rules or concepts presented to answer the questions. Students then use their ARS to respond. During the response period, students are encouraged to discuss the possible answers with each other. To encourage student participation, students are given credit for simply responding. Twice as much credit is given for a correct response. This encourages students to think through the possible answers and seek insight from others. This interaction may include discussion about not only what answer is correct by why it is correct and why the others are wrong. The rapid anonymous response possible by using an ARS gives students feedback and helps to keep them all engaged. Knowing how others responded helps them understand their position in the class. Knowing their response relative to the correct answer begins to raise questions as to why, and what is wrong with other popular choices that were incorrect.

Initially it was assumed that great critical thinking questions could be developed for this course. However, it was difficult at best to create multiple choice questions that require critical thinking. This has clearly been a challenge. During the development of the questions, it became evident that the discussion that should occur during the answer response period is very important to student learning. Upon revealing the class responses, the correct response will not be immediately identified but assumed to be the most popular choice. The presumed incorrect answers can be discussed by the class as to why they are incorrect. Much learning can come from the discussion of the incorrect answers and why they are incorrect. On occasion, the most popular answer may not always be the correct one. This will lead to some interesting discussion and revealing of the correct answer by the students. Engaging students and getting them to understand the answers is a doorway into more in depth, critical thinking. It also encourages student questions that may otherwise be left unasked.

It was not the original intent to capitalize on the discussion surrounding answer choices. However, it is emerging in my mind as a strong component of involving students in critical thinking. Drawing a student into a discussion may be more easily accomplished through their participation using an ARS system. Their interest piqued, students may be more readily pulled into active discussion of the answers and the class distribution of choices.

Only two weeks into the semester, I have not been able to do more than an initial trial of the system. I can see that the discussion component will be a critical piece of this project. I intend to consider thought provoking questions about correct and incorrect answers and may modify the existing questions for future use. I will work on the assumption that the most popular choice is correct and discuss why the other answers are incorrect. I will capitalize on discussion of the presumably incorrect answers and will be excited when the most popular answer is an incorrect choice. What ever the result of the polling, the active participation will enhance student interest and learning considerably. The incorporation of critical thinking will enhance the learning even more.

I anticipate refining of questions and discussion during the implementation of the project. It may well be a work in progress for some time to come. I also plan to take notes on particularly good questions, majority responses different from what I expected and use them in the future to strengthen presentation of concepts that students do not seem to understand.

Dissemination of the project results

I expect to be able to present the findings of this project at a National Meeting of the American Chemical Society, Division of Chemical Education and the Biennial Conference on Chemical Education. Both are arguably the premier meetings at which to present this sort of work. I also would consider presenting this at a local or regional meeting such as the Collaboration for the Advancement of College Teaching and Learning in the Twin Cities in February. This work will be presented in oral or poster format as may be appropriate at a particular conference.