FLIPPING THE GENERAL CHEMISTRY LABORATORY: INCREASING STUDENT ENGAGEMENT BY ENHANCING SELF-DIRECTED LEARNING

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The Power of AND

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 there 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. The goal of this study is two-fold: to gather information about the impact of flipped and traditional teaching modes on student understanding of course material as well as measure the students attitudes towards the subject of chemistry. 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.

Flipped Learning[1]

Flipped Learning is a pedagogical approach in which direct instruction moves from the group learning space to the individual learning space, and the resulting group space is transformed into a dynamic, interactive learning environment.

Why Flipped Learning?

Flipped lectures courses are more common throughout the undergraduate curriculum, flipped laboratory experiences are more rare.

Flipped learning involves[1]:

- Flexible learning environments
- Student-centered classrooms
- Just-in-time teaching
- More intentional instruction

Project Tasks

Faculty
1) Created a flipped course structure
2) Implemented flipped course structure

Student
1) Collected data from attitude and exam scores
2) Interpreted the data through statistics software

Timeline of Events

Part	Description	Data Collection Fall 2014 and Fall 2016
1	Flipping the lab	Implemented more active learning strategies into the lecture part of the lab
2	Instruction delivery	Increase student learning participation in their own learning
3	Post-instruction Final exam	Flipping the lab did no harm
4	Continue to study flipped learning	Use peer instruction in future semesters in the general chemistry laboratory

Populations studied

At the University of Wisconsin – Eau Claire, two sections of a first-term general chemistry course were studied.

Fall 2014 - general chemistry I – control section
Fall 2016 – general chemistry I – flipped section

Dr. Theisen is lecture instructor of both courses
Halfen & Theisen laboratory instructors
The flipped and control courses were designed to achieve equivalent expectations

Statistical Analysis

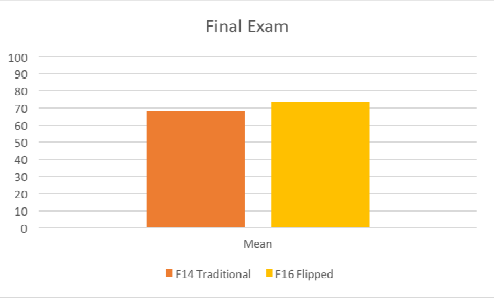
Using IBM SPSS Statistics, a software package used for statistical analysis, the final exam scores were compiled and processed for statistical significance by the independent samples t-test. The t-test measures the degree to which two groups/experiments have the same average value. When $p>.05$, statistical analysis indicates that the difference between groups is not significant. Composite attitude score means (M) and standard deviations (SD) were also evaluated. The final exam questions (out of 70) were processed for statistical significance by the independent samples t-test and the means and standard deviations of these assessments were evaluated.

Results

	Final Exam
Tradition Fall 14 Mean	68.13
Std. Dev.	10.39
N	96
Flipped Fall 16 Mean	73.49
Std. Dev.	13.69
N	76

The average score for the Fall 14 traditional group is 68 and for the Fall 16 flipped group is 73. The Fall 16 group performed better on the final exam assessment.

Traditional vs Flipped Final Exam Scores



- There is a significant difference between the final exam scores ($t(170)=-2.92$, $p = .004$).
- This outcomes match our hypothesis.

Instructor and Student Feedback

- More schedule flexibility for instructor and students
- Less instructor-centered lecture time enhanced participatory learning during lab
- More quality interaction between students and professor
- Quicker than traditional laboratory experience
- Reinforces content learned

Future Work

Increase peer instruction in the classroom.

Peer Instruction: learning lecture content outside of the classroom and being able to use this information to engage in discussion to be able to make a clearer understanding of the content.[2]

Use ConcepTests to increase peer instruction.

ConcepTest: pose a question to the classroom, first answer the question individually, then discuss with peers, and finally the professor explains to the classroom.

Example of a ConcepTest for future general chemistry laboratory:

Gas Laws Unit

How does an increase in molecular velocity affect collisions in molecules?

- collisions increase
- collisions decrease
- collisions remain the same

Further questions could be asked to help students clarify the relationship between molecular velocity and collisions in molecules.

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