11 Active Learning Practices in Chemistry Courses

Flipping a Massive General Chemistry Lecture: A Three-year Analysis of Results and Techniques, AMANDA HOLTON1*, WENLIANG HE2, and GEORGE FARKAS2 (1Department of Chemistry and 2School of Education, University of California, Irvine, Irvine, CA, 92697; abrindle@uci.edu, hewenliang@gmail.com, gfarkas@uci.edu).

Flipped classrooms in massive lecture halls offer many unique options and challenges. The presentation will include a discussion of a fully and partially flipped classroom of over 300 students. The two studies discussed have direct comparisons to control classrooms taught in a traditional lecture format. The courses were taught by the same instructor, and include isomorphic exams. Results were compared in authentic long-term settings. Results include quantitative discussions on learning outcomes, motivation, perceived class quality and a qualitative analysis of students’ opinions. In addition to quantitative outcomes, common practical implementation issues and their solutions will be addressed. Discussed implementation issues will include assignment accountability, in-classroom response systems, video creation and preparation time.

An Interdisciplinary Project-based Laboratory: Determination of N-Methylaniline in Gasoline using ATR-IR and GC-MS, FANGYUAN TIAN (Department of Chemistry and Biochemistry, California State University Long Beach, 1250 Bellflower Boulevard, Long Beach, California 90840; Fangyuan.Tian@csulb.edu).

A project-based learning (PBL) laboratory was introduced in the upper-division instrumental analysis course. In this PBL approach, organic, physical and analytical chemistry are integrated in an undergraduate laboratory setting. N-methylaniline as an antiknock agent is widely used in fuel additives. During the multipart experiment, N-methylaniline was synthesized through a one-step hydroalkylation of nitrobenzene over copper/chromium-containing catalyst. The resulted products were characterized by attenuated total reflectance infrared spectroscopy (ATR-IR), and complemented with density functional theory (DFT) studies. The vibrational frequency calculations were performed with the Gaussian 16 suite of programs with the B3LYP functional and 6-31+G(d,p) basis set. The experimental spectra were compared with the simulation results to provide a visual aid on understanding molecular vibrational and rotational motion. Finally, students were provided with a gasoline sample with an unknown amount of N-methylaniline, and they were guided to use both ATR-IR and gas chromatography-mass spectrometry (GC-MS) for analysis. These two instrumental methods were compared in terms of limit of detection (LoD) and limit of quantitation (LoQ). Student learning outcomes were assessed by laboratory notebooks and ACS-style lab reports.

Choose Your Own Adventure! An Attendee Guided Presentation About Active Learning Strategies in Chemistry Courses, NATHAN D. RAWLINSON (Science Department, Treasure Valley Community College, Ontario, OR 97914; nrawlinson@tvcc.cc).

Instead of giving a 25-minute lecture based presentation about the merits and benefits of active learning over conventional lectures, this presentation will be directed by attendees to the topics of most interest. My successes and failures implementing a variety of active learning strategies will be used as a case study to highlight how active learning approaches have helped my students. Active learning strategies that I have used include clicker based polling, flipped classroom format, student led and directed organic synthesis experiments, students teaching problems to the whole class, alternative testing methodologies, and others. Topics of presentation could include the why of each active learning technique, how to implement each technique, the successes I have had, the challenges of each technique, student receptiveness to these techniques, etc. In this presentation, I will try to practice what I preach. Active learning and engagement in a symposium presentation.

Active Learning Simulation Activities for an Analytical Chemistry Course, KARNO NG (Department of Chemistry and Biochemistry, California State University San Marcos, 333 S. Twin Oaks Valley Rd., San Marcos, CA 92096; kng@csusm.edu).

Active Learning In Chemical Education (ALICE) is an innovative teaching approach. It minimizes the traditional lectures. Instead, students work in small groups or individually during the class time in a cooperative setting. With the ALICE approach, students are transformed from passive listeners to active learners, and the instructors become facilitators or guiders. This project describes the use of ALICE to introduce the Beer’s Law concept in an Analytical Chemistry course. The relationship between different terms of Beer’s law was investigated by running the simulations on Excel with a guided inquiry worksheet. In addition, factors that lead to deviations from Beer’s Law were investigated by running a web-based simulation. Different arrangements for running the simulation in the classroom were investigated and it was concluded that each student running his or her own simulation and conducting the investigation provides the best learning experiences. It was found that with this arrangement, students initiate discussion with classmates. At the end of the investigation, students
took turns to present their results from the investigation. The instructor provided clarification if needed. The effectiveness of the described active learning method was evaluated by comparing the test results with the traditional lecture method. It was shown that there is no significant difference in student performance between the two methods. A class survey conducted at the end of the semester indicated that students preferred the active learning approach over the traditional lecture. These results show that active learning method has the potential to replace the traditional lecture.

An Examination of Student Outcomes in Studio Chemistry at California Polytechnic State University, ALAN L. KISTE* and GREGORY E. SCOTT (Department of Chemistry and Biochemistry, California Polytechnic State University, 1 Grand Ave. San Luis Obispo, CA 93407; akiste@calpoly.edu, gscott02@calpoly.edu).

Twenty years ago, a major curriculum revision at California Polytechnic State University led to the implementation of an integrated lecture/laboratory (studio) experience for our engineering students taking general chemistry. Based on these twenty years of experience, construction of four purpose-built studio classrooms to house the majority of the remaining general chemistry courses was completed in 2013. A detailed study of the effects of the entire ecology of the studio experience on student success was initiated at that time. Data from content knowledge pre- and post-tests, learning attitudes surveys, and student course evaluations show positive effects on student performance, the development of more expert-like learning attitudes, increased student engagement, and increased student-instructor interactions vs. the previous separate lecture and laboratory instruction. Our data also show that an associated new peer Learning Assistant program increases student engagement while also having positive impacts on the Learning Assistants themselves.

Brewing in Lab? Inquiry-Based Approach to Analytical Chemistry, GREGORY A BARDING JR. (Chemistry and Biochemistry Department, California State Polytechnic University Pomona, 3801 W. Temple Ave., CA 91768; gabarding@cpp.edu).

Traditional laboratory are controlled experiments where the outcome is known and the students generally follow a recipe. These can be useful tools for expressing theory directly through application, however students often become focused on the outcome instead of the process. Traditional labs seldom foster innovation, introspection, revision, and failure. In fact, the “right answer” becomes the goal, instead of the knowledge that is being tested. In contrast, inquiry-based approaches place the focus on the journey of discovery, where students are given specific tasks or objectives and then have to design the experiment, test a hypothesis, revise the procedure and repeat. Depending on the experiment, the outcome can be known or at least expected with the added benefit that the students have to interpret their data independently. Using this model, I have recently developed and implemented a lab focused on brewing a “beer-like” product in an upper division spectroscopy course. Students are tasked with developing a hypothesis focused on fermentation conditions (such as temperature, mineral content, etc). The experiment design must include a control, a treatment, and a proposed procedure for analysis from the primary literature. Although guided, the students are encouraged to understand these fundamental aspects of designing an experiment independently, and finally testing their own independently generated hypothesis. I will present the design, implementation, organization, outcomes, and pitfalls associated with this specific inquiry-based project and what future iterations might entail.