GRADE 3 UNIT 6 OVERVIEW

Predicting and Tracking Hurricanes

Introduction

Hurricanes are tropical cyclones that form over tropical oceans, often causing considerable on-shore damage, and flooding. Tropical cyclones are characterized by the magnitude of sustained wind speeds as they transition from tropical depressions to tropical storms, and finally hurricanes. The tropical cyclone, typhoon, and hurricane are all the same type of storm, but they are called by different names depending on where in the world they occur.

Tropical storms become hurricanes only when certain conditions exist over warm tropical oceans. Tropical storms, warm ocean waters, moisture, and winds are prerequisites in the formation of hurricanes. Once formed, hurricanes are further categorized based on sustained wind speeds. Hurricanes are rare phenomena in Hawai'i; only five hurricanes have hit the Hawaiian Islands since 1950.

In this unit, students learn about hurricanes, and how they form. They also get acquainted with six technologies—buoys, ships, satellites, radiosonde, reconnaissance aircraft, and Doppler radar—used by the National Oceanic and Atmospheric Administration (NOAA) to forecast, track, measure, monitor, and keep islanders informed, through timely broadcasts, about approaching hurricanes.

From online videos, internet searches, class instruction, readings, and group brainstorming, students become adept at recognizing what hurricanes look like, and also at tracking tropical storms, through stages, to their final transformation into hurricanes. The main student focus is on safety issues associated with hurricanes, and on preventive measures designed to minimize the impact of hurricanes on island residents and homes.

After reviewing actual news bulletins, weather reports, weather report updates (hurricane warnings), and weather alerts, students modify these broadcasts to simulate hurricanes approaching their islands, and re-enact the sequence of events scientists track to keep islanders informed. Students also write hurricane family preparedness plans designed to protect their homes and the lives of loved ones, and share these plans with others.

Major Understandings: In this unit, students learn about hurricanes, and how they form. They also get acquainted with six technologies—buoys, ships, satellites, radiosonde, reconnaissance aircraft, and Doppler radar—used by the National Oceanic and Atmospheric Administration (NOAA) to forecast, track, measure, monitor, and keep islanders informed, through timely broadcasts, about approaching hurricanes.

At A Glance

Each Lesson addresses HCPS III Benchmarks. The Lessons provide an opportunity for students to move toward mastery of the indicated benchmarks. *Suggestion:* These lessons could be taught as individual lessons 1–6, or you may want to teach lesson 1 as a class, then jigsaw lessons 2–5 with 6-7 students working on each lesson, culminating with a performance task, such as a PSA, poster, brochure, museum display, skit, etc. Lesson 6 paper/pencil assessment may also be given. Instructions for jigsaw can be found after Lesson 1.

ESSENTIAL QUESTIONS	HCPS III BENCHMARKS	LESSON, Brief Summary, Duration
What is a hurricane? How would you describe a hurricane? What are the key elements of a hurricane? Why do we need to know what is used to categorize a storm as a hurricane?	Science Standard 1: Scientific Investigation: SC.3.1.2: Safely collect and analyze data to answer a question Language Arts Standard 6: Oral Communication: LA.3.6.1 Use oral language to obtain information, complete a task, and share ideas and personal opinions with others. Fine Arts Standard 1: Visual Arts: FA.3.1.3 Use observational skills in creating an original work of art	**Lesson 1: Hurricane Awareness** Students draw their current ideas and impressions of hurricanes in order to stimulate their prior knowledge about hurricanes. They view photos of hurricane wind damage and flooding, and then modify their drawings. Students then complete portions of a K-W-L chart to assess their prior knowledge and determine what they want to learn. One 45-minute period
How are hurricanes formed and classified? How do hurricanes move?	Science Standard 1: Scientific Investigation: SC.3.1.2 Safely collect and analyze data to answer a question. SC.3.8.2 Describe how the water cycle is related to weather and climate Language Arts Standard 5 Writing: LA.3.5.1 Add details, descriptions, and information from different sources to elaborate meaning. Fine Arts Standard 3: FA.3.1.3 Use observational skills in creating an original work of art	**Lesson 2: Hurricane Formation** Students model a tropical depression and a hurricane using a glass of water and their own breath. They then monitor a tropical depression on screen as it turns into a hurricane. These observations allow students to illustrate and describe a tropical depression, tropical storm, and hurricane. Students complete part of a K-W-L chart to record what they learned in this lesson. Two 45-minute periods

ESSENTIAL QUESTIONS	HCPS III BENCHMARKS	LESSON, Brief Summary, Duration
What technologies are used to locate and keep track of storms and hurricanes? How does technology assist society in preparing for a hurricane?	Science Standard 2: Nature of Science SC.3.2.1: Describe ways technologies in fields such as agriculture, information, manufacturing, or communication have influenced society	**Lesson 3: Who's Watching for You?** After hearing a story and PowerPoint presentation on technologies that the National Oceanic and Atmospheric Administration (NOAA) uses to monitor hurricanes, students choose flashcards about one method of technology that NOAA uses and presents this technology to their small group. They compare and contrast methods and complete a record sheet on the six types of technologies. Students complete part of a K-W-L chart to record what they learned in this lesson. Two 45-minute periods
What are hurricane hazards? How can we prepare for hurricanes?	Science Standard 1: Scientific Investigation: SC.3.1.2 Safely collect and analyze data to answer a question	**Lesson 4: Hurricane Preparedness** Students view videos and images of hurricane hazards, to gather information (collect data) about hazards, then make a list of the actions they would need in a family disaster plan to prepare for a hurricane. Students complete part of a K-W-L chart to record what they learned in this lesson. Two 45-minute periods

ESSENTIAL QUESTIONS	HCPS III BENCHMARKS	LESSON, Brief Summary, Duration
What do we do during a hurricane watch? What do we do during a hurricane warning? What do we do during a hurricane?	Science Standard 2: Nature of Science SC.3.2.1: Describe ways technologies in fields such as agriculture, information, manufacturing or communication have influenced society Lang. Arts Standard 4: Writing- Conventions and Skills: LA 3.4.1 Write in a variety of grade-appropriate formats for a variety of purposes and audiences. Lang. Arts Standard 5: Writing-Rhetoric: LA 3.5.1 Add details, descriptions, and information from different sources to elaborate meaning. Fine Arts Standard 1: Visual Arts: FA 3.1.3 Use observational skills in creating an original work of art.	**Lesson 5: Hurricane Warning** Through news reports, radar, and satellite images, students monitor a hurricane from hurricane watch, to hurricane warning, to actual hurricane. They then write a hurricane story to describe what happens as a hurricane nears shore, including coming to shore. Upon completion of the story, students complete the remaining part of the K-W-L chart. Two 45-minute periods
Culminating lesson, reviews all of the previous EQs.	Science Standard 2: Nature of Science SC.3.2.1 Describe ways technologies in fields such as agriculture, information, manufacturing, or communication have influenced society.	**Culminating Lesson: Taking Action** As suggested in "At a Glance" in the beginning of this unit, you may want to teach Lesson 1 as a class, and then jigsaw Lessons 2-5 and use the Culminating Lesson for group presentations. The extended activity, which is a unit test may or may not be given. Two 45-minute periods

Benchmark Rubric

I. HCPS III Benchmarks*

Below is a general Benchmark Rubric. Within each lesson, there are other assessment tools and additional rubrics specifically addressing the performance tasks of each lesson topic.

Topic		Scientific Inquiry	
Benchmark SC.3.1.2		Safely collect and analyze data to answer a question	
Rubric			
Advanced	Proficient	Partially Proficient	Novice
Summarize and share analysis of data collected safely to answer a question	Safely collect and analyze data to answer a question	With assistance, safely collect and analyze data	With assistance, safely collect data and attempt to analyze data

Topic		Science, Technology, and Society	
Benchmark SC.3.2.1		Describe ways technologies in fields such as agriculture, information, manufacturing, or communication have influenced society	
Rubric			
Advanced	Proficient	Partially Proficient	Novice
Compare how technologies in various fields have influenced society	Describe ways technologies in fields such as agriculture, information, manufacturing, or communication have influenced society	Identify, with assistance, ways that technologies have influenced society	Recall that technologies have influenced society

Topic		Forces that Shape the Earth	
Benchmark SC.3.8.2		Describe how the water cycle is related to weather and climate	
Rubric			
Advanced	Proficient	Partially Proficient	Novice
Describe how the phases of the water cycle relate to weather and climate	Describe how the water cycle is related to weather and climate	Give an example of how the water cycle is related to weather or climate	Recognize that the water cycle is related to weather and climate

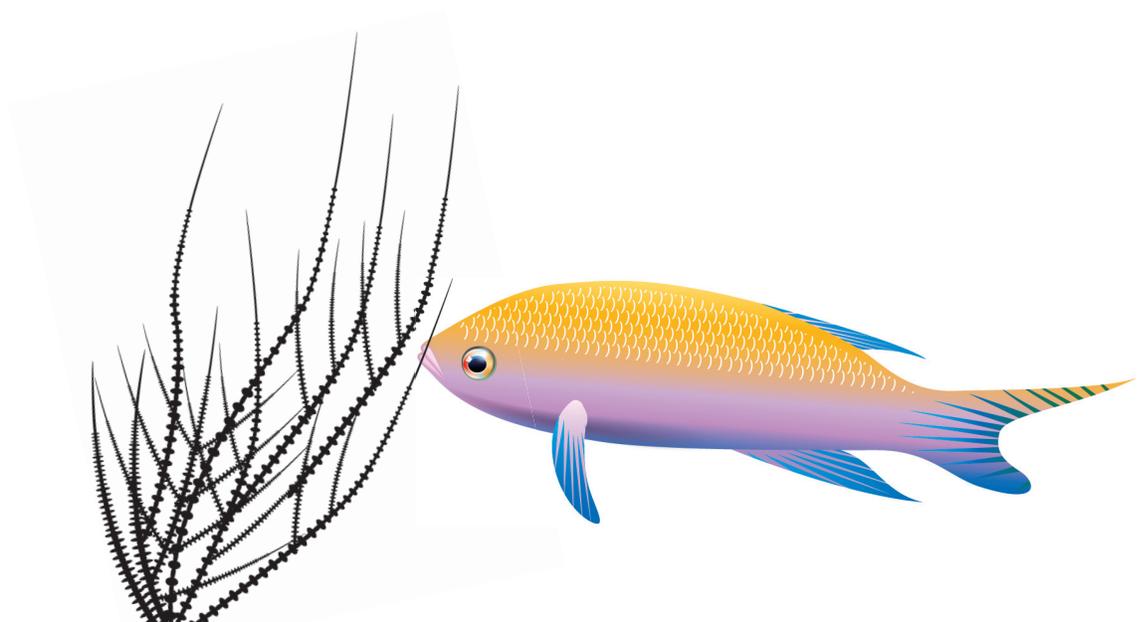| Topic		Range of Writing	
Benchmark LA.3.4.1		Write in a variety of grade-appropriate formats for a variety of purposes and audiences, such as: • stories with a beginning, middle, and end and poems with sensory details • short reports on content area topics • pieces related to completing tasks • friendly letters • responses to literature • pieces to reflect on learning and to solve problems	
Rubric			
Advanced	Proficient	Partially Proficient	Novice
Insightfully adapt writing to grade-appropriate formats for a variety of purposes and audiences	Adapt writing to grade-appropriate formats for a variety of purposes and audiences	Write with some adaptation to grade-appropriate formats for a variety of purposes and audiences	Write with little adaptation to grade-appropriate formats for a variety of purposes and audiences

Topic	Meaning
Benchmark LA.3.5.1	Add details, descriptions, and information from different sources to elaborate meaning
Rubric	

Advanced	Proficient	Partially Proficient	Novice
Add relevant details, descriptions, and information from different sources that insightfully elaborate meaning	Add relevant details, descriptions, and information from different sources that elaborate meaning	Add some trivial details, descriptions, and information from different sources that relate to but do not elaborate meaning	Add irrelevant or very few details, descriptions, and information from different sources that do not elaborate meaning

Topic	Discussion and Presentation
Benchmark LA.3.6.1	Use oral language to obtain information, complete a task, and share ideas and personal opinions with others
Rubric	

Advanced	Proficient	Partially Proficient	Novice
Use creative oral language to obtain information, complete a task, and share ideas and personal opinions with others, in a highly effective way	Use oral language to obtain information, complete a task, and share ideas and personal opinions with others	Use typical oral language that sometimes aids in obtaining information, completing a task, or sharing ideas and personal opinions with others	Use inappropriate oral language that does not aid in obtaining information, completing a task, or sharing ideas and personal opinions with others

Topic	How the Arts Communicate
Benchmark FA.3.1.3	Use observational skills in creating an original work of art
Rubric	

Advanced	Proficient	Partially Proficient	Novice
Consistently use observational skills in creating an original work of art	Usually use observational skills in creating an original work of art	Sometimes use observational skills in creating an original work of art	Rarely use observational skills in creating an original work of art

Unit Rubric for Teacher or Student Self-Assessment

Lesson	Advanced	Proficient	Partially Proficient	Novice
1. Hurricane drawing Date _____	I included wind, water, and types of hurricane damage in my drawing as well as other elements like the eye of the hurricane.	I included wind, water, and other damage caused by hurricanes in my drawing.	I included two of three key elements (wind, water, and other damage) caused by hurricanes in my drawing.	I included one of three key elements (wind, water, and other damage) caused by hurricanes in my drawing.

| Lesson	Advanced	Proficient	Partially Proficient	Novice
2. Tropical depression, tropical storm and hurricane drawing. Date _____	I drew a tropical depression, tropical storm, and hurricane in detail, including listing the wind speed.	I drew a tropical depression, tropical storm, and hurricane with some detail.	I drew 2 of 3: a tropical depression, tropical storm, and/or hurricane.	I did not draw a tropical depression, tropical storm, or hurricane.
3. Identify hurricane monitors Date _____	Identify six methods of monitoring hurricanes and describe each one in detail.	Identify six methods of monitoring hurricanes and describe each one with some detail.	Identify less than six methods of monitoring hurricanes with very little description if any.	Identify zero methods of hurricane monitoring with no description.
4. Hurricane preparedness Date _____	I identified 5 hurricane hazards and described in detail preparation for these hazards.	I identified 5 hurricane hazards, but incompletely described preparation for these hazards.	I identified 2-4 hurricane hazards and incompletely described preparation for these hazards.	I did not identify a hurricane hazard or preparation.

Lesson	Advanced	Proficient	Partially Proficient	Novice
5. Hurricane story Date _____	I described a hurricane watch, warning, and an actual hurricane with lots of details through writing and drawing pictures.	I described a hurricane watch, warning, and an actual hurricane with some details through writing and drawing pictures.	I described a hurricane watch, warning, or an actual hurricane incompletely and without details in words or pictures.	I did not describe hurricane watch, warning, or an actual hurricane.

II. General Learner Outcomes*

Below is a list of the HIDOE General Learner Outcomes (GLOs). Each Unit of the Lessons from the Sea Curriculum addresses the GLOs. Within some lessons, there is more specific mention of individual GLOs with specific pertinence.

I.   Self-directed Learner. (The ability to be responsible for one's own learning.)
II.   Community Contributor. (The understanding that it is essential for human beings to work together.)
III.   Complex Thinker. (The ability to demonstrate critical thinking and problem solving.)
IV.   Quality Producer. (The ability to recognize and produce quality performance and quality products)
V.   Effective Communicator. (The ability to communicate effectively.)
VI.   Effective and Ethical User of Technology. (The ability to use a variety of technologies effectively and ethically.)

"Hawaiʻi Content & Performance Standards III Database." Hawaiʻi Department of Education. June 2007. Department of Education. 17 Dec. 2007.
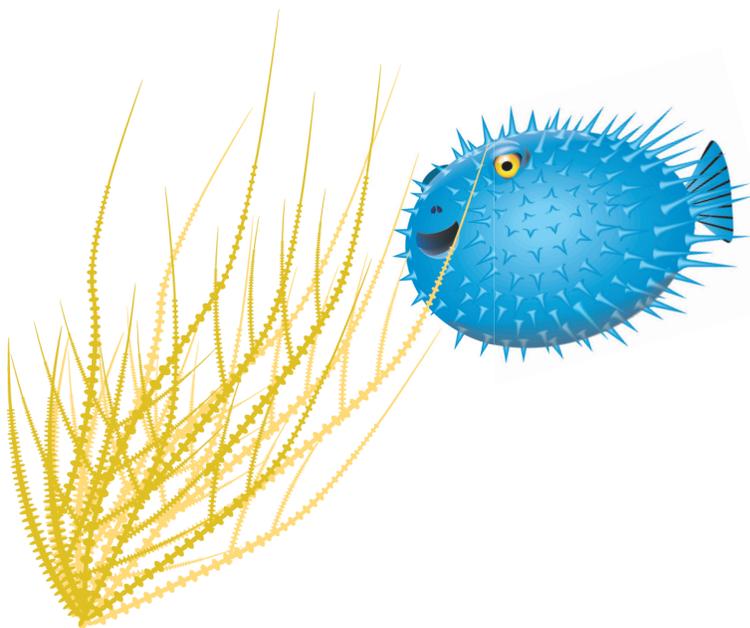
Science Background for the Teacher

Note: Bolded words found within this section are defined in the *Science Background for the Teacher Glossary.* The footnotes refer to the references found in the *Science Background for Teacher- Bibliography* at the end of this section.

What is a hurricane?[1] (Lesson 1)

One of our oceans many effects on the earth's **climate** is their contribution to hurricanes. **Hurricanes** occur in the North Atlantic, the Northeast Pacific Ocean east of the dateline, or the South Pacific Ocean east of 160E longitude. In other parts of the world, these types of storms have different names: typhoons (the Northwest Pacific Ocean west of the dateline), severe tropical **cyclone** (the Southwest Pacific Ocean west of 160E or Southeast Indian Ocean east of 90E), severe cyclonic storm (the North Indian Ocean), and **tropical cyclone** (the Southwest Indian Ocean). Although different names are used they all mean the same thing. The definition of hurricane in the glossary applies to all these names.

Hurricanes are a type of **tropical cyclone** which is accompanied by thunderstorms and, in the Northern Hemisphere, a counterclockwise circulation of winds near the earth's surface that revolve around an eye. There are three types of tropical cyclones which are characterized by the magnitude of their sustained wind speeds: **tropical depressions, tropical storms, and hurricane.**

Type of Tropical Cyclone	Description
Tropical Depression	A system of clouds and thunderstorms with a defined circulation and maximum sustained winds of less than 39 mph.
Tropical Storm	A system of strong thunderstorms with defined circulation and maximum sustained winds of 39-73 mph.
Hurricane	A system of strong thunderstorms with well-defined circulation and maximum sustained winds higher than 73 mph.

Tropical cyclones form over warm waters from pre-existing disturbances. These disturbances typically emerge every three or four days from the coast of Africa as "tropical waves" that consist of areas of unsettled weather. Tropical cyclones can also form from the trailing ends of cold fronts and occasionally from upper-level low pressure systems. The process by which a tropical cyclone forms and subsequently strengthens into a hurricane depends on at least three conditions:
1. A pre-existing disturbance with thunderstorms
2. Warm (at least 79 degree F) ocean temperatures to a depth of about 150 feet
3. Light upper level winds that do not change much in direction and/or speed throughout the depth of the atmosphere (low wind shear)

Heat and energy for the storm are gathered by the disturbance through contact with warm ocean waters. The winds near the ocean surface spiral into the disturbance's low pressure area. The warm ocean waters add moisture and heat to the air which rises. As the moisture condenses into drops, more heat is released, contributing additional energy to power the storm. Bands of thunderstorms form, and the storm's cloud tops rise higher into the atmosphere. If the winds at these high levels remain relatively light (little or no wind shear) the storm can remain intact and continue to strengthen.

In these early stages, the system appears on the satellite image as a relatively unorganized cluster of thunderstorms. If weather and ocean conditions continue to be favorable, the system can strengthen and become a **tropical depression** (winds less than 39 mph or 33 kt). At this point, the storm begins to take on the familiar spiral appearance due to the flow of the winds and the rotation of the earth.

If the storm continues to strengthen to **tropical storm** status (winds 39-73 mph) the bands of thunderstorms contribute additional heat and moisture to the storm. The storm becomes a **hurricane** when winds reach a minimum of 74 mph. At this time, the cloud-free hurricane eye typically forms because rapidly sinking air at the center dries and warms the area. For more information on the hurricane basics see: http://www.climate.noaa.gov/education/hurricanes/hurricane_basics.pdf

Hurricanes are categorized according to the Saffir-Simpson Scale in terms of the speed of the winds and the amount of damage they can cause.

Hurricane Categories	Description
Category 1	Hurricane has winds of 74 to 95 mph and causes no substantial damage to buildings though areas on the coast may flood.
Category 2	Hurricane has winds of 96 to110 mph and may cause damage to buildings, especially to mobile homes.
Category 3	Hurricane has winds from 111 to 130 mph and may cause structural damage to small residences and considerable coastal flooding.
Category 4	Hurricane has winds of 131 to 155 mph and damage may include structural failures, major beach erosion, and flooding.
Category 5	Hurricane has winds over 155 miles per hour and damage may include structural failures for residences and industrial buildings and major flooding.

There are on average six Atlantic hurricanes and nine East Pacific hurricanes each year. Hurricanes are particularly dangerous when they move onto land where heavy rains, strong winds and heavy waves can cause significant damage and sometimes death. For example, the category 1 Hurricane Iwa struck the Hawaiian Islands on November 23, 1982 causing 234 million dollars in property damage, with the island of Kauaʻi receiving one third of the damage. Only ten years later, the category 4 Hurricane Iniki struck the island of Kauaʻi on September 11, 1992 with 130 mph winds causing 2.3 billion dollars in property damage. Hurricanes in the Hawaiian Islands are relatively rare events. Since 1950, five hurricanes have caused serious damage in Hawaiʻi: Hurricanes Nina, Dot, Estelle, Iwa and Iniki. For more information on hurricanes in Hawaiʻi see:
http://www.soest.hawaii.edu/MET/Faculty/businger/poster/hurricane

How does NOAA predict hurricanes?[2] (Lesson 3)

The ability of scientists to predict or forecast hurricanes and tsunamis has only recently begun to improve. Technological advances are allowing forecasters to collect real-time data on these potentially devastating events, providing forecasters with the means to accurately determine the degree of danger these events pose to human populations. While these events cannot be stopped, with a better understanding and ability to predict when and where they will occur, the potential danger to property and life can be minimized.
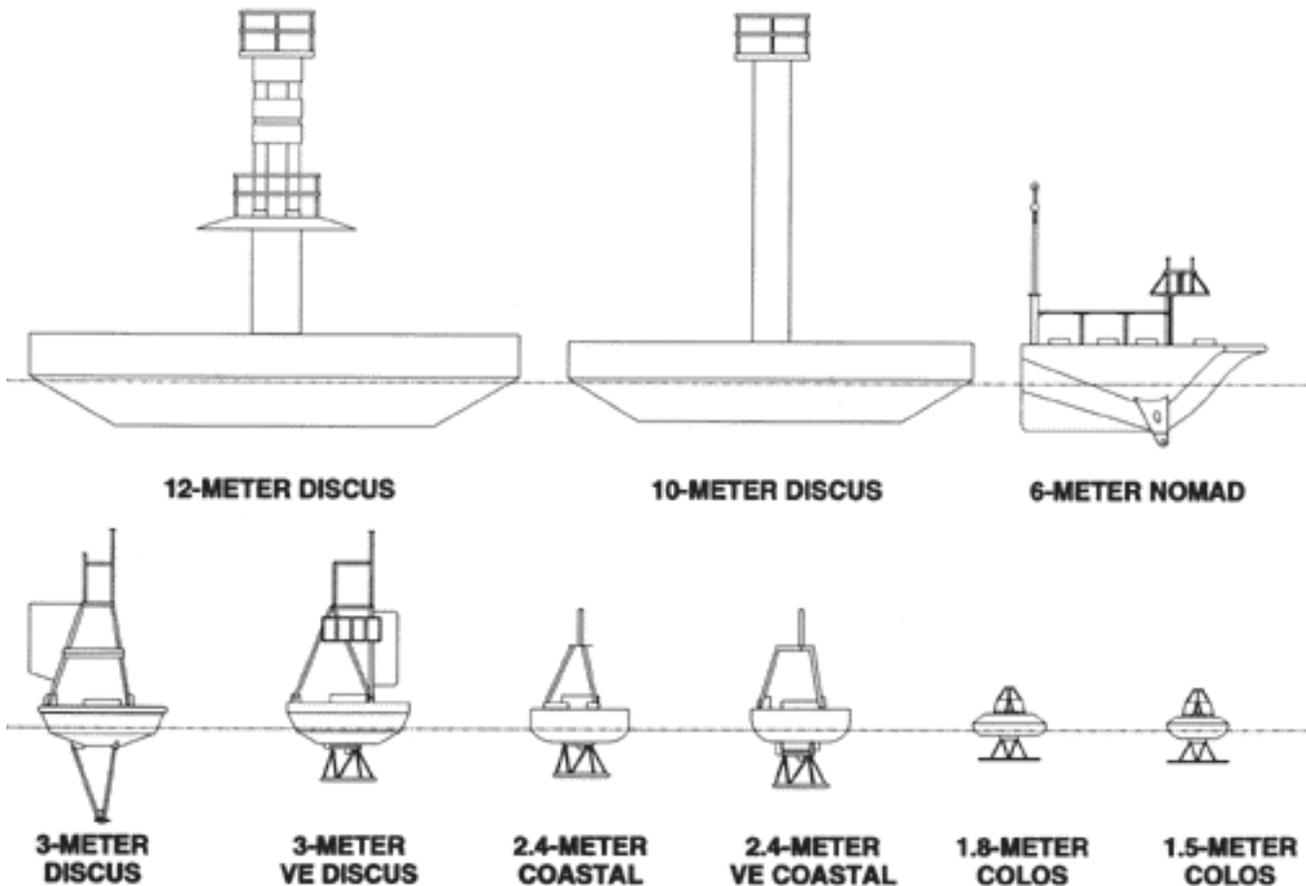
To help predict hurricanes, NOAA utilizes a variety of technological tools to monitor, evaluate and predict the **climate** and its associated weather disturbances including aircraft, **satellite,** weather radar, **buoys** and floats and computer forecast models. Aircraft operated by NOAA and the U.S. Air Force are used to gather data from around, within and above hurricanes. Aircraft are routinely flown into potentially threatening storms where onboard radar and sensors, some of which are ejected from the belly of the aircraft, measure a **cross-section** of a hurricane. **Satellite** greatly improved hurricane forecasting with their ability to provide informative snapshots of Earth. With satellites, scientists are able to track atmospheric variables such as temperature and cloud formation, providing data necessary to track and understand hurricanes. Weather radar allows scientists to measure motion inside storms, recording precipitation intensity and movement, and a variety of wind data. This data provides forecasters with a valuable cross-sectional analysis of a storm. Today, more than 150 WSR-88 Doppler radars monitor weather patterns over the United States and its associated territories. Buoys and floats, located throughout our oceans, provide a variety of data including air and water temperature, **wave height**, and wind direction and speed at and below the waters surface. This allows NOAA to monitor areas of the ocean at and around where hurricanes occur. All of the observational data provided by these technologies are brought together in computer forecast models. Computer forecast models allow forecasters to calculate and predict future weather behavior. As more data is collected, forecasters are better able to predict not only the path and strength of current storms, but also seasonal outlooks extending through the entire six-month hurricane season. For more information on how hurricanes are predicted see: http://celebrating200years.noaa.gov/magazine/devast_hurricane/welcome.html

What is an oceanographic data buoy?[3] (Lesson 3)

The NOAA National Data **Buoy** Center's (NDBC) observing system consists of multiple types of moored and drifting buoys. Drifting buoys are expendable systems launched from ships or aircraft into specific ocean areas. They collect data as they drift in response to ocean currents and winds. Moored buoys are anchored to the sea floor in areas around the Pacific Ocean and Western Atlantic where they also collect data. Moored and drifting buoys measure and transmit barometric pressure, wind direction, speed, and gust, air and sea temperature, and wave energy spectra from which significant **wave height,** dominant **wave period,** and average wave period are derived, depending on the type of buoy. Even the direction of wave propagation is measured on many moored buoys.

NDBC currently deploys six different types of moored buoys. The type of buoy used depends on its deployment location and measurement requirements. To ensure optimal performance, a specific mooring design is produced based on buoy type, location and water depth. For more information on the types of buoys employed by NOAA see: http://www.ndbc.noaa.gov/mooredbuoy.shtml

Moored Buoy Program

12-METER DISCUS   10-METER DISCUS   6-METER NOMAD

3-METER DISCUS   3-METER VE DISCUS   2.4-METER COASTAL   2.4-METER VE COASTAL   1.8-METER COLOS   1.5-METER COLOS

What can buoy data tell us?[4] (Lesson 3)

The data collected through oceanographic data buoys have many applications. Weather forecasts are a compilation of multiple monitoring technologies including satellites and buoys. Buoys are crucial to weather forecasting because they are often deployed in open ocean areas where no other source of data is available. For similar reasons, data buoys are critical for marine forecasts where they collect real-time information for sea surface conditions that are difficult or impossible to collect from other sources. Fisheries scientists often depend on buoy data. Sea surface temperature is an important tool to predict seasonal and longitudinal variation in fish distributions. Buoys provide local data on changes in oceanographic conditions which are essential for fisheries management. Oceanographic buoys also provide valuable data for **climate** predictions and oceanographic research. For example, buoy data is utilized in predicting **El Niño/Southern oscillation** phenomenon. The School of Ocean and Earth Science and Technology (SOEST) in the University of Hawaiʻi at Mānoa employs several data buoys which collect data on a wide range of oceanographic variables. One such project, the Hawaiʻi Air Sea Logging Experiment, A Long-Term Oligotrophic Habitat Assessment (HALE ALOHA) buoy has been deployed off the coast of Oʻahu to help ocean scientists develop and test a variety of sensors and data recorders. These sensors allow scientists to study parameters such as productivity, gas exchange and temperature fronts remotely. For more information on SOEST buoys see: http://hahana.soest.hawaii.edu/hot/hot_jgofs.html

Where are data buoys located?[5] (Lesson 3)

The NOAA NDBC moored buoys are located in coastal and offshore waters from the Western Atlantic to the Pacific Ocean around Hawaiʻi, and from the Bering Sea to the South Pacific. The buoys transmit approximately every hour to one of NOAA's Geostationary Operational Environmental Satellites (GOES). The data is then relayed to the National Environmental Satellite, Data, and Information Service (NESDIS) Data Acquisition Processing System (DAPS) at Wallops Island, Virginia. The data is then sent to the National Weather Service Telecommunications Gateway (NWSTG) in Silver Spring, Maryland, for data quality control and distribution. From there the information is sent to the NDBC and National Weather Service (NWS) offices, posted on the internet and broadcast on NOAA weather radio. Additionally, international scientific associations maintain arrays of drifting and moored buoys throughout the world's oceans. For information on the location and type of theses moored buoys see: http://www.ndbc.noaa.gov/mooredbuoy.shtml

Science Background for the Teacher Glossary

automated: to operate electronically and automatically without continuous input from an operator.

buoy: a distinctively shaped and marked float, sometimes carrying a visual signal or signals, anchored to mark a channel, anchorage, navigational hazard, etc.; also used to collect oceanographic data.

climate: long-term average of conditions in the atmosphere in a particular part of the world.

coriolis effect: effect that the earth's rotation has on a path of air and water moving at or above its surface, causing the path to curve to the right in the Northern Hemisphere and to the left in the Southern Hemisphere.

cyclone: an area of low atmospheric pressure characterized by inward spiraling winds that rotate counterclockwise in the Northern Hemisphere.

cross-section: a section formed by a plane cutting through an object.

El Niño: unusually warm ocean temperatures in the Equatorial Pacific that occurs every 4 to 12 years. It affects weather over much of the Pacific Ocean.
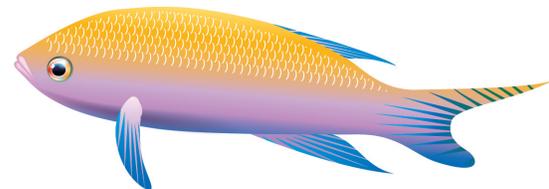
eye: the roughly circular area of comparatively light winds that encompasses the center of a severe tropical cyclone.

hurricane: a severe tropical storm with heavy rains and high wind speeds in excess of 73 mph or 119 km/hr, enormous waves, and subsequent flooding that can damage buildings and beaches. An area of low pressure around which winds blow counterclockwise in the Northern Hemisphere. The term hurricane is used for Northern Hemisphere tropical cyclones east of the International Dateline to the Greenwich Meridian. The term typhoon is used for Pacific tropical cyclones north of the Equator west of the International Dateline. In the Indian Ocean they are called cyclones.

low-pressure weather system: An area of a relative atmospheric pressure minimum that has converging winds and rotates in the same direction as the Earth.

weather: conditions in the atmosphere which include temperature, precipitation, pressure, cloud cover and humidity.

weather satellite: a devise that orbits the Earth, equipped with instruments to measure and transmit data about weather features such as air pressure, humidity, and temperature. Weather satellite observations can cover high parts of the atmosphere that cannot be reached by weather balloons.

Saffir-Simpson Scale: classifies hurricanes with a 1-5 rating based on the hurricanes present intensity. Used to give an estimate of potential property damage expected along the coast from a hurricane landfall. Wind speed is the determining factor.

southern oscillation: a periodic reversal of the pressure pattern across the tropical Pacific Ocean during El Niño events.

tropical cyclone: a low pressure system in which the central core is warmer than the surrounding atmosphere.

tropical depression: a tropical cyclone in which the maximum sustained surface wind speed (using the U.S. 1-minute average) is 38 mph or 62 km/hr or less.

tropical storm: a tropical cyclone in which the maximum sustained surface wind speed (using the U.S. 1-minute average) ranges from 39 mph or 63 km/hr to 73 mph or 118km/hr.

wave height: the vertical distance between a wave crest and the preceding trough.

wave length: the distance between two successive points of equal amplitude and phase on a wave.

wave period: the time required for two successive wave crests or troughs to pass a point in space.

Science Background for the Teacher- Bibliography

[1-5] *Science background information condensed and/or compiled from the following sources:*

1: Businger, S. (1998). *Hurricanes in Hawai'i.* Retrieved March 19, 2007 from NOAA. (2007).
   Hurricane Basics. Retrieved March 19, 2007 from Oahu Civil Defense Agency. (2004).
   Hurricanes in Hawai'i: What are the risks of damage? Whate con home owners do to reduce their risks? Retrieved March 21, 2007 from NOAA.
2: *Predicting Hurricanes: Times have changed.* Retrieved March 20, 2007 from http://celebrating200years.noaa.gov/magazine/devast_hurricane/welcome.html
   The Tsunami Story. Retrieved March 20, 2007 from NOAA. (2003).
   Deep-ocean Assessment and Reporting of Tsunamis (DART): Real-time Tsunami reporting from the deep ocean. Retrieved March 20, 2007 from University of Washington. (2005).
   The tsunami warning system. Retrieved March 21,2007 from NOAA. (2006).
3: *Moored Buoy Program.* Retrieved March 20, 2007 from Fujieki, L. (2007).
4: *Laboratory for Microbial Oceanography.* Retrieved March 21, 2007 from Miedema, A. (1998).
   Weather Data Collection Methods. Retrieved March 21, 2007 from NOAA. (2006).
5: *Moored Buoy Program.* Retrieved March 20, 2007 from NOAA. (2006).
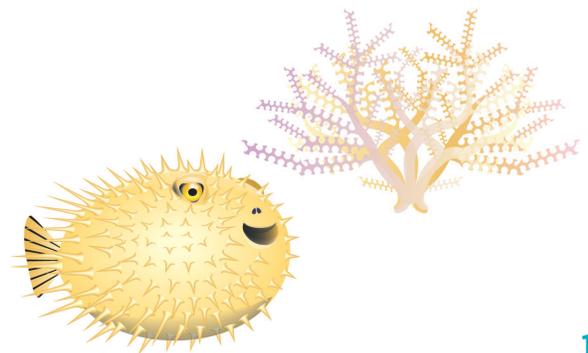
NOAA Resources

Below is a list of resources compiled by the Outreach Education Office of the National Oceanic and Atmospheric Administration. The science standards and the ocean literacy principles addressed in this unit were used as a guideline in selecting the following resources. To access the print resources listed below, contact NOAA's Outreach Education Office directly:

Outreach Unit
NOAA Office of Public and Constituent Affairs
1305 East West Highway #1W514
Silver Spring, MD 20910
Phone: (301) 713-1208
Email: NOAA-OUTREACH@noaa.gov
http://www.education.noaa.gov/

Resources:

• **JetStream at http://www.srh.noaa.gov/srh/jetstream/matrix.htm**

• **Build Your Own Weather Station sections in Discover Your World with NOAA 200th Anniv. informal activity book**

• **"Follow That Hurricane" from Discover Your World with NOAA 200th Anniv. Informal Activity Book. Can also access Pacific Hurricane Tracking Maps at http://www.nhc.noaa.gov**

• **Billy and Maria Weather Coloring Books**

• **http://www.nssl.noaa.gov/edu/bm/bm_main.html**

• **NOAA satellite data depicting currents, wave patterns and weather**

OCEAN LITERACY ESSENTIAL PRINCIPLES

3. The ocean is a major influence on weather and climate
    3a. The ocean controls weather and climate by dominating the Earth's energy, water and carbon systems.
    3b. The ocean absorbs much of the solar radiation reaching Earth. The ocean loses heat by evaporation. This heat loss drives atmospheric circulation when, after it is released into the atmosphere as water vapor, it condenses and forms rain. Condensation of water evaporated from warm seas provides the energy for hurricanes and cyclones.

6. The ocean and humans are inextricably interconnected.
    6f. Coastal regions are susceptible to natural hazards (Tsunamis, hurricanes, cyclones, sea level change, and storm surges).

7. The ocean is largely unexplored.
    7b. Understanding the ocean is more than a matter of curiosity. Exploration, inquiry and study are required to better understand ocean systems and processes.
    7d. New technologies, sensors and tools are expanding our ability to explore the ocean. Ocean scientists are relying more and more on satellites, drifters, buoys, subsea observatories and unmanned submersibles.
    7e. Use of mathematical models is now an essential part of ocean sciences. Models help us understand the complexity of the ocean and of its interaction with Earth's climate. They process observations and help describe the interactions among systems.

Lesson 1: 3a.3b. 6f.
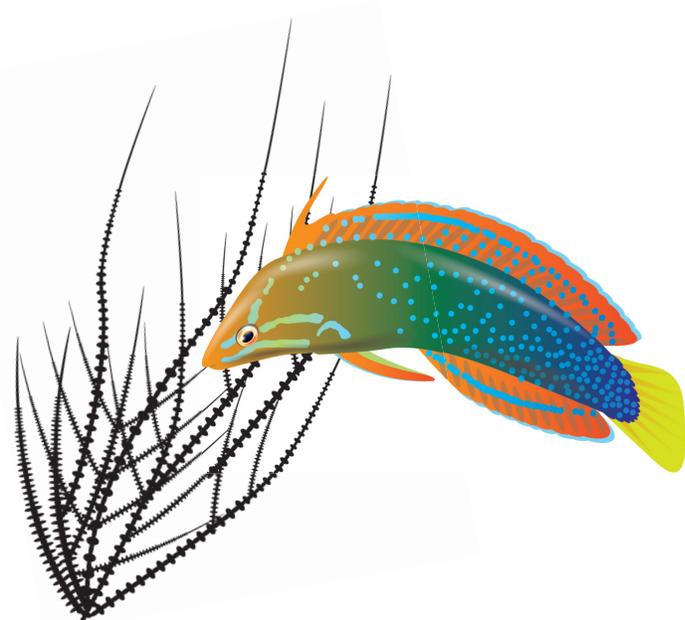Lesson 2: 3a. 3b. 7b.
Lesson 3: 7d. 7d. 7e.
Lesson 4: 6f.
Lesson 5: 6f. 7d.
Culminating: 3b. 6f. 7d. 7e.

CLIMATE LITERACY ESSENTIAL PRINCIPLES

There is no appropriate alignment of Climate Literacy Essential Principles to the unit lessons.

Glossary of Cooperative Learning Techniques

In an effort to maximize student engagement and learning, the NOAA Sea Earth and Atmosphere curricular resources were designed using cooperative learning techniques. This guide defines the expectations for implementation of each technique.

What is Cooperative Learning?

Cooperative learning may be broadly defined as any classroom learning situation in which students of all levels of performance work together in structured groups toward a shared or common goal. According to Johnson, Johnson and Holubc, (1994): "Cooperative learning is the instructional use of small groups through which students work together to maximize their own and each other's learning." In classrooms where collaboration is practiced, students pursue learning in groups of varying size: negotiating, initiating, planning and evaluating together. Rather than working as individuals in competition with every other individual in the classroom, students are given the responsibility of creating a learning community where all students participate in significant and meaningful ways. Cooperative learning requires that students work together to achieve goals which they could not achieve individually.

Jigsaw

To Jigsaw materials refers to the use of a strategy in which each student on a team receives only a piece of the material that is to be learned in which that student becomes the "expert." Once the material is learned each member of the team takes a turn teaching the other members their assigned content. This type of dynamic makes the students rely on the other members of their team to learn all of the material.

Think-Pair-Share

This four-step discussion strategy incorporates wait time and aspects of cooperative learning. Students (and teachers) learn to LISTEN while a question is posed, THINK (without raising hands) of a response, PAIR with a neighbor to discuss responses, and SHARE their responses with the whole class. Time limits and transition cues help the discussion move smoothly. Students are able to rehearse responses mentally and verbally, and all students have an opportunity to talk.

Numbered Heads

This structure is useful for quickly reviewing objective material in a fun way. The students in each team are numbered (each team might have 4 students numbered 1, 2, 3, 4). Students coach each other on material to be mastered. Teachers pose a question and call a number. Only the students with that number are eligible to answer and earn points for their team, building both individual accountability and positive interdependence.

KWL Chart

A pre-assessment tool consisting of three vertical columns. Students list what they "**K**now" about a topic. What they "**W**ant" to know about a topic. The last column students share what they have "**L**earned" about a topic.

KWL CHART
Be sure to bullet your list.
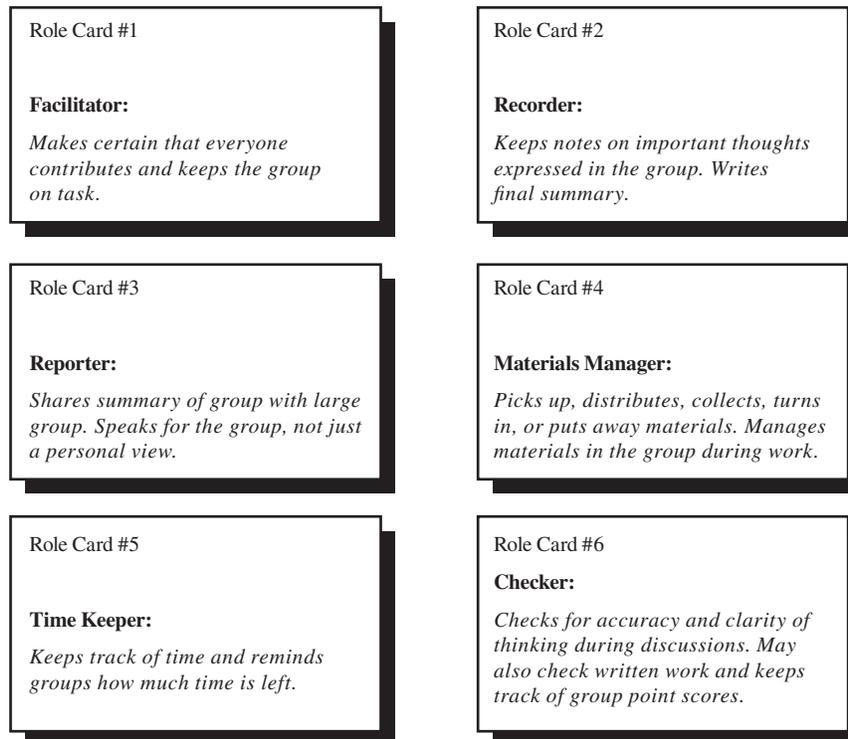*Use content words only (nouns, verbs, names of people and places, dates, numbers, etc.).*

WHAT DO I **K**NOW?	WHAT DO I **W**ANT TO KNOW? *or* WHAT DO I **W**ANT TO SOLVE?	WHAT HAVE I **L**EARNED?
•		•
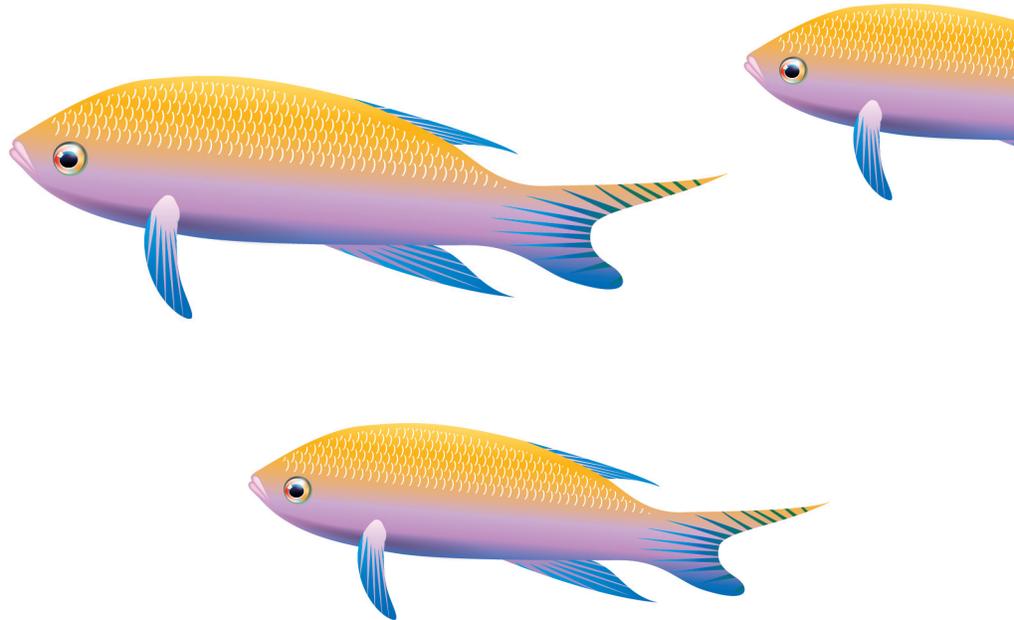
Role Cards

Assign students to cooperative learning groups. Once students are in their groups the teacher will hand out premade role cards that will help each member of the group contribute to the completion of the given task. Before roles are assigned, the teacher should explain and model the task as well as the individual roles for students so that they know and understand how his/her individual role will contribute to the success of the group completing the task. When this technique is used, taking on a different role will aid in student proficiency.

Example of role cards:

Role Card #1

Facilitator:

Makes certain that everyone contributes and keeps the group on task.

Role Card #2

Recorder:

Keeps notes on important thoughts expressed in the group. Writes final summary.

Role Card #3

Reporter:

Shares summary of group with large group. Speaks for the group, not just a personal view.

Role Card #4

Materials Manager:

Picks up, distributes, collects, turns in, or puts away materials. Manages materials in the group during work.

Role Card #5

Time Keeper:

Keeps track of time and reminds groups how much time is left.

Role Card #6

Checker:

Checks for accuracy and clarity of thinking during discussions. May also check written work and keeps track of group point scores.
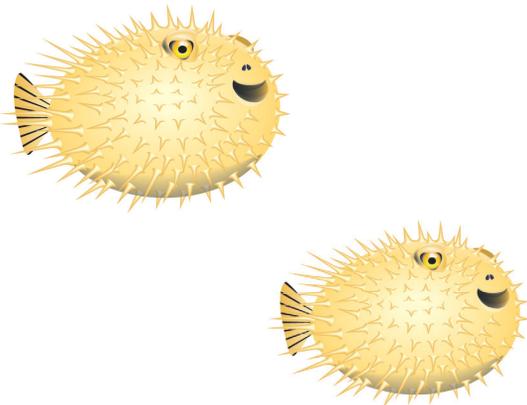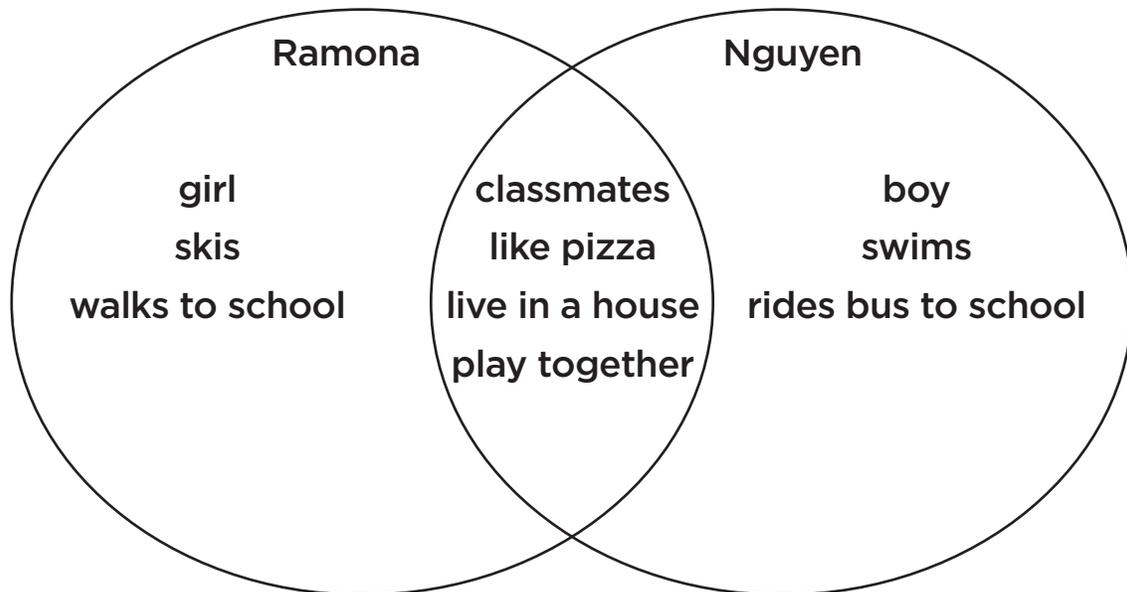
Round Table

Round table can be used for brainstorming, reviewing, or practicing while also serving as a team builder. Students sit in teams of 3 or more, with one piece of paper and one pencil. The teacher asks a question which has multiple answers. Students take turns writing one answer on the paper, then passing the paper and pencil clockwise to the next person. When time is called, teams with the most correct answers are recognized. Teams reflect on their strategies and consider ways they could improve.

Three-Step Interview

This involves structured group activity with students. Using interviews/listening techniques that have been modeled; one student interviews another about an announced topic. Once time is up, students switch roles as interviewer and interviewee. Pairs then join to form groups of four. Students take turns introducing their pair partners and sharing what the pair partners had to say. This structure can be used as a team builder, and also for opinion questions, predicting, evaluation, sharing book reports, etc.

Venn Diagram

A diagram using circles to represent sets, with the position and overlap of the circles comparing and contrasting the relationships between two given pieces of information.

Ramona | Nguyen

girl
skis
walks to school

classmates
like pizza
live in a house
play together

boy
swims
rides bus to school

References and Credits

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