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## Incorporating Worksheets to Enhance Active Learning in a Laboratory Course

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# Incorporating Worksheets to Enhance Active Learning in a Laboratory Course



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## Objective

- To improve student participation and information retention when completing laboratory experiments in the classroom
- To emphasize key points of the topic being explored

## Study Goals

To create worksheets that would aid the students in properly completing the required experiments and challenge them to do more than just follow the instructions. Each week there were often multiple experiments to be completed and pre-made samples to be observed within the class period. By providing the worksheet, I ensured the students completed all tasks and comprehended the covered material before class ended.

## Classroom Structure

Worksheets were utilized in a biology laboratory course geared towards non-majors. This course fulfilled a university science requirement which meant that a wide range of majors were present in the classroom (e.g. political science, art, etc.) creating a unique learning environment. A new topic was covered each week, starting with building basic laboratory skills such as handling a microscope and data collection.

The main goals of the course were to introduce students to an array of biology topics and emphasize the influence science has on their everyday lives.

## Acknowledgements

Thank you to Celene Jackson, my course supervisor, for allowing me the flexibility to incorporate new teaching methods into the classroom. Thank you to the program organizers and speakers for providing insight and instruction into how to improve student learning experiences within a STEM course. Thank you to fellow participants for the mutual support and encouragement as we improved our effectiveness as instructors.

## Literature Review

Jin, G. & Bierma, T. (2013). STEM for non-STEM majors: enhancing science literacy in large classes. *Journal of College Science and Teaching* 42 (6), 20-26.

Weasel, L. H. & Finkel, L. (2016). Deliberative pedagogy in a nonmajors biology course: active learning that promotes student engagement with science policy and research. *The Journal of College Science Teaching* 45, 38.

McClanahan, E. B. & McClanahan, L. (2002). Active learning in a non-majors biology class: lessons learned. *College Teaching* 50 (3), 92-96.

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## Traditional Classroom

### Methods

Worksheet format varied depending on the experiments that would be taking place

Each worksheet contained some of the following:

- List of required activities
- Space for drawing images
- Space to record observations (if not already provided in lab manual)
- Open ended questions about results
- Emphasis on key points

### Lab 7: Botany

#### Angiosperms

Draw diagram of life cycle of one of the fruits on display around the laboratory. Label where appropriate.

#### Plant Structures

Food Item	Plant Part	Purpose/Function
	Leaf, Stem, Root, Flower, Fruit, Seed	Photosynthesis, Storage, Reproduction
Onion		
White Potato		
Lettuce		
Tomato		
Celery		
Carrots		
Rice		
Asparagus		
Broccoli		
Sweet Potato		

Figure 1. Portion of worksheet used during traditional instruction. Specifically related to observing plant structures and understanding which portion of a plant we eat.

## Distance Education

### Methods

The shift from in-person class interaction to distance education was especially challenging for this course, a biology laboratory which assessed based on participation and completion of experiments.

For the remainder of the semester, educational videos or virtual labs with accompanying worksheets substituted for the originally planned experiments.

Each worksheet included the following:

- Link to educational video
- Questions directly related to video content
- Incorporation of originally planned experiments (when possible)

### LAB 13: SYMBIOTIC RELATIONSHIP

#### GENERAL VIDEOS

Symbiotic relationships by Amoeba Sisters: <https://youtu.be/rNjP84sApQ?2=207>

Symbiotic relationships by BBC Earth: <https://youtu.be/doB6fyzoO68>

#### MUTUALISM

##### Mutualism definition:

- Observe zooflagellates in termites: <https://www.youtube.com/watch?v=HOx7SDdIqyU>
  - Describe the movement of the zooflagellate
  - How does the termite benefit?
  - How does the zooflagellate benefit?
  - Can zooflagellates survive outside the termite gut?
- Ants and acacia trees: <https://youtu.be/Xm2qdxVVRm4>
  - How do the ants benefit?
  - How does the acacia tree benefit?
  - In what part of the tree do the ants live?

Figure 2. Portion of worksheet used during distance education. Specifically geared towards examining interactions between different species. General overview videos along with focused videos were incorporated.

## Results

Pre-worksheets	With worksheets
Portions of experiment were skipped	All activities were completed
Majority of experiments completed by one student	Tasks were divided among group members
Little opportunity for ungraded assessment	Constant informal assessment during class
Few practice questions available in lab manual	Additional exercises for practice with answers online
Presentation slides main study guide	Key points were easily identifiable for easier studying

## Conclusions

- Though active learning occurs each week due to hands-on experiments, the worksheets provided an additional push to think outside the pages instead of only focusing on the experiment.
- The worksheets were a helpful informal assessment of comprehension for the students and myself.
- In comparison to previous years, worksheets have greatly improved the flow of activities and increased involvement by each member of a group.

## Student Comments

"My favorite lab was the dissection lab because it was cool to be able to try it out on our own, especially the sea star. The inside was fascinating."

"[My favorite lab was] botany because I got a lot of useful information about how plants react to sun and how the root system works."

"I learned that I really like science, it's really interesting"

"A fun fact that I learned from this class would be how well our body adapts to our surroundings. I had a lot of fun with the human senses lab and my guesses for what I thought was going to happen were completely different than what the outcome was. Your sense of smell adapts faster than I would have imagined!"

"My favorite lab was the agarose gel electrophoresis. I had never done an experiment like this one before and it was a challenging yet fun experiment to partake in!"