Session 1: Communicating Ocean Sciences—Introduction

Overview

This introductory session of the course begins with participants sharing and discussing their ideas about learning and where learning takes place. The participants then experience different inquiry-based, hands-on activities, as examples of the kinds of activities they will present on the floor of the informal science setting later in the course. A short presentation on what constitutes "learning in informal environments" provides the participants with a context for the next 10–15 weeks of the course and presents an overview of learning in informal science institutions and their important role in helping people learn science content and practices. The goals, syllabus and requirements of the course are reviewed. The rationale for teaching ocean science, including its interdisciplinary nature, is discussed with an overview of the science content that will be covered in the course, kicked-off by an introduction to ocean biomes. The session concludes with a discussion about the homework.

Background Information for the Presenter

The relationship between science and society has evolved considerably in the last three decades—with implications for the learning of science and preparation of future generations of scientists. Lubchenco (1998) argued for the scientific community to formulate a new "Social Contract" for science with society. She advocated for scientists to "communicate their knowledge and understanding widely in order to inform decisions of individuals and institutions" (p. 495). Ten years later, the American Association for the Advancement of Science (AAAS) once again urged scientists to engage more effectively with the public about scientific issues (Leshner, 2007). Leshner argues that science graduates need to know how to communicate their scientific knowledge with the public as science and technology advances occur at unprecedented rates. Even though such a requirement adds "yet another element to overtaxed research training programs," the knowledge and skills of communication are needed for future scientists (Leshner, 2007, p. 161). At present, there are a limited number of opportunities for science students that prepare them to communicate their research with the general public via the media, and via work with K–12 students and teachers (Lally, Brooks, Tax, & Dolan, 2007; Warren, Weiss, Wolfe, Friedlander, & Lewenstein, 2007).

The *Communicating Ocean Sciences* courses engage undergraduate and graduate science students in discussions and practice on how to communicate their scientific knowledge of ocean sciences with K–12 students and with the public who visit informal science education institutions, such as aquariums, museums, and science centers.

Informal environments are valued as places where people come to learn, play, talk, and explore science (National Research Council—NRC, 2009). Informal environments are used in *Communicating Ocean Sciences* as training grounds for young scientists to learn to communicate science with the community. In turn, members of the community have the opportunity to interact directly with the next generation of scientists.

We focus on ocean sciences in particular because, of all the science disciplines, ocean sciences are poorly represented in K–12 national and state science frameworks and standards (Hoffman & Barstow, 2007; McManus, et al., 2000). The effects of this oversight are reflected in a citizenry that has low knowledge and awareness of the concepts and environmental issues pertaining to the ocean (Steel, Smith, Opsommer, Curiel, & Warner-Steel, 2005; The Ocean Project, 2009).

While Americans are expected to comprehend and respond to increasingly complex issues, such as global climate change, environmental pressures on coastal and marine resources, and biotechnology potential within the ocean, they often do so with no more than a 6th grade understanding of how the natural world works (Sarewitz, 1996). One way to remedy the lack of ocean sciences content in schools is to help future ocean scientists learn how to communicate effectively about the ocean in order to raise ocean literacy and awareness.

The need for young scientists to learn how to communicate about their science to the public is especially critical when considering ocean sciences. Ocean scientists, science educators, and educational researchers need to work together to build public understanding of the unique challenges inherent in learning ocean sciences content. Considerable work has been done to identify the content that K–12 students should understand about the ocean. The content is documented in Ocean Literacy: The Essential Principles of Ocean Sciences K–12 (Schoedinger et al., 2005, *NMEA Special Report on Ocean Literacy*, 2010).

In our own studies of undergraduate and graduate students doing outreach in informal science education institutions as part of their COSIA course, we found that talking with (young, future) scientists during activities at informal environments affects visitors' attitudes about science (Tran, Werner-Avidon, & Randol, 2008). Some visitors acknowledged that interacting with young, "future" scientists changed their stereotype of science and scientists (as unapproachable, exclusively physics- or space-oriented, and not doing "anything for us") to recognize scientists as ordinary people interested in helping society, and science to be inclusive of the ocean and the environment.

Informal science environments that are "intentionally designed for learning about science and the physical and natural world" (NRC, 2009, pp. 5-1) offer people of all ages the opportunity to learn about, talk about, and engage in a range of science concepts and issues. These informal environments include museums, science centers, aquariums, zoos, and botanical gardens. The environments are referred to as being free-choice (Falk & Dierking, 1992), while the learning experiences are characterized as learner-motivated, learner-directed, voluntary, ongoing, contextualized, personal, and nonlinear (Falk & Dierking, 2000; Rennie, 2007; Vadebonceour, 2007).

The learners in these environments are diverse in age, socioeconomic and cultural backgrounds, interests, and abilities; and also, configurations of learners range from single-aged school groups to multi-generational families. Meanwhile, the science explored is interdisciplinary and contemporary (Rennie, in review). For these reasons, informal science environments are recognized as places that "have the potential to bolster science education broadly on a national scale" (NRC, 2009).

While schools are important learning environments, schools alone cannot be responsible for addressing the scientific knowledge needs of society. First, science in K–12 classrooms is often marginalized by traditional emphases on mathematics and literacy, while school science, itself, focuses predominantly on received knowledge and simplistic notions of scientific practice (National Research Council, 2007). Second, most individuals spend only about 9% of their lives in schools (Sosniak, 2001). Instead, it is necessary to draw upon all available resources including informal science environments like museums, zoos, and aquariums in order to support and build a scientifically literate society.

Recently, the National Research Council identified six strands of science learning that represent the ideal that all institutions that create and provide informal environments for people to learn science can strive for in their programs and facilities. These six strands are:

— Developing interest in science
— Understanding science knowledge
— Engaging in scientific reasoning
— Reflecting on science
— Engaging in scientific practice
— Identifying with the scientific enterprise

Learning in informal environments in one form or another can be found in every state in the U.S. and are a significant source of scientific information for people of all ages. Zoos and aquaria, with their "charismatic megafauna" such as elephants, dolphins, turtles, and sharks, are a significant source of information about nature. The Association of Zoos and Aquariums (AZA) has 210 accredited institutions that had an attendance of 143 million visitors during 2005. Astonishingly, more people visit museums (all informal learning environments) each year than attend all professional sporting events combined. School field trips are almost an American tradition. Busloads of students visit science centers, zoos, and aquariums as part of the formal schooling experience, but the informal environment presents a very different context for learning.
The goals of the *Communicating Ocean Sciences to Informal Audiences* (COSIA) course are to:

- introduce diverse future scientists to the importance of public outreach and K–12 education in order to enhance the breadth of the impact of their work in ocean sciences;
- introduce diverse students working toward degrees in science to possible careers in informal or formal teaching;
- encourage thoughtful, mutually beneficial collaborations between ocean scientists and educators;
- provide significant ocean science instruction and college-age role models for under-represented science center or aquarium visitors;
- improve educational skills of educators at science centers.

College students are important role models who can make a real and substantive difference in the choices that young science center visitors make about their education and careers. Providing communication opportunities at informal science institutions for future ocean scientists can broaden their view of learning and teaching and enable them to communicate more effectively in all aspects of their professional and personal lives.

Session Objectives

In this introductory session, participants:
—learn about the goals, design and requirements of the course;
—discuss the interdisciplinary nature of the ocean sciences;
—brainstorm ideas about what constitutes "learning";
—are introduced to learning in informal environments and how these settings can increase the public's knowledge about science;
—experience inquiry-based, hands-on ocean sciences activities that can be used at informal institutions, e.g., museums, aquariums and science centers.

Session Activities at a Glance

Quick Write (10 minutes)
The course begins with a Quick Write in which participants work individually for 5 minutes writing their thoughts to a question, statement, or topic. In this session, participants focus on the questions: "How do people learn?" and "Where do people learn?"

Thought Swap (25 minutes)
Pairs of participants share their ideas in rotating pairs and discuss the following questions:

1) What do you hope to get out of this course—why did you sign up?
2) What kinds of experiences have you had teaching something to someone? Please describe.
3) Why do you think it's important for people to know about the ocean?
4) Name the museum, science center, or aquarium you last visited and one thing you remember about your visit.
5) Was learning about the ocean included in your K–12 education? Describe a few things you remember doing in your classes.

Modeling Activities. (45 minutes on the floor, including break)
Participants experience five very different inquiry-based, hands-on ocean sciences activities and have the opportunity to participate in learning as it occurs in a museum. Participants discuss what it looks and feels like to ***do*** hands-on ocean science in an informal learning setting.

Debriefing Activities. (15 minutes)
Participants do a Think-Pair-Share using "Things to Ponder" prompts to reflect on their experiences observing and doing activities in the museum.

Introduction to Learning in Informal Environments. (15 minutes)
Participants are introduced to informal science education environments and revisit their ideas from the Quick Write exercise.

Brief Introduction to Course. (10 minutes)
The goals and background of the course are introduced.

Science Content Overview, Ocean Literacy, Biomes Discussion. (25 minutes)
Participants are introduced to an overview of the science content included in this semester's course. The first science content about ocean biomes is presented.

Overview of Course Mechanics. (15 minutes)
The course goals, requirements, schedules, syllabus, online discussions, course reader and an overview of the sessions are shared with the class.

Conclusion and Homework Assignment. (10 minutes)
The second set of readings from the course reader and textbook, and exploration of a web site is assigned. (The first reading was assigned prior to coming to the first class.)

Optional: *If you are also using the on-line discussions, remind participants how to access the website.* *(Note – this homework is assigned as part of the UC Berkeley course; other institutions may decide to use these assignments or develop different assignments.)*

Time Frame

Total Workshop: 3.0 hours

- Quick Write (10 minutes)
- Thought Swap (25 minutes)
- Modeling Activities (50 minutes)
- Break (10 minutes)
- Debriefing Activities (10 minutes)
- Introduction to Learning in Informal Environments (15 minutes)
- Brief Introduction to the Course (10 minutes)
- Science Content Overview, Ocean Literacy, Biomes Discussion (25 minutes)
- Overview of Course Mechanics (15 minutes)
- Conclusion and Homework Assignment (10 minutes)

Materials Needed

For the class:
- PowerPoint presentation
- digital (data) projector

For Modeling Activities:
- See activity write-ups for the activities you have chosen to model.

For each participant:
- 1 copy of Course mechanics handouts
- 1 copy of Things to Ponder
- 1 copy Science Content Overview handout
- 1 copy of *Ocean Literacy: The Essential Principles of Ocean Sciences K–12*
- 1 copy of Informal Environments Observation Worksheet

For each pair:
- Research Statements handouts

Preparation of Materials

1. For Modeling Activities. See individual activity write-ups for how to prepare to model the activities with the participants. Duplicate one copy of Things to Ponder on a half sheet for each participant.

2. Duplicate copies of Course Mechanics and Science Content Overview and Informal Environments Observation Worksheet handouts for each student and 1 copy of Research Statements for pairs of students.

3. Order 20 or so copies of *Ocean Literacy: The Essential Principles of Ocean Sciences K–12* brochure available from Jeannine Montgomery at the NOAA Outreach Unit: Jeannine.Montgomery@noaa.gov or for more information and a pdf version of the brochure go to: www.coexploration.org/oceanliteracy

Instructor's Guide—Session Details

Quick Write

1. Introduce Quick Write. Tell the participants they will begin the class with a "Quick Write." Explain that a Quick Write is a short writing task—they will have five minutes to answer a question. Tell them that answering Quick Writes is a part of their grade but that some Quick Writes, like this one, are designed to elicit learners' ideas more than as an assessment task, so they should do their best to answer the question but not to focus on a "correct" answer.

2. Start the Quick Write. Write the questions below on the board or display in some prominent way. Then ask participants to take out a piece of paper and answer the question, reminding them that they only have five minutes.

- How do people learn?
- Where does learning occur?

3. Collect Quick Write responses. Tell participants they'll have a chance to share ideas about these questions later in the session.

4. Reflect on the goals of a Quick Write. Ask participants: What do instructors get from Quick Writes? What do participants get out of writing answers to a Quick Write?

Thought Swap

1. Introduce Thought Swap. Thought Swap is a whole group activity for participants to become accustomed to sharing their ideas first with a partner and then with the whole group. Tell participants they will get a chance to talk with different classmates while discussing a series of questions to get them thinking about the session's topic—Communicating Ocean Sciences. *(See Thought Swap question prompts below.)*

2. Line up participants. Have participants stand shoulder to shoulder to form two parallel lines, so each person is facing a partner in the opposite line. Participants standing side by side should be at least 6 inches apart.

3. Explain procedure for discussing questions. Say that you'll pose a question for them to talk about with the person across from them (their partner). They'll have about a minute or so to talk. You'll signal them to be quiet, to prepare to share out, and for the next question or statement by gently tapping on the shoulders of the first two people at the end of the lines. They will pass the tap on down the line, until the touch has made it down the entire line resulting in everyone ending their discussions.

4. Begin Thought Swap. Pose the first question for participants to discuss:

— What do you hope to get out of this course and why did you sign up? Ask them to introduce themselves to their partner across from them, and then discuss the question.

5. Participants share responses. After about a minute, tap the first two participants at the end of the lines, remind them to pass the touch to the next set of partners, and wait for the entire group to become silent. Repeat the question you posed, and ask a few participants to share with the large group what their partner told them. *Optional:* Record their ideas on chart paper.

6. Change Thought Swap partners. Say that one of the lines needs to after each question, while the other remains in place. Have one of the lines move one position to the left so everyone is facing a new person—the person at the end of that line walks around to the beginning. Everyone now has a new partner.

7. Continue Thought Swap. Pose the next question/discussion topic for participants to discuss from the list below. Repeat Steps #5 and #6, shifting partners each time, until you've been through all the questions.

Prompts for Thought Swap:

1. What do you hope to get out of this course—why did you sign up?
2. What kinds of experiences have you had teaching something to someone? Please describe.
3. Why do you think it's important for people to know about the ocean?
4. Name the museum, science center or aquarium you last visited and one thing you remember about your visit.
5. Was learning about the ocean included in your K–12 education? Describe a few things you remember doing in your classes.

   Note to Facilitator: *If there are fewer than six participants, considering doing a Think-Pair-Share instead (see below).*

Modeling Activities

1. Invite participants to learn by doing. Say that they will now have the opportunity to experience five inquiry-based, hands-on ocean sciences activities reflective of the kinds of lessons they will themselves take onto the floor during the outreach (*practicum*) portion of the course.

2. Explain why they are doing these activities. Say that taking part in these activities gives them a common experience as a basis for a reflective discussion about what it looks and feels like to ***do*** inquiry-based ocean sciences activities. The activities focus on different content areas, and are actual activities that participants may choose to present on the museum floor during the course. Tell them that the class will go out on the floor to participate in these activities where experienced educators will lead the activities with the participants in this course and also with visitors.

3. Display "Things to Ponder." Display "Things to Ponder" and tell participants to keep these things in mind as they participate in the activities on the floor. When they come back to the classroom, they'll have a chance to discuss their observations.

- How were you and other visitors interacting with the facilitator?
- Do you think you learned something? Describe.
- What did you like or not like about the interactions?

4. Encourage participants to engage in activities. Encourage participants to really engage in the activities as if they were an actual visitor to the museum. Tell them to feel free to ask questions, share ideas, and interact with the educator and with other visitors participating in the activity. Remind them to keep the "Things to Ponder" in mind as they participate in the activities and distribute a copy to each student to refer to as they observe and do the activities. Emphasize that they should spend about 10 minutes at each of the five different activity stations.

5. Give time limit. Tell participants they will have a limited time on the floor to do their observations and tell them the time when to return to the classroom. Send or escort them to where the activities are set up.

Debriefing Activities

1. Introduce "Think-Pair-Share." Think-Pair-Share allows participants to activate their prior knowledge and share ideas about content or beliefs with peers. This structure gives participants a chance to organize their ideas—first in their own minds, then in a smaller group setting, before sharing with the group. In a Think-Pair-Share, participants *Think* individually about the question or idea(s) put forth, *Pair* up with someone to discuss their thinking, then *Share* their conversation with their table group, then finally with the whole group.

2. Display the "Things to Ponder." Display the "Things to Ponder" prompts again and have participants spend a minute or two **THINKING** about their observations and experiences about engaging in the activities.

- How were you and the other visitors interacting with the facilitator?
- Do you think you learned something? Describe.
- What did you like or not like about the interactions?

3. Participants PAIR up to discuss. Ask participants to turn to someone next to them and discuss their responses to the questions. Tell them to take two minutes to discuss this in their **PAIR** with each person getting some time to talk.

4. Participants SHARE with whole group. After a few minutes, ask a couple of participants to share their ***partner's*** thoughts with the entire group. Encourage others to participate by asking questions such as: "Does anyone have a different idea?" "Did anyone notice anything different?" "Can anyone explain that in a different way?" "Can you tell me more about that?" Call on a few participants—try to keep your acknowledgment of and response to their comments as neutral as possible.

Introduction to Learning in Informal Environments – Overview

1. Do "Think-Pair-Share." Do another Think-Pair-Share for participants to think about their beliefs and assumptions about learning.

2. THINK. Ask participants to first think again about their ideas from the Quick Write at the beginning of class (first two questions below) and then consider responses to the next two questions.

1) How do people learn?
2) Where does learning occur?
3) When does learning occur?
4) What are "informal learning environments"?

— PAIR. Ask participants to turn to someone next to them and discuss their responses to the questions. Tell them to take two minutes to discuss this in their PAIR with each person getting some time to talk.

— SHARE. After two minutes, ask a couple of participants to share their **partners'** thoughts with the entire group.

3. Key ideas from research literature. Introduce these key ideas on learning in informal environments and scientific literacy. Distribute a copy of the following statements to each pair. Invite participants to read the ideas and discuss their responses and reactions with their partner. After a few minutes, lead a whole group discussion. Encourage participants to express their ideas and questions. Challenge the group to share alternative ideas and opinions and to support their ideas with evidence.

— Experiences in informal environments for science learning are characterized as learner-motivated, guided by learner interests, voluntary, ongoing, contextually relevant, and collaborative. There are also other roles, and such experiences can and should play an important role in science education now more than ever.

— Visitors talking with (young, future) scientists (such as college students taking COSIA) during activities at informal environments affected the visitors' attitudes about science (Tran, Werner-Avidon, & Randol, 2008). Some visitors acknowledged that interacting with young, "future" scientists changed their stereotypical view of science and scientists (as unapproachable, exclusively physics- or space- oriented, and/or not doing "anything for us") to recognize scientists as ordinary people interested in helping society, and that science also includes studying the ocean and the environment.

— While Americans are expected to comprehend and respond to increasingly complex issues like global climate change, environmental pressures on coastal and marine resources, and biotechnology potential within the ocean, they often do so with no more than a 6^{th} grade understanding of how the natural world works (Sarewitz, 1996).

— The relationship between science and society has evolved considerably in the last three decades, which has implications for the learning of science and preparation of future generations of scientists. Lubchenco (1998) argued for the scientific community to formulate a new "Social Contract" for science with society. She advocated for scientists to "communicate their knowledge and understanding widely in order to inform decisions of individuals and institutions."

— Science graduates need to know how to communicate their scientific knowledge with the public as science and technology advances occur at unprecedented rates. Even though such a requirement adds "yet another element to overtaxed research training programs," the knowledge and skills of communication are needed for future scientists (Leshner, 2007).

— Contrary to the idea that schools are responsible for addressing the scientific knowledge needs of society, the reality is that schools cannot act alone and individuals spend as little as 9% of their lives in schools.

— Science in K–12 schools is often marginalized by traditional emphases on mathematics and literacy, and much of school science focuses on received knowledge and simplistic notions of scientific practice.

— There are six strands of science learning that represent the ideal that all institutions that create and provide informal environments for people to learn science can strive for in their programs and facilities:

- Developing interest in science;
- Understanding science knowledge;
- Engaging in scientific reasoning;
- Reflecting on science;
- Engaging in scientific practice; and
- Identifying with the scientific enterprise.

4. Introduce theories about learning. Share some or all of the following information regarding learning.

— There are people who think about and study learning, science learning in particular. They are generally in fields of education, psychology, cognitive science, and sociology. Underlying their work are many theoretical perspectives, and like theories in science, learning theories are used to organize, think about, and analyze the data. The theories are tested and challenged.

— Aside from their value and significance for research on learning and teaching, theories on learning influence and define how one may teach, communicate, and engage with learners. There are particular theoretical perspectives on learning that the developers and instructors of this course draw on, and these will be examined in further detail throughout the semester. In brief:

- Knowledge is constructed not "absorbed" (everyone comes to any situation with some knowledge. No mind is a "blank slate");
- We actively learn when ***doing*** something (this is the idea behind "hands-on" activities, especially for informal learning);
- Learning is social (we learn from each other all the time). Learning involves tools or objects (there are many tasks we cannot accomplish with making use of an object).

5. Explain *Communicating Ocean Sciences* course title. Share some or all of the following to explain that there are three ideas expressed in this title.

— Ocean Sciences. *The content*. Participants are often science majors, or as we call them, future scientists. But what good is a scientist if your research and ideas can't be communicated beyond the scientific community? Science literacy has implications beyond simply knowing how, as in how a light bulb works, for the sake of knowing. Everyday and political decisions rely on a science literate populace. Our bias in this course is on ocean sciences—which are persistently overlooked in K–12 education, despite the major social, historical, economical, biological, and ecological significance of the ocean.

— Informal audiences. Who do we mean? We've been talking about learning occurring beyond school hours and school grounds. As we discussed, among these out-of-school environments are museums. So for the purposes of this course, "informal audiences" refers to people who visit museums, science centers, aquariums, and natural history museums. The people visiting these informal science settings are members of the public, but each setting is different and, for each group of visitors, the learning conditions are different.

— Communicating. Here's the hard part. Communicating your (ocean) scientific knowledge and research to/with those members of the public (informal audiences). That's what we'll learn about and practice in this course.

Brief Introduction to the Course

1. Describe goals. Tell participants that some of the course goals include helping science majors (some with interest or specific background in ocean sciences) to become more aware of how people learn and how to communicate more effectively, in hopes that:

— if they become scientists, they'll care about teaching (including their own) and public education; and will devote some of their efforts to "informal and K–12 outreach";
— they will be better able to communicate ocean sciences concepts to various audiences;
— some participants might even consider choosing a career in informal or K–12 education.

2. Provide information on the need for effective ocean sciences communicators. Share some or all of the following information with the participants.

— The National Science Foundation (NSF) has acknowledged that the Ocean Sciences are nearly absent from the K–12 (and undergraduate) curriculum.
— College students like them are important role models that can make a real and substantive difference in the choices that young science center visitors make about their education.
— With the number of annual visits to museums outnumbering the annual attendance at all professional sporting events COMBINED, they have an incredible opportunity to share their knowledge and improve scientific literacy on a large scale.

— Graduate students have said that this course was of major importance to them because they wanted to learn how to share more effectively their research with the public in order to a) encourage the public to become enthusiastic and knowledgeable about their "incredibly cool and interesting research subject", b) help the public to better and more deeply understand their research, so that it will be deemed important and engage public attention and support, and c) increase the likelihood of receiving additional funding to support their research.

3. Describe "communicating science" model. Tell the participants that the course is designed to "practice what we preach" in that each session of the course is taught using the same teaching strategies that are being presented in the session. As learners, participants get to experience the strategies they will later be using as educators. This pedagogical model will be practiced in presenting the course content, in the hands-on science activities they take onto the floor of the museum during the outreach portion of the course, and in the activity they design.

4. Describe courses and course background.

— There are two versions of the course: COS K–12 and COSIA. The difference between them is where college students conduct their "field" practicum: either in an elementary/middle school classroom or in an informal science environment, such as a science center, museum or aquarium. In COS K–12, students are immersed in a course that explains and models inquiry-based pedagogy and learning theory for the K–12 environment.

— In both courses, the ideas students read about, discuss, and have modeled are practiced and reflected on during field experiences and a final project. Pairs of students use exemplary existing classroom curriculum or informal activities to engage underrepresented K–12 students or the public, and practice their teaching and communication skills. Throughout, students design an activity that teaches an ocean sciences concept of their choice as their final project.

— The courses were first developed at the University of California, Berkeley then disseminated around the country. Together the courses are now being taught in over 20 colleges and universities.

— Two new versions of the course are in development; one focused on traditional knowledge and another on bringing ocean sciences to inland parts of the country.

Science Content Overview

1. Introduce and Distribute Ocean Literacy brochure. Introduce the Ocean Literacy (OL) brochure and tell participants that this brochure describes the seven Essential Principles and underlying Fundamental Concepts that scientists and educators have determined an "ocean literate person" should know. For this consensus document, hundreds of scientists and educators contributed their time, knowledge, and experience to sum up what they think are the most important things everyone should know about the ocean. They suggest that in order to be science literate, not just ocean literate, we need to understand these ideas.

2. Review OL brochure. Quickly walk participants through the format of the brochure and highlight the 7 Essential Principles. They are:

- *Earth has one big ocean with many features*
- *The ocean and life in the ocean shape the features of the earth*
- *The ocean is a major influence on weather and climate*
- *The ocean makes Earth habitable*
- *The ocean supports a great diversity of life and ecosystems*
- *The ocean and humans are inextricably interconnected*
- *The ocean is largely unexplored*

3. Provide overview of semester's science content. Let participants know that a part of learning how to communicate science is developing an understanding of science content knowledge. They will learn some ocean sciences concepts in two ways. First, as a part of class sessions, different ocean science activities will model teaching practices, so participants have the opportunity to explore and develop a deeper understanding of some concepts. Second, as a part of their homework and designing their own activity, participants will be challenged to learn concepts that interest them on their own, through any ***credible*** sources available—journals, books, documentaries, lectures from other classes, discussions with scientists, etc.

There are several major topic areas of science content the class will explore. Show how each of these topics relates to the Ocean Literacy Principles.

- Ocean Biomes
- Climate Change
- Seaweeds
- Phases of the Moon
- Currents and Upwelling
- Biodiversity – with focus on invertebrates
- Tides

Note: *Course instructors should feel free to introduce any science content or science theme for the semester that reflects their research interests and expertise and that they feel is important for their participants to know and understand for their specific course.*

4. **Introduce Biomes**. For this first session, as an overview of the ocean to introduce participants to the diverse areas of ocean sciences they may want to learn more about, present participants with a slide show of ocean biomes. Present some or all of the following:

- **Intertidal** – In the intertidal, organisms are alternately underwater and exposed to air, and are frequently battered by waves. Intertidal organisms live in zones or bands on the shore. Why?
- **Estuaries** – Where rivers empty into the sea, organisms must deal with changing salinity – and often, human pollution. Are estuary organisms fresh water organisms, salt water organisms, or both?
- **Continental Shelf** – The underwater edges of the continents comprise the most biologically diverse ocean biome. What are some reasons for its high diversity?
- **Coral Reefs** – Tropical and topographically complex, coral reefs are home to a great diversity of colorful organisms. Is a coral, an animal, a plant or a rock?
- **Ocean Surface** – The top of the ocean, where light can penetrate, is full of fish, marine mammals, and the important primary producers, the plankton. What lives at the ocean surface?
- **Deep Sea** – Sunlight does not penetrate to the deep sea; its inhabitants are adapted to this dark world, where primary producers get their energy from chemical seeps rather than the sun. Why is it so dark in the deep sea?

Overview of Course Mechanics

1. Distribute course mechanics handouts. Distribute the course mechanics handouts and review details of the COSIA Course requirements. Describe the requirements, syllabus, online discussions, scheduling for presentations, and any other necessary information. *(See course mechanics section for examples.)*

Conclusion and Homework Assignment

1. **Describe online discussions.** Explain how students will access the online discussions and the procedures they will follow. They are required to answer the online question and also respond to at least one other student's answer. Also, pairs of students will take one turn during the semester monitoring the online discussions and providing an overview of the responses to the class that week. When a pair are monitors, they do not need to answer the question or respond to other students' answers.

2. Assign readings for next class session. Assign the second readings and let them know you'll use a Quick Write in the next session to assess their understanding/completion of the reading.

- Feynman, R. (1985). Amateur Scientist. In *Surely you're joking Mr. Feynman: Adventures of a curious character.* W.W. Norton & Co.
- Leiserowitz, A., Maibach, E., & Light, A. (2009). *Global warming's six Americas: An audience segmentation analysis.* Center for American Progress. Retrieved from: http://www.americanprogress.org/issues/2009/05/6americas.html
- Ocean Biomes reading from textbook. Read the first few pages of each biome chapter: 224–228; 268–269; 287–288; 307–310; 332–333; 361–363.

3. **Introduce activity development.** Describe how participants will go through a series of steps and experiences in order to design their own activity. Describe the first step in the process as follows (below) and remind the participants that it is due next week.

— Immerse yourself in ocean sciences concepts and ideas. Explore course textbook, videos, television programs, magazines, books, Internet content and newspapers.

— Make a list of ocean concepts that interest you and that you might want to learn more about and develop into your activity.

4. **Explore Informal Learning Environments.** Visit an informal learning environment of your choice (e.g., museum, aquarium, zoo, botanical garden, etc.) and complete the Informal Learning Environment Observation Worksheet. Be ready to share your observations next session.

Things to Ponder

- How were you and the other visitors interacting with the facilitator?
- Do you think you learned something? Describe.
- What did you like or not like about the interactions?

Research Statements

— Experiences in informal environments for science learning are characterized as learner-motivated, guided by learner interests, voluntary, ongoing, contextually relevant, and collaborative. There are also other roles, and such experiences can and should play an important role in science education now more than ever.

— Visitors talking with (young, future) scientists (such as college students taking COSIA) during activities at informal environments affected the visitors' attitudes about science (Tran, Werner-Avidon, & Randol, 2008). Some visitors acknowledged that interacting with young, "future" scientists changed their stereotypical view of science and scientists (as unapproachable, exclusively physics- or space- oriented, and/or not doing "anything for us") to recognize scientists as ordinary people interested in helping society, and that science also includes studying the ocean and the environment.

— While Americans are expected to comprehend and respond to increasingly complex issues like global climate change, environmental pressures on coastal and marine resources, and biotechnology potential within the ocean, they often do so with no more than a 6^{th} grade understanding of how the natural world works (Sarewitz, 1996).

— The relationship between science and society has evolved considerably in the last three decades, which has implications for the learning of science and preparation of future generations of scientists. Lubchenco (1998) argued for the scientific community to formulate a new "Social Contract" for science with society. She advocated for scientists to "communicate their knowledge and understanding widely in order to inform decisions of individuals and institutions."

— Science graduates need to know how to communicate their scientific knowledge with the public as science and technology advances occur at unprecedented rates. Even though such a requirement adds "yet another element to overtaxed research training programs," the knowledge and skills of communication are needed for future scientists (Leshner, 2007).

— Contrary to the idea that schools are responsible for addressing the scientific knowledge needs of society, the reality is that schools cannot act alone and individuals spend as little as 9% of their lives in schools.

— Science in K–12 schools is often marginalized by traditional emphases on mathematics and literacy, and much of school science focuses on received knowledge and simplistic notions of scientific practice.

— There are six strands of science learning that represent the ideal that all institutions that create and provide informal environments for people to learn science can strive for in their programs and facilities:

- Developing interest in science;
- Understanding science knowledge;
- Engaging in scientific reasoning;
- Reflecting on science;
- Engaging in scientific practice; and
- Identifying with the scientific enterprise.

Informal Environments Observation Worksheet – Homework

1. Is there an educator presenting the exhibit or activity and how does he or she get the visitors to engage with it?

2. How do visitors of different ages interact differently with the same exhibit?

3. Briefly explain how two different visitors interacted with the exhibit.

4. Use a watch to time how long five visitors interact with one exhibit. What does this tell you about learning at informal science education institutions as compared to a classroom?

5. Watch a group of visitors interact. Write down a short exchange of dialog. What was the character of the conversation?