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Applying a virtual experience to complement first year undergraduate biology teaching labs

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Introduction

Hands-on activities are an integral component of science teaching labs, however with increases in class sizes and budgetary constraints, these approaches are becoming more restrictive, and therefore, less common. As such, many instructors have moved towards online learning and virtual lab simulations. Critics however have argued against this virtual approach due to the lack of hands-on discovery. In this proposed project, we aim to combine both the virtual experience and hands-on exercises in the first-year biology teaching labs as a blended learning approach that will enhance the effectiveness of these labs. Blended learning approaches have shown to enhance student learning by reinforcing the subject material using a variety of teaching and learning strategies. This is of particular significance to student populations that have variable learning styles, such as that found in first-year biology courses that include both biology majors and other science students.

In this project, a team of undergraduate student researchers have worked closely with the instructor and the lab coordinator for the first-year biology courses to explore the application of virtual labs within the teaching lab curriculum that complement and enhance the current hands-on learning activities. This blended learning approach reinforces the subject material and provides more opportunities for self-assessment and evaluation. This research project has also allowed the student researchers opportunities for self-reflection and growth regarding their own learning and teaching practices, thus enhancing their own undergraduate experience.

Research Goals

To investigate the application of a virtual experience to complement and enhance the current hands-on approach in the first year undergraduate biology teaching labs

Learning Outcomes

The following are the planned learning outcomes for the undergraduate student researchers for the proposed research project.

- Analyze the effectiveness of the current first-year biology teaching labs in delivering a positive student experience
- Compose a group of online (open educational) tools that are available for use in a first-year biology teaching lab to complement current hands-on teaching methods
- Test and analyze the effectiveness of these online tools in enhancing student learning in first-year biology teaching labs
- Self-reflection of current teaching practices and learning techniques

Lab 1 – Mitosis and Meiosis Lab

Pre-Lab

- Internet searches were performed to research online activities that would complement current in-lab procedures. YouTube website was also explored to find animated videos that described in detail the processes of Mitosis and Meiosis.
- Interactive online tutorials and quizzes, self-assessment questions and a supplemental YouTube video were added to the existing pre-lab section of the Mitosis/ Meiosis Lab to enhance learning.

In-Lab

- The in-lab procedure was altered to better reflect the pre-lab exercises and reinforce learned material.
- Hands-on, interactive activities were introduced to the in-lab exercises to help students visualize the cellular mechanisms of Mitosis and Meiosis.
- **Both** new pre-lab and in-lab activities were tested using 1st year biology student volunteers and a survey asking for their feedback was conducted.

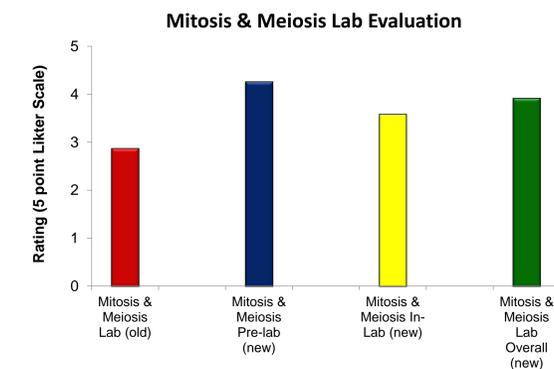
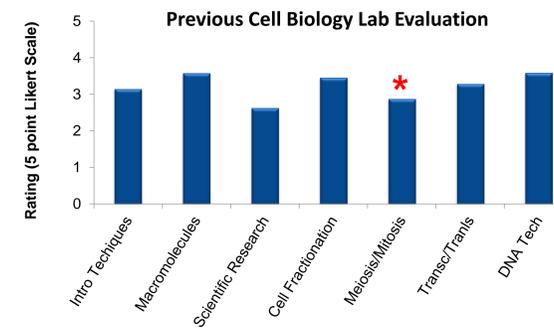
Lab 2 – Population Genetics Lab

Pre-Lab

- Internet searches were performed to research online activities that would complement current in-lab procedures. YouTube website was also explored to find videos that described in detail Population Genetics
- A pre-lab was designed that included interactive online activities and quizzes, self-assessment questions, and a YouTube video as an additional resource to further student learning.
- The pre-lab was developed so that students could learn the concepts of Hardy-Weinberg Equilibrium, and could practice population equilibrium questions. These online activities could be conducted at the student's own pace and repeated multiple times so that students could be better prepared to conduct the in-lab hands-on exercises.
- New pre-lab activities were tested using 1st year biology student volunteers and a survey asking for their feedback was conducted.

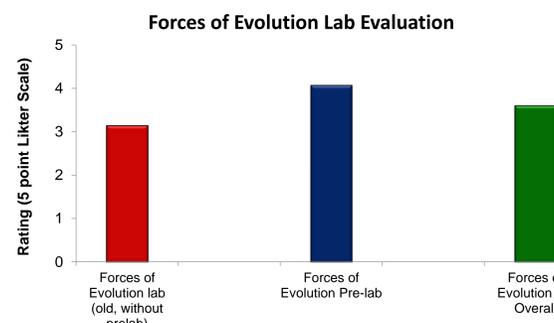
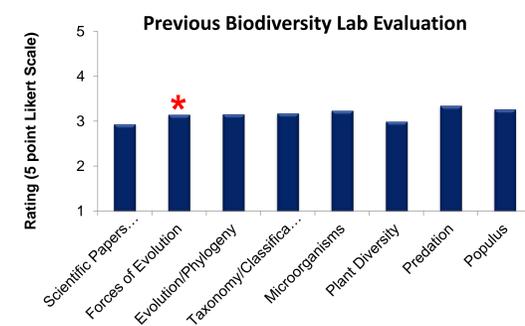
Results – Mitosis and Meiosis Lab

Graph of survey results



Results – Population Genetics Lab

Graph of survey results



Summary

- Overall, blended learning techniques improved the average rating, out of 5, of both labs.
 - Mitosis & Meiosis lab increased from 2.87 to 3.58
 - Forces of Evolution lab increased from 3.14 to 3.60
- Interactive pre-lab videos allowed students to explore the concepts presented in each lab at their own pace
- Pre-lab self-assessment questions allowed students to gauge their understanding of the topic before attempting the in-lab activities
- Pre-lab videos and activities provided materials that visualized concepts, thereby allowing students to better grasp the mechanisms of Mitosis and Meiosis and the processes of Population Genetics
- The additional interactive activities provided a more hands-on approach to the Mitosis & Meiosis lab exercises, making the concept more clear to students
- As Undergraduate Researchers, we learned that students benefit from different teaching mechanisms, and that resources and time are limiting factors when designing labs to complement material learned in lecture.

Student Feedback

Mitosis & Meiosis Lab:

"The animations are visually appealing, easy to follow, and provided just the right amount of detail."

"It was helpful to have questions on the website alongside the simulations to make sure concepts were grasped."

"[The lab was] very hands-on, therefore it was very helpful in depicting all of the [Mitosis/ Meiosis] stages."

"The blue cells and yellow nuclei were very helpful in demonstrating what happened to the cell and nuclear membrane during mitosis and meiosis."

Forces of Evolution Pre-Lab:

"[The pre-lab] enhanced my understanding of lab material and made me feel actively engaged in my learning."

"Overall, I am very happy to know the Biology department values the opinions of their students."

Funding and Approvals

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