Using Technology to Flip an Undergraduate Analytical Chemistry Course

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Abstract

This paper describes the design and implementation of a blended analytical chemistry course. The redesign applied to the lecture portion of the course. The objective of the approach was to improve students’ “quantitative problem solving and conceptual understanding of the material in a junior-level undergraduate analytical chemistry course. The redesigned course was inspired by the flipped classroom concept. Lecture materials were made available online to accompany a free online textbook. The online materials incorporated text, graphics, and video clips embedded in publicly available flash presentations. Post-presentations provide a mechanism for guiding learners through the self-study learning path, providing an atomic concept linked to a non-linear knowledge structure while allowing them to “flip” in and out of material as they wish. The class period included short tests to ensure students were familiar with assigned content, a short review and question session, and one or two multiple choice questions to test knowledge of concepts. The majority of classroom time involved students working in small teams to solve online homework questions with the guidance of the instructor. Students were assessed using graded online homework, shortanswer written tests and a standardized American Chemical Society (ACS) multiple-choice test. The success of the approach was assessed using pre- and post-course questionnaires and student performance on the ACS test compared to previous years. This presentation will report on the findings of this approach in terms of student learning and attitude.

Course Description

• Junior-level analytical chemistry course
• Offered every fall
• Required for chemistry and biochemistry majors
• Taken by other science majors for the chemistry minor
• Typically 8 to 14 students
• Class meets twice a week for 1 hour 15 minutes
• Laboratory session once a week for 2 hours 45 minutes

Student Learning Objectives:
• to familiarize students with the theory and implementation of some quantitative methods
• to improve laboratory and data treatment skills
• to reinforce and extend the general chemistry material and apply it to analytical chemistry
• to gain experience in maintaining a proper laboratory notebook
• to become proficient in report writing in an acceptable format
• to improve scientific thinking and problem solving ability
• to improve communication skills, both written and oral

Assessment:
• Online homework
• Three written in class exams
• Comprehensive standardized final (ACS)
• Laboratory reports and notebooks
• Performance and presentation of a laboratory based problem-solving activity

Why Change?

• Passive to active learning environment
• Increased instructor-student interaction
• Satisfies student requests for more help on homework
• Instructor time used more efficiently (students struggle more with problem solving than content)

Table 1: Comparison of Old and New Learning Models

<table>
<thead>
<tr>
<th>Question</th>
<th>Pre Course (Mode response, N = 13)</th>
<th>Post Course (Mode response, N = 11)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I Learn well by...</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Using computer-based materials</td>
<td>Agree</td>
<td>Strongly agree</td>
</tr>
<tr>
<td>Reading a (good) textbook</td>
<td>Agree</td>
<td>Neutral</td>
</tr>
<tr>
<td>Getting good help / tutorial aid</td>
<td>Agree</td>
<td>Neutral</td>
</tr>
<tr>
<td>Completing presentations</td>
<td>Agree</td>
<td>Strongly agree</td>
</tr>
<tr>
<td>Writing papers</td>
<td>Neutral</td>
<td>Disagree</td>
</tr>
<tr>
<td>Completing lab notebooks or lab reports</td>
<td>Neutral</td>
<td>Agree</td>
</tr>
<tr>
<td>Reading and re-reading materials</td>
<td>Strongly agree</td>
<td>Agree</td>
</tr>
<tr>
<td>Working on my own</td>
<td>Strongly agree</td>
<td>Agree</td>
</tr>
</tbody>
</table>

Figure 1: Responses to pre and post course survey questions related to learning style where changes on mode response were recorded

Figure 2: Test Scores for the American Chemical Society Analytical Chemistry Exam

Outcomes

Students very positive of approach according to informal discussion and anonymous student evaluation comments. ACS test scores were highest recorded and well above national averages. Pre and posts course surveys based on the Field-tested Learning Assessment Guide (1) suggested that:
• Students believe computer based materials have a strong positive emphasis on their learning
• Students feel less need for outside help after completing the course
• The textbook is deemphasized
• Students apply less importance to working by themselves pointing to an increased appreciation of team learning

Resources

(1) Available at: www.flaguide.org

* Course Prezis available at: foxweb.marist.edu/users/neil.fitzgerald/analyticalchemistry
‡ News and information at: www.facebook.com/analyticalonline

Instructional Technology

Lectures replaced by online resources using Prezi: *
• Cloud-based, story-telling presentation tool
• Flash platform incorporating text, images, voice-overs, animations and YouTube videos
• Allows material to be presented in a non-linear format to guide student’s learning
• Available on a variety of devices (including ipad and iphone)