Design and Implementation of Marine Biology Lessons at the Avila Beach Sea Life Center

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BACKGROUND

My passion for the ocean began at a young age and has developed over the years as I have become a surfer, a diver, and a biology student at Cal Poly. I was initially attracted to the university both because of its excellent reputation for sciences and its coastal location. I was not disappointed in either regard. After completing my first year of studies, I decided to look for ways to get involved in the community, and was directed towards the Avila Beach Marine Institute. This small building, nestled behind the community park in the small seaside community just south of San Luis Obispo, is often overlooked by beachgoers and tourists, but has been offering marine education to the Central Coast for ten years. After visiting the Marine Institute, I decided it was a place where I would like to invest my time, and I began volunteering weekly. I began by cleaning tanks and feeding the local marine animals on display in the small public aquarium. Later, I also began participating in their school programs; helping teach marine mammal lessons and giving brief tours of San Luis Bay to local school groups. It was a wonderful experience- both enriching and rewarding, but after my first year of volunteering I left to study abroad, and during that time period, the Marine Institute shut its doors to the public, and only continued with educational programs.

In the fall of 2009, after nearly a year and a half of being gone, I returned to volunteering at the Marine Institute. The leadership had changed, and there were plans to reopen to the public as the Avila Beach Sea Life Center. I once again began cleaning and feeding, but slowly got more involved in the educational programs as well. Early in the year, I decided I wanted to develop a senior project related to my volunteer work. I expressed this desire to Priscilla Kiessig, the Executive Director of the Sea Life Center, and she told me they were in great need

of written curriculum that would help the school programs be more consistent and structured. With my biology background and experience with marine education, I felt that I could design several lesson plans in order to fulfill my senior project requirements, while also benefitting the Sea Life Center. I focused my plan on three lessons: plankton, squid dissection, and the rocky intertidal. The objective was to create lesson plans that would be inquiry-based, information rich, organized, and easily accessible to volunteer teachers interacting with K-12 school children, as well as informal audiences. It was also important for the lessons to be adaptable for different age groups, and for the California State Science Standards to be included. In addition, we wanted a way to assess learning and to receive feedback from the students themselves. The overarching goal of the educational program is to inspire curiosity and a desire to learn, as well as empower students with the realization that they are capable of doing science. It was also essential to keep this underlying aim in mind when developing the more specific lesson objectives.

I began by pooling resources and trying to determine how to write a lesson plan. I used resources already available at the Sea Life Center as sources of information and models for my lesson plans, and also worked closely with a retired elementary school teacher, Donna Farrow. She met with me several times throughout the process and gave valuable suggestions and feedback. Given my lack of formal education as an educator, it was important to have someone so experienced as a source of advice.

As the lesson plans developed, the potential for a new way to implement them also came to life. In January 2010, I began working with the Cal Poly TAP program as a biology teacher's assistant at Santa Maria High School. Due to a very limited school budget, the students rarely, if ever, have the opportunity to go on field trips. For a biology class especially, I felt that it would

be wonderful to get students outside the classroom and give them a taste of hands-on biology in our beautiful local environment.

I began to entertain the idea of inviting the two biology classes I worked in to participate in field trips at the Sea Life Center. At first, I was met with some skepticism at the high school. The cost of the program could be covered by generous scholarships given to the Sea Life Center, but the cost of transportation was not included, and there appeared to be no funding available to cover the cost of a bus for the day. I planned on asking local businesses in Santa Maria if they would be willing to make donations, but was pleasantly surprised when the school's community liaison informed me that she would use some of her funding to pay for a bus. Once the funding was secured, a date was set, the necessary paperwork faxed, and the students informed of the upcoming opportunity.

On May 13th, 2010, forty-four biology students from Santa Maria High School arrived at the Sea Life Center and participated in a day of hands-on marine biology activities. Students toured the bay on a sport fishing boat while learning about such topics as local history, marine mammals, and water chemistry. They were also able to help deploy an otter trawl and to look at various fish and invertebrate species brought up from the bay before releasing them back into the water. Back on land at the Sea Life Center, I was able to implement my newly developed lesson plans by taking the students through a squid dissection and a rocky intertidal lesson, focusing on animals from the touch tanks. For many of the students, it was their first time ever being on a boat, and for one young man, it was actually his first time visiting the ocean, despite living just eleven miles away in Santa Maria. The students were incredibly respectful and engaged during each of the activities, and very enthusiastic about the marine life they were exposed to.

As I taught at the Sea Life Center, both to the group from Santa Maria Highschool and other local students, I saw the strengths and weaknesses of the lesson plans I was developing. They were areas which worked wonderfully, and others which looked much better on paper than in the actual classroom, and I had modify and revise accordingly.

The following report includes the lesson plans that were designed over the course of the past year, an overview of the methodology and resources used to create them, and a reflection and discussion of their implementation, as well as suggestions for future improvements.

INTRODUCTION

The marine environment, and the wealth of species that have evolved there, are currently facing many human-induced changes, such as rising temperature, increasing acidity, and alarming accumulations of plastics in ocean gyres. These threats make today a very challenging, but also very exciting time for marine science. As we begin to appreciate the incredible importance of the marine ecosystem, and the devastation that human activities have caused it, the necessity for understanding ocean systems becomes more and more apparent. Not only is it essential that current researchers continue their work, but a new generation of marine scientists and conservationists must also arise.

In order for this to occur, youth must be exposed to marine science and inspired to inquire about (and then care for) the world around them. For the past ten years, this has been the goal of the Avila Beach Sea Life Center, which has worked to provide marine education for local school children and community members on the central coast. Now, as the Sea Life Center seeks to expand these efforts, it has become necessary to develop new curriculum-which will provide a more organized framework for teaching,

This project includes lessons on squid dissection, the rocky intertidal, and plankton. The lesson plans were based on procedures already implemented in the Sea Life Center's education program, as well as a plankton lesson from the UCLA OceanGLOBE program and a squid dissection lesson from the Smithsonian Institution's National Museum of Natural History. These resources were found online during the preliminary research stage of design, and provided a source of ideas, as well as information for the lessons. California State Science Standards were also incorporated and a list of the standards met was included at the beginning of each lesson for each age group. The idea behind their inclusion was that teachers would be more apt to bring their students on field trips to the Sea Life Center if they could be assured that the lessons being taught were compatible with these standards.

The squid dissection lesson has been part of the education program since its inception, and this version looks similar to the procedure that has been carried out in previous years, but with added information and a more structured format. The rocky intertidal lesson is based on several of the organisms in the touch tanks, which have only recently been made available to the school groups, and thus was essentially created *de novo.* The plankton lesson might be thought of as an expansion to the educational program because students have long participated in "sink or float" activities which include some basics about plankton, but no lesson based solely on plankton was offered.

Previously, the lessons at the Sea Life Center were largely taught by experienced volunteers and staff who had most of the information in their heads. If a new teacher were to come in, they would be handed a sheet of information about their topic, but no formal lesson plans existed. This type of system is less than ideal for an expanding program trying to recruit and train new teachers and may lead to inconsistency and confusion for both teachers and

students. The following three lessons plans were designed to create a framework by which different teachers could provide consistent, information rich, inquiry-based instruction for a variety of age groups.

LESSON PLANS

Lesson 1: Touch Tanks/Rocky Intertidal

Duration: 30-45 min.

Grade Level: K-2

Anticipatory Set: Today we're going to learn about the rocky intertidal and some of the organisms that live there.

Learning Objectives: By the end of the lesson, students should be able to:
- identify a rocky intertidal habitat
- identify several of the invertebrate species that live there
- recognize basic sea star anatomy- some body parts and their functions

Materials: touch tanks with sea stars, sea cucumbers, anemones, and crabs

CA State Standards:
- Kindergarten : Physical sciences 1.a Life Sciences 2.a,c Investigation and Experimentation 4. a,b,c,d,e
- Grade 1: Life Sciences 2. a,c
- Grade 2: Life Sciences 2. a,b,d Investigation and Experimentation 4. a,c,d,f,g

Rocky Intertidal Introduction:
How many of you have been to the tide pools? What did you see there?
Tide pools are part of a habitat called the rocky intertidal, where the ocean meets land. Many special animals live there and have to survive in both water and air as the tide moves in and out!

Procedure:
Part 1. Sea Star Body Parts
Introduction- Sea stars are not "fish", they are animals in a special group called Echinoderms, which means spiny skin. Since they are animals, they have some of the same body parts that we have (mouth, eyes, arms, feet)! What do we use each of these parts for? (eating, seeing, grabbing things, walking, moving….)

Allow students to move around the tanks, gently touch and observe the sea stars.

Gently pull a sea star out of one of the tanks to use as a model. Point out:

1. Arms- How many arms does each sea star have? (5-for most species most of the time) What happens if a sea star loses an arm? (regeneration!) Allow students to feel the aboral surface of the sea star pull on their arm hair. These are pedicellaria which keep other animals from living on top of the sea stars!
2. Tube feet-What do these feet do? They are small suction cups that help the sea star move and grab food,
3. Eye spots-Where are the eyes? (tips of each arm) What do eyes do? Sea stars can't see images like we do, just dark and light.
4. Mouth-Where is the mouth? (underneath) Sea stars' mouths are different from ours. They actually push their stomach outside of their mouth and start to digest their food outside of their body! What do sea stars eat? (mussels, small fish…)

Part 2. Other Invertebrates

1. Sea cucumbers- related to sea stars (Echinoderms), but they do not have any hard spines. These animals live on the bottom of the sea floor and use their frilly mouth parts to mop up food from the water and sand. To defend themselves, they can eject their stomach and intestines to distract enemies and then regrow them afterward!
2. Anemones- Are they animals or plants? (animals) These are actually in the same group as jellyfish and use their tentacles to sting their prey (food) too.
3. Crabs-How do crabs grow? They start out as eggs that hatch into larvae that then grow and change into adults. When adults grow, they have to shed their shells (molt) and regrow a larger one!

Vocabulary

rocky intertidal
habitat
enchinoderm
sea star
sea cucumber
crustacean
larvae
molt
prey
predator

Lesson 1: Touch Tanks/Rocky Intertidal

Grade Level: 3-5

Anticipatory Set: Today we're going to learn about the rocky intertidal and some of the organisms that live there.

Learning Objectives

After the lesson, students should be able to:

- identify a rocky intertidal habitat
- recognize basic sea star anatomy-body parts and their functions
- identify various intertidal invertebrates
- recognize some of the challenges that face animals living in this environment, and the adaptations that allow them to survive there

Materials: touch tanks with sea stars, sea cucumbers, anemones, and crabs

CA State Standards:

- Grade 3: Life Sciences 3.a,b,c
- Grade 4: Life Sciences 2.a,b 3.a,b
- Grade 5: Life Sciences 2.a,b,c,f Earth Sciences: 3.a

Introduction:

How many of you have been to the tide pools? What did you see there?
Tide pools are part of the habitat called the rocky intertidal, where the ocean meets land. Many animals live there. What are some of the challenges these animals face? (waves, tides, air and water, sunlight, rain, cold and hot…)
These animals have to hang onto the rocks as the waves crash on them, and as the tide goes in and out, their surroundings change. What happens at high tide? What happens at low tide? As we look at and talk about the animals in the touch tanks think about how their body parts help would them to live in this tough environment.

Procedure:

Part 1. Sea Star Body Parts

Introduction- Sea stars are not "fish" they are animals in a special group called Echinoderms, which means spiny skin. Since they are animals, they have some of the same body parts that we have. What common characteristics do we share with sea stars? (mouth, arms, feet, eyes)

Allow students to move around the tanks, gently touch and observe the sea stars.

Gently pull a sea star out of one of the tanks to use as a model. Point out:

1. Arms- How many arms does each sea star have? (5-for most species most of the time) What happens if a sea star loses an arm? (regeneration!) Allow students to feel the aboral surface of the sea star pull on their arm hair. These are pedicellaria which keep other animals from living on top of the sea stars!
2. Tube feet-What do these feet do? They are small suction cups that help the sea star move and grab food,
3. Eye spots-Where are the eyes? (tips of each arm) What do eyes do? Sea stars can't see images like we do, just dark and light.
4. Mouth-Where is the mouth? (underneath) Sea stars' mouths are different from ours. They actually push their stomach outside of their mouth and start to digest their food outside of their body! What do sea stars eat? (mussels, small fish…)

Part 2. Other Invertebrates

1. Sea cucumbers- related to sea stars (Echinoderms), but they do not have any hard spines. These animals live on the bottom of the sea floor and use their frilly mouth parts to mop up food from the water and sand. To defend themselves, they can eject their stomach and intestines to distract enemies and then regrow them afterward!
2. Anemones- Are they animals or plants? (animals) These are actually in the same group as jellyfish and use their tentacles to sting their prey (food) too.
3. Crabs-How do crabs grow? They start out as eggs that hatch into larva that then grow and change into adults. when adults grow, they have to shed their shells (molt) and regrow a larger one!

Vocabulary
rocky intertidal
habitat
enchinoderm
sea star
sea cucumber
crustacean
larvae
molt

Lesson 1: Touch Tanks/Rocky Intertidal

Grade Level: 6-12

CA State Standards
- Grade 6: Ecology 5.e
- Grade 7: Structure and Function in Living Systems 5.a Physical Principles in Living Systems 6. d
- Grade 8:
- Grades 9-12: Waves 4.a 5.d Ecology 6.e

Objectives: After the lesson, students should be able to:
- identify a rocky intertidal habitat
- recognize some of the challenges that face animals living in this environment, and some of the adaptations that allow them to survive there
- recognize basic sea star anatomy-body parts and their functions
- differentiate between an Echinoderm, a Crustacean, and a Cnidarian

Rocky Intertidal Introduction:
How many of you have been to the tide pools? What did you see there?
Tide pools are part of the habitat called the rocky intertidal, where the ocean meets land. Intertidal means between the high and low tide marks. What are some of the challenges that face

animals that live in this zone? (exposure to air and water, waves, sunlight, rain, temperature and salinity changes ect.)
Waves carry lots of energy across the ocean and then crash once they get into shallow water. Intertidal animals have to hang onto the rocks as the waves crash on them, and as the tide goes in and out, their surroundings change drastically. What happens at high tide? What happens at low tide? As we look at and talk about the animals in the touch tanks think about how their body parts help would them to live in this tough environment.

Procedure:

Part 1. Sea Star Body Parts

Introduction- Sea stars are not "fish" they actually invertebrates (no back bone) that belong to a group called Echinoderms, which means spiny skin. Since they are animals, they have some of the same body parts that we have. What common characteristics do we share with sea stars? (mouth, arms, feet, eyes)

Gently pull a sea star out of one of the tanks to use as a model. Point out:

1. Arms- How many arms does each sea star have? (5-for most species most of the time) What happens if a sea star losing an arm? (regeneration!) Allow students to feel the aboral surface of the sea star pull on their arm hair. These are pedicellaria which keep other animals from settling on top of the sea stars!
2. tube feet-What do these feet do? How do they help the animal live in the rocky intertidal? (They are small suction cups that help the sea star move, grab food, and suction onto rocks.)
3. eye spots-Where are the eyes? (tips of each arm) What do eyes do? Sea stars can't see images like we do, just dark and light.
4. mouth-Where is the mouth? (underneath) Sea stars' mouths are different from ours. They actually push their stomach outside of their mouth and start to digest their food outside of their body! What do sea stars eat? (mussels, small fish…) Where do sea stars usually live in the rocky intertidal? (lower, in shady areas, cracks, ect. to avoid desiccation.)

Part 2. Other Invertebrates

1. Sea cucumbers- related to sea stars (Echinoderms), but they do not have any hard spines. These animals live on the bottom of the sea floor and are decomposers that use their frilly mouth parts to mop up waste from the water and sand. This is called detritus feeding. To defend themselves, they can eviscerate, or eject their stomach and intestines in order to distract enemies and then regrow them afterward!
2. Anemones- Are they animals or plants? (animals) These are actually in the same group as jellyfish and use their tentacles to sting their prey. What do they do at high and low tide?
3. Crabs-How do crabs grow? They start out as eggs that hatch into larva that then grow and change into adults. when adults grow, they have to shed their shells (molt) and regrow a larger one!

Allow students to move around the tanks, gently touch and observe the animals.

Vocabulary

rocky intertidal
sea star
sea cucumber
larvae
molt
Echinoderm
Crustacean
Cnidarian
eviscerate

Post-lesson Survey for Rocky Intertidal Lesson

What is the Rocky Intertidal?

What is one challenge that an animal living in the Rocky Intertidal has to face?

Name one Echinoderm:

Name one Crustacean:

Have you visited the tide pools before?

Would you like to visit them in the future?

Lesson 2: Squid Dissection

Grade Level: 3-12 (modify to suit age group)
CA State Standards:
Grade 3: Life Sciences 3.a,b
Grade 5: Life Sciences 2.a,b Investigation and Experimentation 6.a
Grade 6: Investigation and Experimentation 7.a
Grade 7: Structure and Function in Living Systems 5. a,g
Physical Principles in Living Systems 6. d,j
Grade 9-12: Earth Sciences 5.d

Duration: 1 hr

Materials: one whole squid per pair of students*, scissors, needle tools, plastic plates, squid diagrams, paper towels, drawing paper, squid model
*keep frozen until morning before dissection, then place in container of water and put in fridge

Objectives:
After the lesson, students should be able to:
- locate and identify major external and internal features and organs of a squid
- understand and use basic dissection techniques and terms
- understand the function of several major squid body parts
- understand how squid is adapted to its environment

Procedure:

1. Orientation and external anatomy- place the squid in the pan with the dorsal (back) side up- funnel down, fin up, tentacles towards you. Locate the head, eyes, beak, 8 tentacles, 2 feeding arms, fins, mantle and skin. What is the difference between arms and tentacles? (Tentacles have suckers all over them, feeding arms only have suckers at the ends.) What do you notice about the skin? What are chromatophores (color-changing cells)? Why do the squid have them? (camouflage, communication, and mate selection) What does the skin feel like? (slimy, smooth) The squid has mucus on its skin that helps protect it from changes in salinity and acidity in the ocean.
note: if there is time, students may draw the external anatomy, labeling the characteristics listed above

2. Eyes-slice into eyeball, and locate the lens (small clear ball). This lens helps focus images just like the one in our eyes or in a camera. If students wish, they can keep probing between the eyeballs and locate the brain (which is white and creamy).

3. Funnel-turn body over ventral (stomach) side up. What is the funnel for? Squid use it to squirt water out of in order to move. This is called jet propulsion because they move in the opposite direction that the water is squirting, just like a jet blasting off. The angle of the funnel determines which way the squid move.

4. Mouth and beaks-open mouth and use scissors (and hands if necessary) to pull out hard beak. Once it is removed have students open and close the beak and think about what types of food the squid might eat (small fish, shelled mollusks, ect.).

5. Opening the mantle-Keep squid on its back, lift up opening to mantle using forceps, pull away from organs, pinch forceps and pull taut, with scissors cut along midline of mantle from opening to tail.
*Make sure that each pair of students have the squid in the right orientation before making their incision!

6. Reproductive organs-How do squid reproduce? How can you tell the difference between a male and a female? Female squid have large, firm white oval structures near the tail. These are Nidamental glands, which enclose the eggs in a jelly-like substance. How do these help the eggs? (protection, nutrition, anchor)
Males have white, fluid-filled genital ducts at the tail end of their body. Sperm are stored in thin tubes in an elongated sac behind their gills.

7. Gills- What are gills for? (Getting oxygen from water just like we get oxygen from air through our lungs) Gills are the long, feathery organs that are attached to the mantle on the front end. How many hearts does a squid have? (Three-one systemic heart and two gill hearts) Locate the gill hearts on the posterior end of both gills. Why do squid have three hearts? (Very quick movers that require lots of oxygen moving through their body rapidly.)

8. Digestive tract-Locate stomach and caecum, which lie together as a white, silky-looking tube. The stomach looks like a deflated bladder, while the caecum looks like a coiled sack. What are the sacks and bunched up looking white portions? (The bunched-up digestive ducts looks like intestines, and the large, dark liver contains lots of brown, oily liquid.) The stomach can be opened and the contents examined. What do you think you'll find inside? (Pieces of fish bone, crab shell, ect. may be identifiable.)

9. Ink sac-Locate the long, silvery, dark tube on bottom of liver, pinch the opening of the sac (near the back of the funnel) with forceps and pull gently while cutting away connective membrane. Once free, set ink sac aside. What do you think the ink used for?
(defense, confusion of predators and prey, communication…)

10. Gladius (pen)- Peel the pointed end of the pen (on the anterior end) away from the mantle, then gently pull to remove (similar to removing a splinter). The gladius is the squid's skeleton or shell. It is much more reduced than the shells of their other mollusk relatives, but it gives the squid's body its form, much like the backbone of vertebrates.
note: students may need help with the initial pulling step of pulling the end of the pen away from the mantle. Students may also ask if they are pulling out plastic because of the look of the gladius.

11. Writing with the ink and pen! Let students use the paper to do artwork or write message as if they were using an old fashioned quill.

12. microscope option? looks at suckers, eyes, and eggs under scope.
13. Clean up!

Post-lesson Survey for Squid Dissection

What is a squid?

Name one defense mechanism the squid has:

How do you tell the difference between a male and a female squid?

Had you ever done a dissection before this field trip?

Would you like to dissect something again?

Lesson 3: Plankton
Grade Level: K-2

Materials: microscope set up to screen for viewing, student activity sheets with Phyto-and Zooplankton, scissors, glue, colored pencils

CA State Standards

- Kindergarten: Physical Sciences 1.a Life Sciences 2.a Investigation and Experimentation 4. a,b,c,d,e
- Grade 1: Life Sciences 2.b Investigation and Experimentation 4.e
- Grade 2: Life Sciences 2.b Investigation and Experimentation 4. c,g

Objectives

After the lesson, students should know:

- what defines plankton
- the two main types of plankton (phytoplankton and zooplankton) and the main differences between them
- why plankton are important for the ocean

Introduction: Who has ever taken a big mouthful of seawater while they were boogie boarding or playing in the water? Did you know that you probably swallowed some plankton? Plankton just means "drifter". Plankton are plants or animals that live in the water and can't swim on their own so they drift around. Plankton can be divided into two main groups: Plant plankton (or phytoplankton) which use sunlight to make their food, and animal plankton (or Zooplankton) which eat phytoplankton. Plankton are very important because they form the base of the food chain which all other animals in the ocean feed off! Why are trees important on land? (They make oxygen.) Phytoplankton are like the trees of the ocean, and are very important because they produce a lot of the oxygen that we breath!

Procedure:

1. Arrange students into small groups (three or four) and have them color and cut out the plankton pictures on their student activity sheets
2. Have each team sort their pictures into two groups: phytoplankton and zooplankton
3. Ask students to explain why they sorted the pictures into those group

Lesson 3: Plankton
Grade Level: 3-5

Materials: microscope set up to screen for viewing, student activity sheets with Phyto-and Zooplankton, scissors, glue, colored pencils

CA State Standards:
- Grade 3: Physical Science 1.a Life Sciences 3.a,b
- Grade 4: Life Sciences 2.a,b 3.d
- Grade 5: Life Sciences 2.f 3.a

Objectives:
After the lesson, students should know:
- what defines plankton
- the two main types of plankton (phytoplankton and zooplankton) and the main differences between them
- why plankton are important for the ocean and the atmosphere

Introduction: What do you know about plankton? Plankton actually means "drifter". Plankton are plants or animals that live in the water and can't swim on their own so they drift around. Who knows what the two main types of plankton are? There are phytoplankton-which use sunlight to make their food, and zooplankton-which eat the phytoplankton. Which do you think would be larger? (zooplankton) Why are plankton important? Plankton are very important because they form the base of the food chain which all other animals in the ocean feed off! Why are trees important on land? (They make oxygen.) Phytoplankton are like the trees of the ocean, and are very important because they produce a lot of the oxygen that we breath! There are also two groups called holoplankton and meroplankton. Does anyone know what the difference is between these types of plankton? Holoplankton live their entire lives as plankton (e.g. copepods) while meroplankton spend only part of their lives as plankton (e.g. larvae of crabs, sea urchins, fish ect.). If you were a plankton, at what depth would you want to live in the water? At the surface? At the bottom? Plankton have to stay away from the surface because they could get eaten, and because the sunlight is too intense, but they can't go down too far or it will be too dark! So they must stay buoyant just below the surface. A very hard balance to keep! How do they keep from sinking? (shape-large surface area, oils in body that are less dense than water, ect.)

Procedure:
1. Arrange students into small groups (three or four) and have them color and cut out the plankton pictures on their student activity sheets
2. Have each team sort their pictures into two groups: phytoplankton and zooplankton
3. Ask students to explain why they sorted the pictures into those groups (How are they different? What do they look like?)

Lesson 3: Plankton

Grade Level: 6-12

Materials: microscope set up to screen for viewing, student activity sheets with Phyto-and Zooplankton, scissors, glue, colored pencils

CA State Standards

- Grade 6: Ecology 5.a,b,c,e
- Grade 7: Cell Biology 1.b
- Grade 8: Density and Buoyancy 8.c,d
- Grades 9-12: Ecology 6.e,f

Objectives

After the lesson, students should know:

- what defines plankton
- the two main types of plankton (phytoplankton and zooplankton) and the main differences between them
- why plankton are important for the ocean and the atmosphere

Introduction

What do you know about plankton? Plankton actually means "drifter". Plankton are plants or animals that live in the water and can't swim on their own so they drift around. Who knows what the two main types of plankton are? There are phytoplankton-which use chloroplasts to turn sunlight into food, and zooplankton-which eat the phytoplankton. Phytoplankton are producers and zooplankton are consumers. Which do you think would be larger? (zooplankton) Why are plankton important? Plankton are very important because they form the base of the food chain which all other animals in the ocean feed off! Why are trees important on land? (They make oxygen.) Phytoplankton are like the trees of the ocean, and are very important because they produce a lot of the oxygen that we breath! There are also two groups called holoplankton and meroplankton. Holoplankton live their whole lives in the ocean, while meroplankton spend only part of their lives as plankton. Has anyone ever heard the word larvae? The meroplankton are usually larvae, (or the smaller younger versions), of marine animals that will eventually grow up into adults and no longer be plankton. Most fish, sea stars, and mollusks have larvae, just to name a few! If you were a plankton, at what depth would you want to live in the water? At the surface? At the bottom? Plankton have to stay away from the surface because they could get eaten, and because the sunlight is too intense, but they can't go down too far or it will be too dark! So they have to float just below the surface. A very hard balance to maintain! Let's take a look at some of the different kinds of plankton and see if we can divide them into two groups based on their physical characteristics (the things you can see in the pictures).

Procedure
1. Arrange students into small groups (three or four) and have them color and cut out the plankton pictures on their student activity sheets
2. Have each team sort their pictures into two groups: phytoplankton and zooplankton
3. Ask students to explain why they sorted the pictures into those groups (How are they different? What do they look like?)

Post-lesson Survey for Plankton Lesson

What are the two types of plankton?

Why are plankton important?

Where do plankton need to live in the water column? (top, bottom, near the top…)

Are all plankton microscopic?

Did you know what plankton were before this field trip?

Will you think twice before you take a gulp of sea water again?

General Field Trip Survey

What was your favorite part of the field trip?

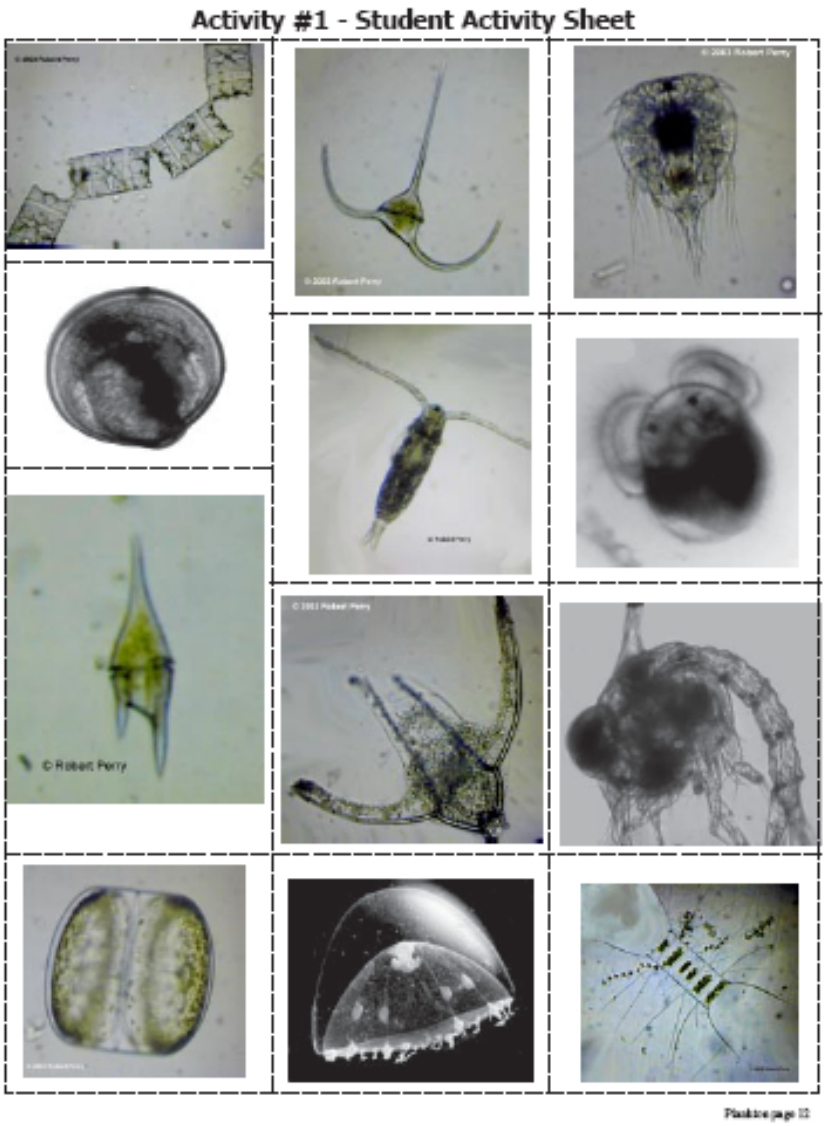
What could have been better about the field trip?

What marine topics would you like to learn more about?

Do you like science?

Do you think you could be a scientist someday?

How many times a year do you typically visit the beach?



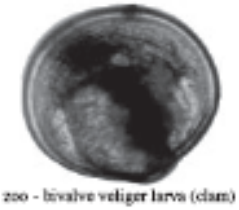
Courtesy of UCLA OceanGLOBE

Activity #1 - Teacher Guide Sheet

phyto - diatom chain (Biddulphia)

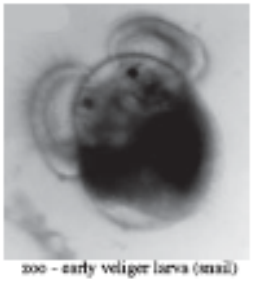
phyto - dinoflagellate (Ceratium)

zoo - naupliu larva (barnacle)

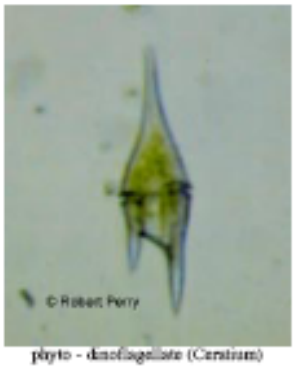


zoo - bivalve veliger larva (clam)

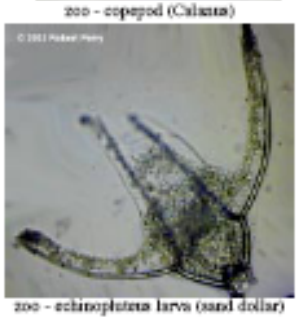
zoo - copepod (Calanus)



zoo - early veliger larva (snail)

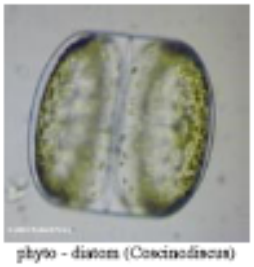


phyto - dinoflagellate (Ceratium)

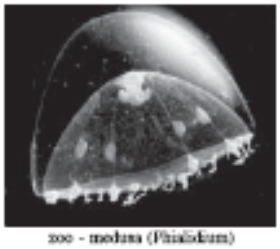


zoo - echinopluteus larva (sand dollar)

zoo - zoea larva (crab)



phyto - diatom (Coscinodiscus)



zoo - medusa (Phialidium)

phyto - diatom chain (Chaetoceros)

Courtesy of UCLA OceanGLOBE

RESULTS/ FEEDBACK

In order to asses student's learning, post-lesson surveys (included in the lessons above) were given to the group from Santa Maria Highschool several days after their visit to the Sea Life Center. They participated in the Squid Dissection and the Rocky Intertidal lessons, and answered questions pertaining not only to what they had learned, but also their attitude towards the field trip and science in general. There was a great deal of variability in their answers regarding specifics from the lessons, but the vast majority said they enjoyed the field trip, would like to visit the rocky intertidal and do a dissection again in the future, and could now see themselves potentially becoming a scientist someday.

CONCLUSION

These lessons will provide teachers with a framework for leading students in discovery about plankton, the rocky intertidal and squid dissection. The lessons will be available for all staff and volunteers at the Sea Life Center, and will serve as a model and guideline for inquiry-based teaching of these three marine topics.

Much time and effort went into making these lessons, yet there is always room for improvement. It would be ideal to have a separate section of each lesson to provide to the school teachers prior to their students coming to the Sea Life Center. This section might include an introduction to the topic as well as vocabulary terms so that students could be better prepared and therefore gain more from the lessons themselves. Also, in order to truly assess student's learning in a more quantitative fashion, surveys would need to be given both before and after participation in the program, and some numeric scale should be incorporated into the surveys. Also, beyond these three lessons there are still several more that need to be created, including marine mammals

and water chemistry. Ideally, these remaining lesson topics will also be developed into more formal curriculum, for which the above lesson plans might serve as a reference.

REFLECTION

My volunteer work at the Sea Life Center, and particularly my work in designing these lesson plans, has been an invaluable learning experience. I have not only expanded my knowledge about marine science, but also realized how challenging it can be to share knowledge in a clear and engaging way to a wide variety of age groups. I now know how to develop a lesson plan, am familiar with the California State Science Standards, and through teaching, I have grown in my personal confidence and communication skills. More importantly, however, I have seen firsthand how students can be inspired and empowered by hands-on science experiences. I have come to realize the importance of these experiences, especially for those children who do not have the opportunity to encounter nature on a regular basis. By bringing students out into the natural environments surrounding them, and providing them with interesting information about these areas, the seeds of inquiry and wonder can be sown. Knowledge of and experience with the local environment is essential if the next generation of scientists and conservationists are to be born. If just one child is empowered by the experience of doing science, or inspired to care more about their local marine environment, then these lesson plans will have met their objective.

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My students at Santa Maria Highschool
My Dad for inspiring in me a passion for the ocean