Comparison of Student Success in Problem-based Learning and Conventional Learning Curriculums

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Problem

- Typical lecture-heavy Biology 1406 classes
  - High student drop rate
  - Low student success rate

PBL Background

Problem-based learning (PBL) provides students:

- Opportunities for critical thinking
- Complex, real-world problems
- Social interaction
- Active learning through “doing”
- Self-directed learning
- Exploration and self-awareness
- Multiple opportunities/methods for interacting with material

Hypothesis

- Student success and retention can be enhanced by PBL techniques as compared with traditional lecture-based format.

Methods

Develop and implement a PBL curriculum for Biology 1406 that:

- Promotes multiple interactions with subject matter
  - Lecture videos, quizzes, and notes prior to class
  - Hands-on problem-solving during class
- Creates a stronger connection between lecture and lab
  - Lab handouts used as worksheets during lecture, completed in lab
- Exposes students to multiple lab exam formats
  - Practical
  - Project

Examples

- Atomic model kits

- Lab Project 1: Atomic Crime Scene

Results & Observations: Pilot Class (Spring 2015)

- Student drop rate was reduced by as much as 36.2% over the other 3 conventional sections.

- Student success rate (grade >70%) among students who completed the course was improved by as much as 52% over the other 3 conventional sections.

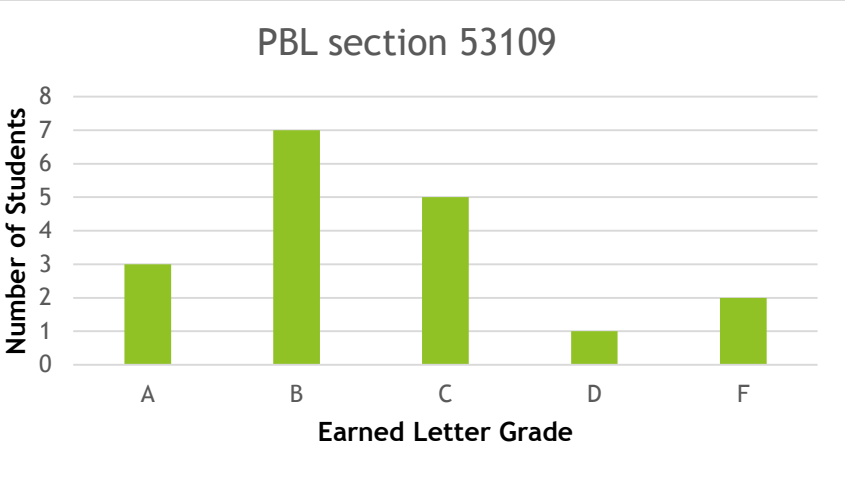
Results & Observations: Pilot Class (Spring 2015)

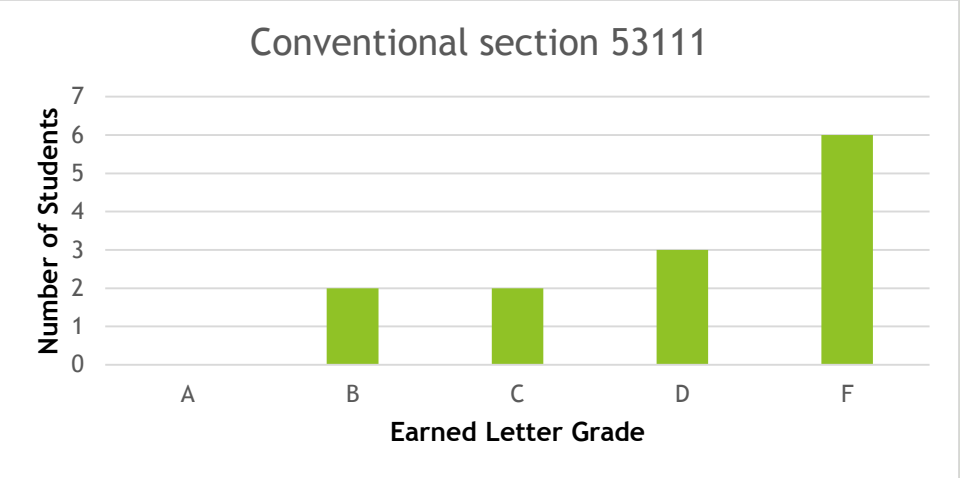
Section number	Total enrolled	Dropped	Drop rate	Completed	Passed (>60%)	Succeeded (>70%)
53109 (PBL)	23	5	21.7	18	16	15
53111	22	9	40.9	13	7	4
53112	22	9	40.9	13	9	7
53113	19	11	57.9	8	8	7

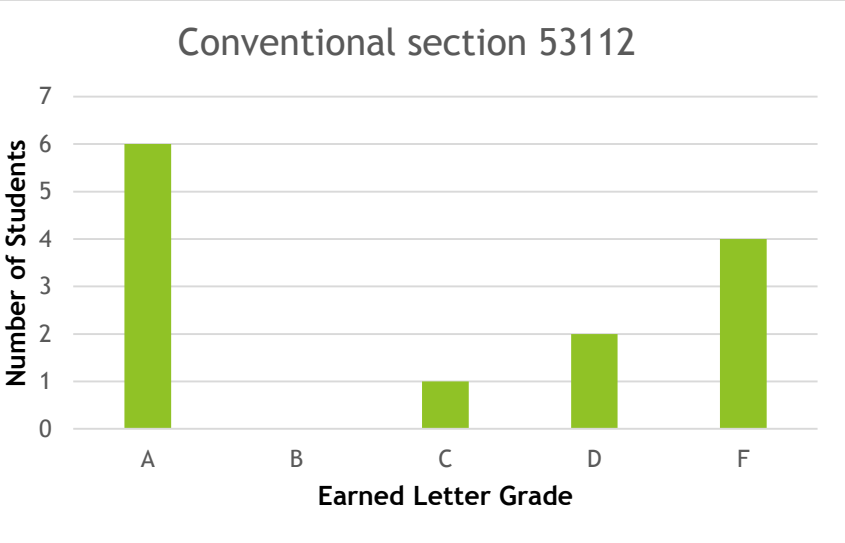
- PBL section showed the highest number of enrolled students, and the lowest number of dropped students.

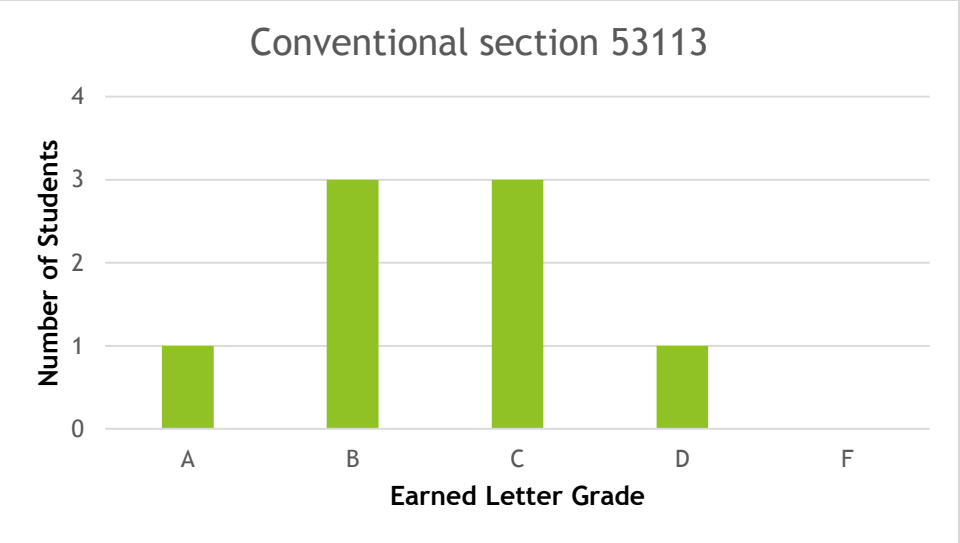
- PBL section produced the highest number of students with a grade above 70%

Results & Observations: Pilot Class (Spring 2015)









The Effects of Project-Based Learning in General Biology Classrooms

Samantha Snavely, Paul Pasichnyk, Robin Graham

Introduction

General biology is a very detailed and technical freshman-level college course, which proves to be a significant challenge for students of all backgrounds (Moore 2006). Fewer than 30% of high school graduates are adequately prepared for college-level biology courses (Cavanagh 2004). In a typical semester, most students predict they will do well in college-level courses, but many fail to succeed (Pryor et al 2010; Moore 2006). These numbers are typical regardless of instructor, which suggests that methods other than the typically lecture-heavy coursework could encourage more student success (Jensen and Moore 2008). As general biology for science majors serves as a prerequisite for several additional courses, failure in early biology classes can set students back from their projected personal and academic goals. This can be discouraging and ultimately prevent students from continuing on in their program or college.

Over the last decade several techniques have been developed and proposed in order to address perceived gaps in student learning. Flipped classrooms, contextualized learning, and project-based learning (also referred to as problem-based learning (PBL)) techniques have become popular methods for encouraging student engagement (Goh, 2014; Smith 2014).

Objective

This project was designed to overhaul the traditional methods used to teach the lecture and lab components of Biology 1406 at El Centro College. The project sought to limit the traditional 'lecture'-style of class time and bring in much more hands-on work including group activities and projects. This PBL design included student review of materials and concepts prior to each class period in order to allow for more interaction and engagement during class time.

Methods

Classroom methods

Implementation of the PBL class involved directing students to watch online lecture videos prior to attending each class. In addition, students were required to take notes while watching the videos. Bringing these notes to each class was required for attendance. In-class activities included students working in pairs and in groups to answer questions, solve problems, and draw-out complex concepts.

Lecture classes were followed by lab classes which reinforced the concepts with further hands-on activities. Lab practicals (standard station-based laboratory exams) were replaced with lab projects which required students to use the knowledge they had learned in lab to answer questions. Such projects required not just memorization of material, but execution of proper techniques. Lab projects were performed in groups of two to four students with some individual activities included.

Biology student interns tested lab projects and experiments for practicality and efficiency. Interns also assisted in constructing materials (such as atomic models; Figure 1) for in-class activities.

Data Analysis

Fisher's Exact t-test for independent variables was used to compare lecture test grades and final averages between classes. A Z-test was used to measure differences between the drop rates of each class. Statistics were performed using SOFA Statistics version 1.4.5 (Paton-Simpson & Associates Ltd, Auckland, New Zealand).

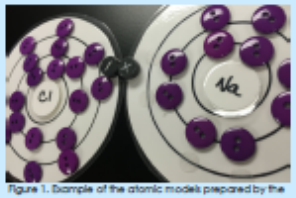


Figure 1. Example of the atomic models prepared by the interns. Buttons were used as electrons which were stuck to the shell using Velcro. Magnets were used to illustrate ionic bonds between atoms.

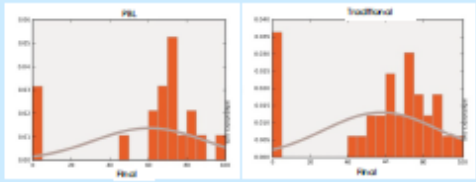


Figure 2. For the PBL course, the final average is 60.5% while the average in the traditional course is 57.8% (PBL: n=19; TRAD: n=33). Final averages for the two courses showed no significant difference (F=0.775, t=0.314).

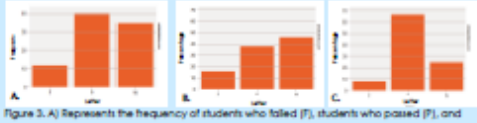


Figure 3. A) Represents the frequency of students who failed (F), students who passed (P), and students who dropped the course (W). B) Represents the percentage of total students who were in the traditionally taught course. C) Represents the percentage of students who were in the PBL course. The drop rates between the two courses was significantly different. In the PBL course the drop rate was 21% while in the traditional course it was 46% (F=0.02, z=2.04).

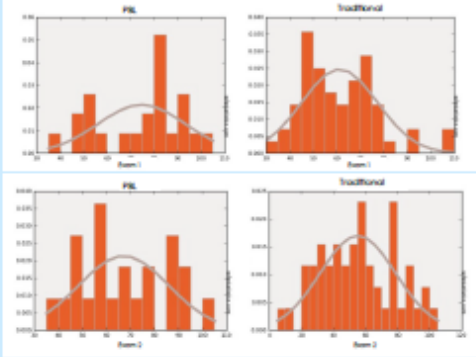


Figure 4. Independent samples t-test of exam 1 (on top) and exam 2 (on bottom) for students in the PBL course versus the traditionally-taught course. The mean for exam 1 in the PBL course is 75% (n=23) while the mean in the traditional course is 61% (n=56). For exam 2, the mean for the PBL course is 67% (n=22) while the mean for the traditional course is 55% (n = 52). These results show a significant difference between the two teaching styles, with p values below 0.05 (Exam 1: F=0.002, t=3.220; Exam 2: F = 0.036, t=2.133).

Results

Students in the pilot PBL class showed a higher overall success rate in the course. Of the 18 students who completed the course, 15 (83%) scored 70% or higher in the class. Of the 34 students who completed the traditional lecture classes, 18 (53%) scored 70% or higher in the class. While there was a dramatic difference between the percentage of students who passed, final averages of all students showed no significant difference (Figure 2).

The PBL class exhibited a significantly lower drop rate as compared to the traditional lecture classes (Figure 3). Of the 23 students who enrolled in the PBL course, five students dropped (21.7%) while of the 63 students enrolled in the traditional lecture classes, 29 students dropped (46%).

Exams 1 and 2 were administered before the drop date and had a greater number of students take these exams than exams 3-5. Both exams exhibited a significantly different average in the PBL course than the traditional course. For exam 1, students in the PBL course averaged 75% while students in the traditional course averaged 61%. Similar results were observed for exam 2 with students in the PBL course averaging 67% compared to 55% in the traditional course (Figure 4).

Discussion

The results of this limited study suggest that students in PBL biology classes succeed at a higher rate than those in typical lecture settings. This success translates into fewer students becoming discouraged and dropping the class. Instructors of the PBL course noted that students were more engaged, asked more questions, and interacted more with their fellow students. These students in general displayed a better overall understanding of the material than the students enrolled in the traditional lecture classes. These success rates may be due to students spending more time preparing outside of class, being more actively involved during class time, and working together in groups.

Being able to address questions and perform activities in groups has been shown to relieve student anxiety (Wilson 1999; Woodard 2004) and increase understanding in the classroom (Curran et al 2013). This could be due to students being able to discuss answers and concepts with each other before reporting them to the class and the instructor. Students may also benefit from being able to share similar frustrations and work through them together (Curran et al 2013). This may alleviate some anxiety that would otherwise be encountered in the classroom. In addition, this method may help students form more meaningful questions, and thus develop a better overall understanding of course material.

As a result of this study, all Biology 1406 classes at El Centro College have been converted to the PBL format. Instructors continue to see higher than average exam scores and student confidence. The PBL format can be an effective tool to increase student success and retention in college biology classes.

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El Centro College
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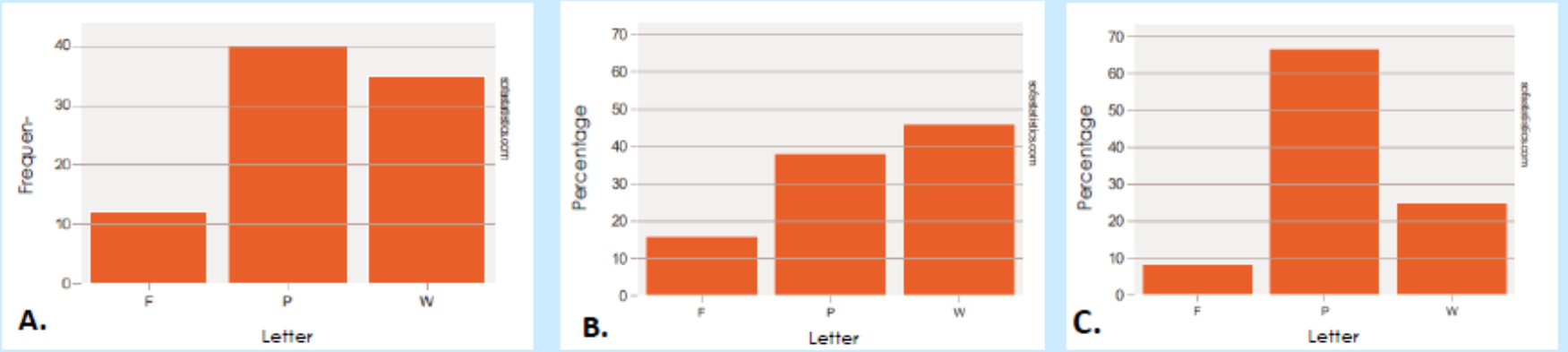
Results & Observations: Pilot Class (Spring 2015) Additional Poster Data



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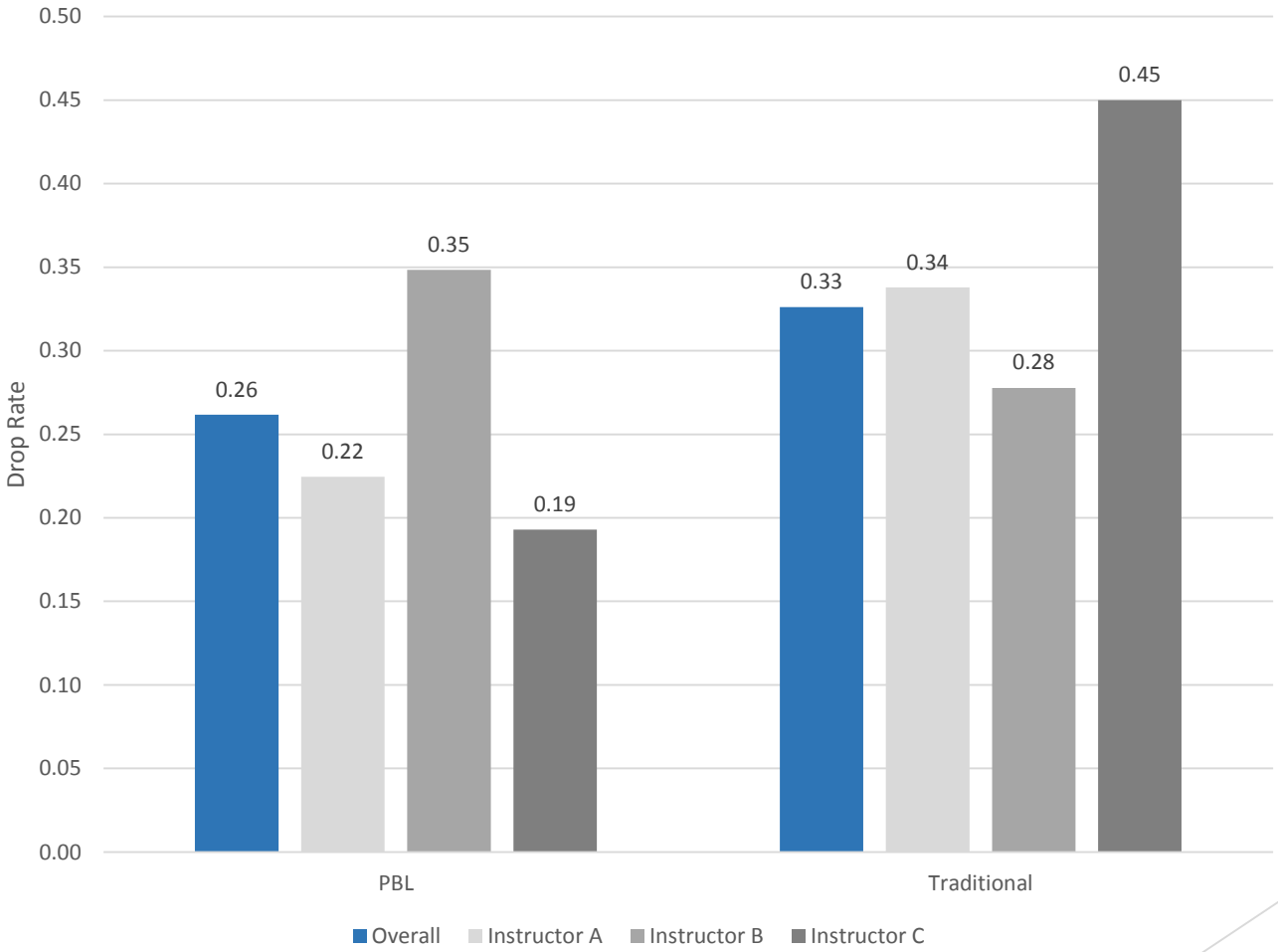
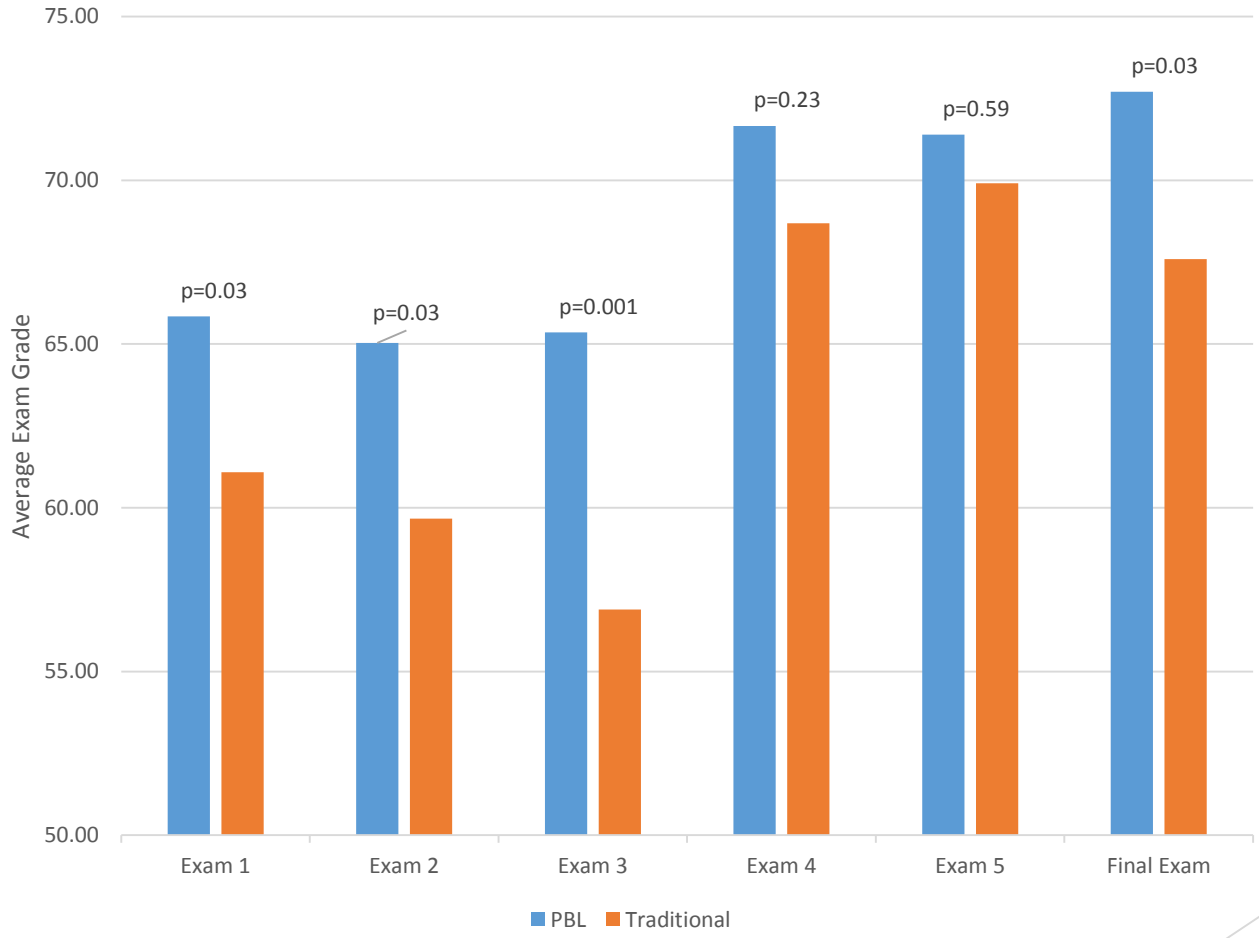
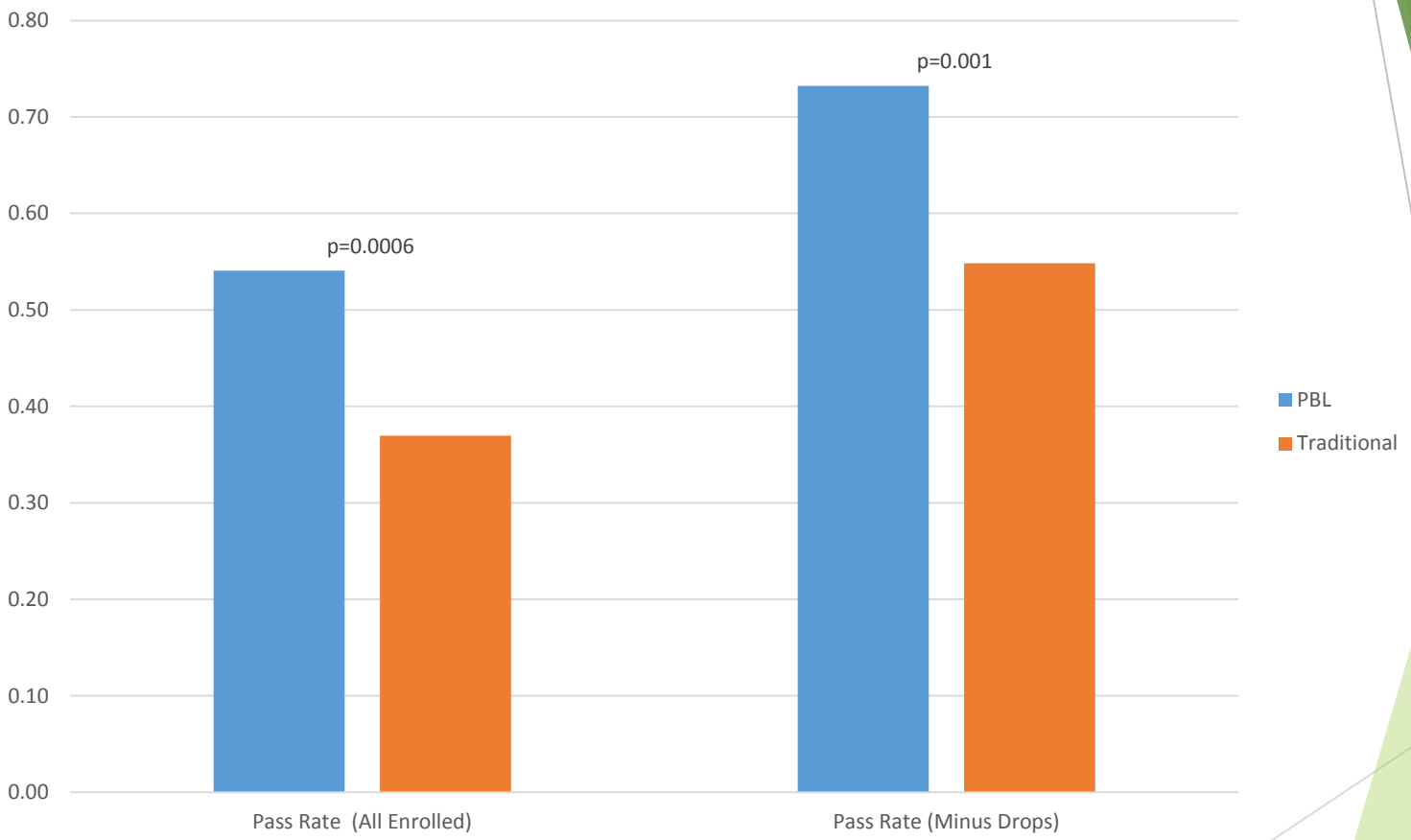
Cumulative Data 2015+ Drop Rates



Cumulative Data 2015+ Exam Scores



Cumulative Data 2015+ Success Rate



Conclusion

- Based on the reduction in drop rate and improvement in success rate, the PBL curriculum offers students a superior experience in Biology 1406.