Flipping the General Chemistry Laboratory Lecture: Increasing Student Engagement By Enhancing Self-Directed Learning

Katrina Idárraga, Hannah T. Nennig, and Dr. Roslyn M. Theisen
Department of Chemistry, University of Wisconsin- Eau Claire

Project Overview

Strengthening instruction in STEM fields can benefit student learning as well as foster positive attitudes towards the sciences. This project tries to answer the question whether there is a measurable difference in understanding of and attitudes towards chemistry of two groups: students who complete a General Chemistry course where the laboratory lecture is in a flipped format and students who complete a General Chemistry course where the laboratory lecture is in a traditional lecture format.

In this study, flipped and traditional student attitudes and understanding will be assessed by several quantitative and qualitative measures. A published, validated and reliable attitude survey on the subject of chemistry will be given to student participants (the AC SI-V2) at the beginning and at the end of the course. To quantitatively assess student understanding of General Chemistry of all groups, standardized final exam scores were examined and statistically analyzed.

Goals
- Gather information about the impact of flipped or traditional teaching modes on student learning.
- Measure student understanding of General Chemistry.
- Measure student attitudes towards the subject of chemistry.

Hypothesis
Our hypothesis is that students who are enrolled in the flipped curriculum course will have a higher measurable outcome of understanding of and attitudes towards chemistry.

Why Flipped Learning?
A flipped course combines the best features of face-to-face teaching with those of the online learning environment. This learning style is a pedagogical approach in which direct instruction moves from the classroom to the home, and the resulting group space is transformed into a dynamic, interactive learning environment.

Flipped Learning Involves:
1. Flexible learning environments
2. Student-centered classrooms
3. Just-in-time teaching
4. More intentional instruction

While flipped lectures courses have appeared throughout the undergraduate curriculum, flipped laboratory experiences are more rare.

Data and Results

<table>
<thead>
<tr>
<th>Timeline of Events</th>
<th>Data Collection Fall 2014 and Fall 2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part Description</td>
<td>Data Collection Fall 2014 and Fall 2016</td>
</tr>
<tr>
<td>Pre-Course</td>
<td>ASCIv2 attitude survey was given to participating students on the 6th week of the course. Bonus points were awarded for participation.</td>
</tr>
<tr>
<td>Lab and Lecture</td>
<td>All groups covered the same topics in lab and lecture and were given similar assessments, but differed in lab lecture content delivery mode (flipped or traditional).</td>
</tr>
<tr>
<td>Post-Instruction</td>
<td>The same standardized final exam was given to all students</td>
</tr>
<tr>
<td>Final Exam</td>
<td>ASCIv2 attitude survey was given to participating students after the 15th week of the course. Bonus points were awarded for participation.</td>
</tr>
</tbody>
</table>

Assessment of Attitude

Attributes are an important non-cognitive factor in science literacy that science educators emphasize. The assessment of both academic achievement and non-cognitive values are an essential component of science education.

The Attitude Toward the Study of Chemistry Survey (ASCIv2) is a semantic differential survey created by Xu and Lewis (2011).

- Items 1, 4, 5 and 7 needed to be re-coded in order for higher scores to represent positive attributes of students’ attitudes.
- The ASCIv2 has two subscales: intellectual accessibility (IA) and emotional satisfaction (ES).
- Items 1, 2, 3 and 6 load on the IA subscale and items 4, 5, 7 and 8 load on the ES subscale.

Final Exam Average and Final Course Average

<table>
<thead>
<tr>
<th>ACS Raw Score Out of 70</th>
<th>Course Grade Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional Mean</td>
<td>32.8</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>8.0</td>
</tr>
<tr>
<td>N</td>
<td>87</td>
</tr>
<tr>
<td>Flipped Group Mean</td>
<td>33.3</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>7.8</td>
</tr>
<tr>
<td>N</td>
<td>65</td>
</tr>
</tbody>
</table>

Attitude and Final Exam Score

- Both Emotional Satisfaction and Intellectual Accessibility (measured by the post-ASCIv2 survey) at the end of the semester was significantly correlated with ACS exam raw score, r = .48 for ES and r = .44 for IA, for the flipped group (all p’s < .001).

References


Theisen, R. Title Approved for Work on This Project by the UW-EC Institutional Review Board (IRB) for the Protection of Human Subjects under the Category of Exempt (IRB Number 2011-070012). August 2012.

Acknowledgments

April Bialek-Richard (UW-Eau Claire, Psychology) Consultant on Data Analysis and Jason Hallen (UW-Eau Claire, Chemistry) for teaching some of the laboratory sections associated with these courses.
Office of Research and Sponsored Programs, the Department of Chemistry and Learning and Technology Services at the University of Wisconsin – Eau Claire.
Student Support Commission Window through the CETL Summer 2015 Grant Program (RIM).
Wisconsin Atlantic for Minority Participation (WAMAP) Small Grants Program through UWECC, supported by the National Science Foundation (Grant No. 1402679).