Exploring the World's Oceans

The first unit I teach in Marine Biology is an introduction to the marine environment. After attending the MATE Summer Institute *ROVing the Oceans*, I added an ROV construction assignment to this unit. These students in this class are advanced college bound juniors and seniors all of whom have completed at least one year of Biology and most have also taken Physics and Chemistry. Part of this unit teaches students why we know so little about what is under the surface of the ocean because of the difficultly in exploring it. Attached are the two lab assignments I used this year for this section of the course.

This section is introduced by a short lecture on the history of ocean exploration. The first of the two lab assignments teaches students how much of our knowledge of the oceans was obtained in the past. In this activity students perform one of four different experiments, three are sounding experiments where students simulate determining the contours of the ocean floor, the third has them simulate sampling the types, number, and location of living organisms in the ocean.

I introduce the second lab with a lecture on ROVs using the MBARI slide sets as visuals. The student activity has groups of students build a coat hanger ROV from supplied materials that must travel to the bottom of the swimming pool (12 feet deep) and back to the surface. After completing this assignment a group of 12 students have joined a club that will be construction a larger ROV equipped with lights and a video camera to explore quiet ocean waters to a depth of 10 m.

Below you will find the instructions and scoring sheets provided to the students and notes to the instructor for each of these assignments. A copy of the grading rubrics that go with the scoring sheets and, finally, a few pictures of my class building and testing their ROVs.

If you have any questions please feel free to contact me.

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What Is Under the Surface?

Introduction

The oceans represent a vast and hostile (to humans) environment. It has been said that we know more about the "seas" on the back of the moon than we do about the oceans on Earth. Part of the difficulty in studying the ocean is that we can only see a short distance into it. In this lab you will learn how scientist have learned what is in the ocean without having to enter the water themselves (a very costly endeavor).

There are two questions that we wish to study at this time. First, what are the contours of the bottom of the ocean? Second, what is in the water column and on the surface of the sea floor? Each group will perform some variation of an experiment to explore one of these questions.

Sounding Experiments

Sounding is a method used to find out how deep water is. It has been used for many centuries by sailors to determine the depth of water in uncharted harbors to avoid grounding their ships. Using the materials provided develop a plan that will allow you to accurately determine the contours of the bottom of the container provided (without looking inside).

Sampling Experiments

Because it is so difficult for humans to travel underwater most of what we know about the contents of the ocean come from various sampling techniques from the surface. These methods include fishing with lines, various forms of nets and dredges for sampling the sea floor. Using the materials provided take several samples of your container. Your goal is to determine what is in the container (without looking) and how many of each item are present.

Presentation of Results

Prepare a formal written lab report according the model presented in you syllabus. Be sure to include answers to the following questions in your "Results" or "Conclusion" sections as appropriate:

- Did the equipment you used allow you to get an accurate "view" of what is in the container?
- What was good about the materials you used?
- Are there better materials? Why would they improve your results? What are you assuming?

Include a drawing of what you believe is in your container.

Select one member of your group to give a brief (no more than 5 minutes) presentation of your results to the class.

What Is Under the Surface?

Content (8 points each)

Title and Introduction	_____	_____		
Methods	_____	_____		
Data	_____	_____		
Results	_____	_____		
Conclusion	_____	_____		
Subtotal (40 possible)			_____	_____

Communication (4 points each)

Paragraphs	_____	_____		
Sentences	_____	_____		
Vocabulary	_____	_____		
Effect	_____	_____		
Drawings	_____	_____		
Subtotal (20 possible)			_____	_____

Connections (4 points)

Examples			_____	_____

Total (64 possible)	_____	_____
Completion (100%)		
Percent Completed	_____	_____
Group Score (Multiply *Total* by *Percent Completed*)	_____	_____

Participation (6 points)

Name	Score	Strengths		Growth
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____

Final Score (70 points possible)	Abstract (Y or N)	Total Score	
_____	_____	_____	_____
_____	_____	_____	_____

Building an ROV

It is much less expensive (and safer) to send unmanned submersibles into the ocean than it is to send manned submarines. As technology improves the amount and quality of information obtained from remotely operated vehicles (ROVs) increases. Currently ROV's a capable of providing an enormous amount of very detailed information at a cost that is a fraction of what would be required to send humans into the ocean. In this activity you will be building an ROV from materials that your teacher.

BASIC PRINCIPLES

The first step is to clearly define the mission your ROV is intended to accomplish. For this activity you are to design an ROV that will provide that is capable of diving to the bottom of the swimming pool and returning to the surface under its own power.

Once you have defined your mission there are six important factors you must consider when designing your ROV:

Structure What are you going to build the main structure of? How strong must it be? Will it be able to withstand the pressures, temperatures, currents, etc. encountered in its intended operating environment?

Power How are you going to power your ROV? Will it work in water? Is it safe?

Propulsion What will drive your ROV underwater?

Floatation and Ballast It is important that your ROV comes to the surface on its own if it should loose power. How will you ensure that it does so? If your ROV is not sufficiently dense it will be very difficult for it to reach any great depth. You will need some sort weight to help it sink.

Control How will you control your craft while it is underwater?

Navigation and Sensors How will you know where your ROV is? Do you need to obtain any information about its surroundings? If so how will you do this and how will this information be sent to the surface?

MATERIALS

You will have the following materials available to you:

Plastic coat hangers
Electrical tape
Film cans
Nails
Electrical wire
An electric motor
Plastic propeller
Batteries

PROCEDURE

Using the materials provided, construct an ROV to accomplish the mission stated above. You will test your ROV in the swimming pool tomorrow.

REPORT

Write a lab report that contains the following sections:

Title

Introduction

Methods Your plan (including diagrams and explanations as to why you chose this design and how you addressed each of the six design factors mentioned above).

Results Describe the results of your test in the pool.

Conclusion Explain your results. What worked and why? What did not work; why not?

Abstract Include an individually written abstract summarizing your experiment.

Building an ROV

Content (8 points each)

Title and Introduction	_____	_____		
Methods	_____	_____		
Results	_____	_____		
Conclusion	_____	_____		
Subtotal (32 possible)			_____	_____

Communication (4 points each)

Paragraphs	_____	_____		
Sentences	_____	_____		
Vocabulary	_____	_____		
Effect	_____	_____		
Drawings	_____	_____		
Subtotal (20 possible)			_____	_____

Connections (4 points)

Examples			_____	_____

Total (56 possible)	_____	_____
Completion (100%)		
Percent Completed	_____	_____
Group Score (Multiply *Total* by *Percent Completed*)	_____	_____

Participation (6 points)

Name	Score	Strengths		Growth
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____

Final Score (62 points possible)	Abstract (Y or N)	Total Score	
_____	_____	_____	_____

Notes to the Instructor

What Is Under the Surface?

Each group of students performs one of the following experiments. The following day each group gives a five minute presentation to the class explaining their methods and results.

Sounding Experiments

There are three types of sounding experiments:

1. Draw a grid with 1 cm spacing on the cover of a box (I use boxes that contained a case of photocopier paper) and use a nail to punch a small hole at the intersections of the grid. Inside the box I place plastic mountain models (originally intended for teaching how contour maps are made) and seal the box shut. Students are given a bamboo skewer and told that they need to determine the contours of the bottom of the box.
2. I use 6-gallon round trashcans lined with a black plastic trash bag. At the bottom of the can I place a large rock, fill the can with water and add enough red, green, *and* blue food coloring so that you cannot see the rock. The students are given a piece of fishing line with a small lead weight on the end and told to determine the size and shape of the object at the bottom.
3. Use a motion sensor* connected to the computer to create a map that shows the contours of you lab table. Be sure that at least one of the transects passes through the sink.

Sampling Experiment

Again I use 6-gallon round trashcans with lids. I cut a 3 _ inch hole in the lid of the can with a hole saw. The can is lined with a black trash bag. I place _–1 inch of black aquarium gravel in the bottom and fill with dechlorinated water. To this I add tubiflex worms, brine shrimp, goldfish, and elodea. The lid is placed on the can and the students are given a deflagrating spoon (a small spoon with a very long handled used in chemistry to heat or burn small samples in a flame) to sample the contents of the container. Their goal is to determine what is in the container, the relative quantity of each organism and its location within the container.

Building an ROV

Students have one hour to build their ROV, a second hour to trouble shoot its performance in the classroom in a 32-gallon garbage can and a final 30 min to fine tune it before we go the the swimming pool for the final test.

* I used a Pasco ultrasonic motion sensor; others should work as well.

Grading Rubrics

General Content

	A (4x)	**B** (3x)	**C** (2x)	**F** (1x)
Correctness of Answers	All answers are correct.	Answers are generally correct with only occasional minor errors present.	Several minor errors or occasional major errors are present.	Major errors are frequent.
Explanations	Explanations are clear, detailed, and based on the material being studied.	Explanations are somewhat detailed, and based on the material being studied.	Explanations are based on the material being studied.	Answers are missing or are not based on the material being studied.
Depth of Understanding	Answers are complete and show a deep understanding of the subject matter.	Answers are mostly complete and show a good understanding of the subject.	Answers are usually complete and show an adequate understanding of the subject.	Answers are often incomplete and show little understanding of the subject.

Lab Report Content

	A (4x)	**B** (3x)	**C** (2x)	**F** (1x)
Title and Introduction	Title clearly communicates what the experiment is about, purpose is clearly stated, hypothesis makes a specific prediction and is testable, and assumptions are explicitly stated.	Title clearly communicates what the experiment is about, purpose is clearly stated, hypothesis makes a specific prediction and is testable.	Title communicates the main idea of the experiment, purpose is stated, hypothesis is testable.	Purpose is not stated or the hypothesis is not testable.
Methods	You have a clearly written procedure, that when followed in the order presented, would allow someone else to repeat your experiment.	Your procedure, though sometimes confusing, would allow someone to replicate your experiment.	Your procedure contains errors that could be corrected by anyone attempting the experiment themselves.	Your procedure could not be followed as written.
Data	All data is accurate, well organized and clearly labeled; significant figures and units are correctly used.	As above but significant figures are not correctly used.	As above but the correct units are not used.	Data is not correct.
Results	You have clearly explained your data; calculations and graphs are clearly presented and labeled.	You have explained your data; calculations and graphs are clearly presented.	You have explained your data; calculations and graphs are not clearly presented.	You have not clearly explained your data.
Conclusion	The conclusion is clearly stated, it is directly related to the purpose of the experiment, explanations are given to justify your	Your conclusion, though sometimes confusing, is related to the purpose and based on the data collected and information learned earlier. Justifications are	Your conclusion, though sometimes confusing, is related to the purpose and based on the data collected and information learned	Your conclusion is often confusing, not related to the purpose or not based on the data collected.

	conclusions and are based on the data collected and information learned earlier in this class, and all assumptions justified.	given for all claims.	earlier. Justifications are not given for all claims.	

Effective Communication

	A (4x)	**B** (3x)	**C** (2x)	**F** (1x)
Effective Paragraphs	Paragraphs always communicate ideas clearly are well organized with a clear topic sentence that is supported by well developed concrete details which are explained with commentaries.	Paragraphs generally communicate ideas clearly and are well organized. Topic sentences are supported by concrete details and explained with commentaries.	Paragraphs generally communicate the ideas clearly. Topic sentences are present and supported.	Ideas are not clearly communicated.
Effective Sentences	Sentences communicate ideas clearly, are well organized and almost always grammatically correct.	Ideas are communicated clearly. Grammatical errors do not interfere with understanding.	Sentences communicate ideas. Grammatical errors do not interfere with understanding.	Sentences contain frequent errors that make understanding difficult.
Effective Vocabulary	Explanations use the science vocabulary correctly and consistently. Spelling is correct.	Scientific vocabulary is frequently used with very few errors. Spelling is generally correct.	Scientific vocabulary is often used with only occasional errors. Spelling errors do not interfere with understanding.	Errors are frequent and interfere with understanding.
Overall Effect	Your writing clearly shows that you understand the question posed and have answered it clearly and completely. It is easy to read and understand.	Your writing shows that you understand the question posed and have answered the question accurately but requires more detail.	Your writing shows a basic understanding of the question. The science behind your answer is accurate. You have not shown a complete understanding.	Writing shows very little or no understanding of the question or the science behind your answer.
Drawings	Your drawing is neat, large clearly labeled, complete, and accurate.	Your drawing is large labeled, complete, and accurate.	Your drawing is labeled, complete, and accurate.	Your drawing is not labeled, incomplete, or not accurate.

Connections

	A (4x)	**B** (3x)	**C** (2x)	**F** (1x)
Use of examples	Frequent use of appropriate personal examples.	Occasionally uses appropriate personal examples or frequently restates those used in class.	Rarely uses appropriate personal examples occasionally restates those used in class.	Never uses appropriate personal examples or rarely restates examples used in class.

Computations

	A (4x)	**B** (3x)	**C** (2x)	**F** (1x)
Calculations	Calculations are clearly labeled, well organized, and correct; units and significant figures are used correctly.	Calculations are clearly labeled, well organized, and generally correct; units are used correctly.	Calculations are labeled, organized, and generally correct; units are used correctly.	Calculations are not organized or are generally confusing; units are not correctly used.
Graphs	The appropriate type of graphs are used, they are easy to interpret, and neatly drawn with a descriptive title, correctly labeled axes and units.	The appropriate type of graphs are used, they are easy to interpret with a descriptive title, correctly labeled axes and units.	The appropriate type of graphs are used, they be a little bit difficult to interpret, include a title, correctly labeled axes, and units.	Graphs are difficult to interpret, title is missing, or axes are not correctly labeled or units are missing.

Lab Abstract

An abstract is required of each group member for every lab, no score is given to anyone not turning in an abstract that meets the following criteria: Your abstract is written as a paragraph that clearly and accurately summarizes your experiment, including its purpose, methods, and conclusion.

Name: _____ _____

_____ _____

Active Participation Rubric

Assignment: _____

Cooperation

Decide on a score for each member of your group based on the following rubric. The total number of points assigned for all members of your group must equal six times the number of members. (A group of four would have a total score of 6x4=24.) Assignments receiving a participation score below 3 will only earn a portion of the overall score (percentage listed in parentheses).

10 = Completed all of the work themselves because all others were not willing to participate; encouraged others to help out.

9 = Completed most of the work themselves because more than one group member was unwilling to participate; encouraged others to help out.

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8 = Completed more than his/her share of the work because one member was unwilling to do any work; other members did their share; encouraged non-participant to participate.

7 = Completed her/his share of the work and provided a lot of leadership in some area of the task, negotiated and helped resolved conflicts.

6 = Completed her/his share of the work and provided leadership in some area of the task, helped others learn. (average score)

5 = Completed her/his share of the work and provided some leadership in some area of the task.

4 = Completed his/her share of the work but nothing else. (100%)

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3 = Did most of his/her share of the work including some of the lab report. Hindered the participation of others by taking on too much of the task. (75%)

2 = Did some of the work required. Prevented others from working by taking on too much of the work. (50%)

1 = Participated in the lab itself but did not help with the lab report. (25%)

0 = Did not participate in this assignment, (0%)

Skill Categories

Select one or two of the following as strengths for each person in your group and one as an area for growth.

Writing	Problem Solving
Active Listening	Organizing
Reading	Equipment Utilization
Leadership	Hypothesizing
Calculations	Interpreting

Scores

Name	Score	Areas of Strength	Growth