# EXPLORATION EXPENSES | EDUCATOR

### Links to Next Generations Science Standards |

5-ESS3-1: Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

### Links to Common Core Standards |

CCSS.MATH.CONTENT. 5.MD: Convert like measurement units within a given measurement system.
CCSS.MATH.CONTENT. 5.MD: Represent and interpret data.

CCSS.MATH.CONTENT. 7.NS: Apply and extend previous understandings of operations with fractions to add, subtract, multiply, and divide rational numbers.

CCSS.MATH.CONTENT. 7.EE: Solve real-life and mathematical problems using numerical and algebraic expressions and equations.

CCSS.MATH.CONTENT. 7.G: Draw, construct, and describe geometrical figures and describe the relationships between them.

**S T E M**

**Pacing |** 1-3 class periods
**Background Needed |** Conversions, basic algebra, calculating percentages, graphing
**Assessment |** Rubric provided
**Materials/Resources |**

- Class sets of expedition cards (http://nautl.us/2e8iolL)
- Rulers
- Calculators
- Graph paper
- Devices with internet access (optional)

## Overview

This module focuses on general aspects of expedition planning and budgeting. Students will work in pairs or small groups to take on the role of expedition planners for a *Nautilus* cruise. Each student or team will choose one expedition card with a map and pertinent expedition details. They will use this information to plan an efficient route and calculate expenses according to their decisions. Students will use basic algebra and units of conversion to complete an expense sheet and show a graph or chart of their budget. Teachers take on the role of a potential funder to decide whether expedition plans will receive the green-light based on completion and accuracy of student work. The expedition cards are based on recent expeditions of the *Nautilus* Exploration Program. The financial and budget information provided are stand-in numbers for student-use and not factual representations of the actual operating budget of Ocean Exploration Trust.

## Objectives & Learning Outcomes

- Students will calculate distance between two points using a scale and basic units of conversion.
- Students will use provided equations to calculate various expedition costs.
- Students will calculate percentages of budget categories.
- Students will represent their budget in graph and/or chart form.
- Students will gain basic understanding of the roles of expedition team members.

## Activity/Tasks

Students will:

- form small groups or pairs, read the introduction, and choose one expedition card,
- read the operational information provided in the procedure,
- examine their expedition card to choose a ship transit path and staffing plan,
- based on their choices, complete the budget overview worksheet using scrap paper for additional calculations as needed,
- create a graph that represents their expedition budget,
- turn in their expense sheet, graph, and all work to teacher for approval.

# EXPLORATION EXPENSES | EDUCATOR

## Set The Stage!

Ask students to brainstorm factors that would need to be considered when planning an ocean exploration expedition. Students can brainstorm in small groups for 5-10 minutes then write some of their ideas on the board. At the end of the lesson, have a discussion about what new information was learned.

## Extensions & Adaptations

Introductory |

For younger students, have them work in groups of 3-4 instead of partners. Students can split up calculations among the group. Walk students through a sample calculation using provided information from the expedition cards. Work as a class to come up with an equation to calculate the number of hours it takes to transit from one site to the next.

Advanced |

Some of the equations could be omitted from the expense sheet so students come up with their own method to solve for cost.

✓ **Expense worksheet answer key (based off of Gulf of Mexico Expedition)**

*** Route of port to dive site 1, dive site 2, port**

| **Expedition Summary**<br>Expedition Name:<br>Dive Targets: | **Category Cost ($)** | **Percent (%) of Total Budget**<br>[Category Cost / Total Expedition Cost] x 100 |
|---|---|---|
| **Total Fuel Cost (Add expense 1 - 5)** | 4373.36 | 7.5 |
| **Total Staffing Cost (Add expense 6 and 7)** | 48300 | 83.7 |
| **Total Meal Cost (Expense 8)** | 3864 | 6.7 |
| **Total Satellite Cost (Expense 9)** | 1200 | 2.08 |
| **TOTAL EXPEDITION COST (Add 4 rows above)** | **57711.36** | |

**Sample calculation answers (based off of Gulf of Mexico Expedition) and expense chart:**

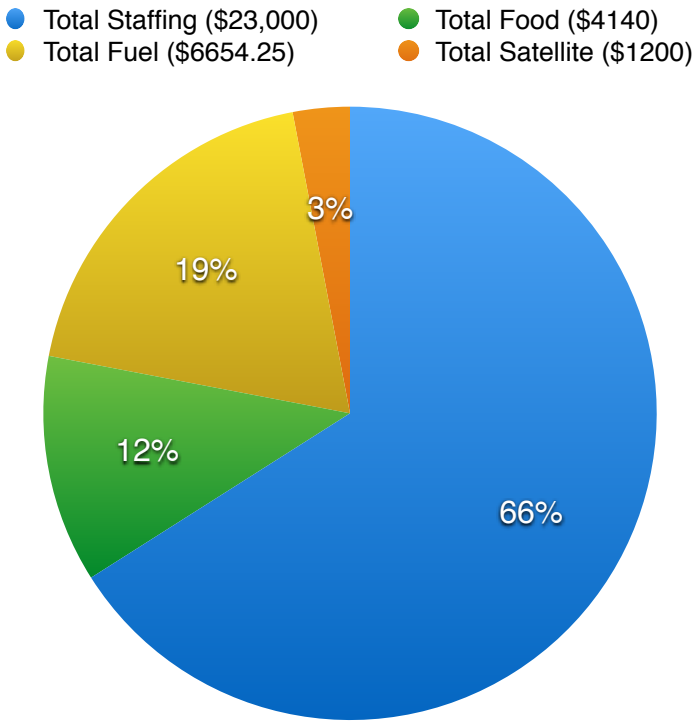
| Expense | Description of Expense | Expense Cost |
|---|---|---|
| 1 | **Fuel burned transiting from port to dive site 1** | **1183.57** |
| | Distance (nm) from port to dive site 1: (2 in. x (50mi/.75in))/ 1.15mi = 115.9nm | |
| | Hours to travel from port to dive site 1: 115.9nm / 12 nm = 9.7 hrs | |
| | Fuel (mT) needed to travel from port to site 1: 9.7 hrs x .25mT = 2.4 mT<br>[time x .25mT/ hr at full speed] | |
| 2 | **Fuel burned exploring at dive site 1** | **117.6** |
| | Dive time (hours): 6 | |
| | Fuel (mT) needed to run ship during dive: 6 x .04mT/hr = .24 mT<br>[time x .04mT/ hr] | |
| | Cost of fuel exploring dive site 1: .24mT x $490 = 117.60<br>[mT x price / mT] | |
| 3 | **Fuel burned transiting from site 1 to dive site 2** | **1479.47** |
| | Distance (nm) from site 1 to site 2: 2.5in(50mi/.75in) = 166.7mi/1.15mi =144.9nm | |
| | Hours to travel from site 1 to site 2: 144.9nm/12nm = 12.08 hrs | |

# EXPLORATION EXPENSES | EDUCATOR

| Expense | Description of Expense | Expense Cost |
|---|---|---|
| | Fuel (mT) needed to travel from site 1 to site 2: 12.08hrs x .25mT/hr = 3.02mT<br>[time x .25mT/ hr at full speed] | |
| | Cost of fuel from site 1 to site 2: 3.02mT x 490 = 3.02mT x $490 = 1479.47<br>[mT x price / mT] | |
| 4 | **Fuel burned exploring at dive site 2** | **235.20** |
| | Dive time (hours): 12 | |
| | Fuel (mT) needed to run ship during dive: 12hrs x .04mT/hr = .48mT<br>[time x .04mT/ hr] | |
| | Cost of fuel exploring dive site 2: .48mT x $490 = 235.20<br>[mT x price / mT] | |
| 5 | **Fuel burned transiting from dive site 2 to port** | **1331.52** |
| | Distance (nm) from dive site 2 to port: 2.25in(50mi/.75in) = 150mi/1.15mi = 130.4nm | |
| | Hours to travel from dive site 2 to port: 130.4nm/12nm = 10.9 hrs | |
| | Fuel (mT) needed to travel from dive site 2 to port: 10.9hrs x .25mT/hr = 2.7 mT<br>[time x .25mT/ hr at full speed] | |
| | Cost of fuel from dive site 2 to port: 2.7mT x $490 = 1331.52<br>[mT x price / mT] | |
| **Number of days at sea:**<br>**[Added transit + dive time] / 24 hrs (may be a decimal)** | | **2.1 days** |
| 6 | **Corps of Exploration Salaries & Stipends** | **46,200** |
| | Number of Mandatory staff: | 44 |
| | Cost of staffing the Corps of Exploration:<br>[# Mandatory staff x $500 x number of days at sea] | 44 x $500 x 2.1 days = 46,200 |
| 7 | **Specialist Staffing** | **2100** |
| | Job Title of specialist staff selected (optional): | Added Scientist |
| | Job Title of specialist staff selected (optional): | Social Media Specialist |
| | Cost of Specialist Staff:<br>[# specialists x $500 x number of days at sea) | 2 x $500 x 2.1 days = 2100 |
| **Number of people on the ship:** | | **46** |
| 8 | **Meals & Ship Stores** | **3864** |
| | Cost of Food:<br>[Number of people x $40 x number of days at sea] | 46 x $40 x 2.1 days = 3864 |

| Expense | Description of Expense | Expense Cost |
|---|---|---|
| 9 | **Satellite Connection for Telepresence:** | **1200** |
| | Number of days at sea rounded up to whole number: | 3 |
| | Satellite Lease Cost:<br>[Days at sea as a whole number x $400] | 3 x $400 = 1200 |

### Sample expense chart:




☐ Helpful tips:

- ✓ Differentiate graphing instructions for various levels of learners by having students graph either itemized percentages or budget category totals.
- ✓ Have students research 'budget charts' online to see real-world examples of how to represent their information in visual form and get ideas for their charts and/or graphs.

# EXPLORATION EXPENSES | STUDENT

## *Learning Goals*

- Learn general aspects of planning a deep ocean exploration expedition.
- Make strategic decisions based on mathematic data.
- Calculate costs and complete a budget for a designated exploration site.
- Represent an itemized budget in graph form.

**Introduction |** Planning a deep sea exploration expedition is an exciting challenge. Only 11% of the ocean has been explored leaving a huge selection of fascinating expeditions ahead for the future. For Exploration Vessel *Nautilus* it takes a team of scientists, engineers, financial officers, and contractors many months to efficiently plan a cruise schedule and propose a realistic and cost-effective budget. In this module, you will take on the role of expedition planner for one *Nautilus* cruise. Given an exploration target you will draft your cruise's route and duration then calculate the cost of your decisions. Prepare an expense sheet and graph of your expenses to present your proposed budget to the president of an organization (your teacher) who will decide whether or not your plan will be funded!


## Procedure |

1. Draw an expedition card out of the pile as a group.
2. Complete the budget overview worksheet.

***Use the following information to help you complete your budget:***

Fuel Expenses

1. Use a rule and the scale on the exploration target map to plot the most cost-efficient route from your starting port to all exploration targets and back to port. Measure the route to determine how many miles you'll transit roundtrip. (1 nautical mile = 1.15 miles; 1 kilometer = .54 nautical miles)
2. E/V *Nautilus* transits at full speed at 12 knots (12 nautical miles / hour). Use your calculated transit route to determine how many hours traveling between each site will take. At full speed, E/V *Nautilus* burns 0.25 metric tons of diesel/hour.
3. During dive operations, powering the ship and holding station *Nautilus* burns 0.04 metric tons of diesel/hour. Dive times are provided on your expedition card.
4. The day you left port, cost of diesel fuel was $490/metric ton.



### *Helpful Resources:*

Learn more about the expedition featured on your card exploring these links on NautilusLive.org.

Gulf of Mexico:

- Blog: Why Do Bubbles Matter? http://nautl.us/1sTEHTU
- 2015 Season: A Return to Origins http://nautl.us/1sTEHTU

Galapagos:

- Photo Album: Dramatic Changes to the Geology of the Galapagos Rift http://nautl.us/28Y4ogs
- Photo Album: The Beautiful Creatures of Deep Sea Hydrothermal Vents http://nautl.us/298UuGG

Ocean Networks Canada:

- ONC: Expedition in Engineering Blog http://nautl.us/292wB4l
- #FriendShips Blog http://nautl.us/28Z34rV

## Staffing Expenses

This is a roster of the mandatory Corps of Exploration staff for an expedition on *Nautilus*. You will need to account for all of them as part of your budget.

| Corps of Exploration Role | Job Duties |
|---|---|
| Expedition Leader | Coordinates the work of all teams onboard; manages the communication with teams ashore writing documents like situation report or dive plans. Maintains open communication between science team and ship's crew. |
| Chief Scientist | Communicates science plans of expedition to crew members, make realistic cruise plans and makes sure all needed equipment is in place. |
| Scientists (5) | Assists chief scientist in data collection and analysis. |
| Video Engineer (3) | Directs cameras around the ship and to audiences ashore through the website. Controls camera focus and zoom for ROV pilots during dives. |
| ROV Pilots (6) | Controls Remote Operated Vehicles (ROVs) from ship, precisely maneuvers vehicles to collect samples and close-up images. |
| Navigator (3) | Directs the movement of the ship to accomplish the goals of a dive; communicates with the bridge officers, ROV pilots, and scientists. |
| Data Logger (3) | Responsible for logging data during dives, processing data at the end of dives, and creating dive reports. |
| Educators (3) | Translates expedition science to viewers around the world and helps public audiences and science experts feel involved in each mission. |
| Deck Chief | Leads the team during all ROV launches and recoveries using the deck crane, winch and A-frame to maneuver heavy equipment. |
| Data Engineer | Troubleshoots the satellite system and all computer controlled systems; manages all the data collected by the ROV and instruments. |
| Captain | Responsible for the safety of everyone onboard. Drives the ship from location to location and holds position during ROV dives. |
| Ship's Crew (16) | Professional mariners who control the ship, maintain the engine and generators, repair any electrical problems within this ship, clean the social spaces of the ship, cook all the meals and maintain safe working conditions for all. |

## Specialist Staffing Expenses

In addition to the exploration team above, you have two additional berths you can fill. Read the list of exploration specialists. Based on your mission goals, decide if you want to invite up to two additional people to sail with you. This expense will be added as specialist staffing on the worksheet.



| Specialist Title | Job Duties | Advantage to the Team |
|---|---|---|
| Mapping Specialist | Collects and analyzes seafloor mapping data (bathymetry) of important or interesting seafloor features. | Increase the speed of locating targets underwater, assist in providing piloting information for safe ROV dives. |
| Documentarian | A filmmaker or photographer who specializes in scientific storytelling to capture exciting moments of life aboard. | Increase in record-keeping, documentation of your expedition, interviews the team to learn how to work together better on future expeditions. |
| Social Media Specialist | Shares out the images and video of discoveries and informs others about the scientific importance of your research. | Extra media and public attention to your discoveries, possibilities of funding and future partnerships. |
| Added ROV Pilot | Helps the ROV Team during complex piloting tasks and assists during maintenance. | Reduce fatigue during long expeditions and reduce troubleshooting time required in the event of a mechanical equipment malfunction. |
| Added Data Engineer | Manages computer and satellite systems. | Reduce troubleshooting time required in the event of an electronic equipment malfunction. |
| Added Scientist | Organizes and studies samples from the deep sea as well as adding expertise to your crew. | Increase specific knowledge of local organisms, habitats, and features to help spot discoveries. |

## Expense Worksheet

Use the information provided on your expedition card and the procedure to complete the expense worksheet. You may need scrap paper or a calculator. Show your calculations and turn them in when assignment is completed. Add your final budget to the expedition summary below and use a computer program or graph paper to show your budget in graph or chart format. Turn in with the expense sheet when completed.

| **Expedition Summary**<br>**Expedition Name:**<br>**Dive Targets:** | **Category Cost ($)** | **Percent (%) of Total Budget**<br>[Category Cost / Total Expedition Cost] x 100 |
|---|---|---|
| **Total Fuel Cost (Add expense 1 - 5)** | | |
| **Total Staffing Cost (Add expense 6 and 7)** | | |
| **Total Meal Cost (Expense 8)** | | |
| **Total Satellite Cost (Expense 9)** | | |
| **TOTAL EXPEDITION COST (Add 4 rows above)** | | |



| Expense | Description of Expense | Expense Cost |
|---|---|---|
| 1 | **Fuel burned transiting from port to dive site 1** | |
| | Distance (nm) from port to dive site 1: | |
| | Hours to travel from port to dive site 1: | |
| | Fuel (mT) needed to travel from port to site 1:<br>[time x .25mT/ hr at full speed] | |
| | Cost of fuel from port to site 1:<br>[mT x price / mT] | |
| 2 | **Fuel burned exploring at dive site 1** | |
| | Dive time (hours): | |
| | Fuel (mT) needed to run ship during dive:<br>[time x .04mT/ hr] | |
| | Cost of fuel exploring dive site 1:<br>[mT x price / mT] | |
| 3 | **Fuel burned transiting from site 1 to dive site 2** | |
| | Distance (nm) from site 1 to site 2: | |
| | Hours to travel from site 1 to site 2: | |
| | Fuel (mT) needed to travel from site 1 to site 2:<br>[time x .25mT/ hr at full speed] | |
| | Cost of fuel from site 1 to site 2:<br>[mT x price / mT] | |
| 4 | **Fuel burned exploring at dive site 2** | |
| | Dive time (hours): | |
| | Fuel (mT) needed to run ship during dive:<br>[time x .04mT/ hr] | |
| | Cost of fuel exploring dive site 2:<br>[mT x price / mT] | |



| Expense | Description of Expense | Expense Cost |
|---|---|---|
| 5 | **Fuel burned transiting from dive site 2 to port** | |
| | Distance (nm) from dive site 2 to port: | |
| | Hours to travel from dive site 2 to port: | |
| | Fuel (mT) needed to travel from dive site 2 to port:<br>[time x .25mT/ hr at full speed] | |
| | Cost of fuel from dive site 2 to port:<br>[mT x price / mT] | |
| **Number of days at sea:**<br>**[Added transit + dive time] / 24 hrs (may be a decimal)** | | |
| 6 | **Corps of Exploration Salaries & Stipends** | |
| | Number of Mandatory staff: | |
| | Cost of staffing the Corps of Exploration:<br>[# Mandatory staff x $500 x number of days at sea] | |
| 7 | **Specialist Staffing** | |
| | Job Title of specialist staff selected (optional): | |
| | Job Title of specialist staff selected (optional): | |
| | Cost of Specialist Staff<br>[# specialists x $500 x number of days at sea) | |
| **Number of people on the ship:** | | |
| 8 | **Meals & Ship Stores** | |
| | Cost of Food:<br>[Number of people x $40 x number of days at sea] | |
| 9 | **Satellite Connection for Telepresence:** | |
| | Number of days at sea rounded up to whole number: | |
| | Satellite Lease Cost:<br>[Days at sea as a whole number x $400] | |

STEM Project & Task Rubric

| OBJECTIVE | CRITERIA | | | |
|---|---|---|---|---|
| | 4<br>Exemplary | 3<br>Commended | 2<br>Emerging | 1<br>Developing |
| **Content Organization, Methodology & Analysis \|** | Student effectively organizes complex ideas, concepts, and information to make important connections and distinctions. This may include detailed, labeled and thorough procedures, data tables, graphs, diagrams and/or analyses. | Student is able to organize ideas, concepts, and information to make connections and distinctions. This may include mostly detailed, labeled and thorough procedures, data tables, graphs, diagrams and/or analyses. | Student attempts to organize ideas, concepts and information to make some connections and distinctions. Student is able to provide basic procedures, data tables, graphs, diagrams and/or analyses. | Student has difficulty organizing ideas, concepts and information to make connections and distinctions. Student is unable to provide basic procedures, data tables, graphs, diagrams and/or analyses. |
| **Self-Directed Learner \|** | Student is actively engaged in the learning process; consistently contributes to class discussions and asks clarifying questions. Seeks out and shares additional resources with the class or teacher. Advocates for his/her learning needs. | Student is engaged in the learning process. Often contributes to class discussions and asks clarifying questions. Advocates for his/her learning needs. | Student is inconsistently engaged in the learning process. Sometimes contributes to class discussions or asks clarifying questions. Inconsistently advocates for his/her learning needs. | Student is weakly engaged in the learning process. Rarely contributes to class discussions or asks clarifying questions. Rarely advocates for his/her learning needs. |
| **Technological Tools \|** | Use of digital resources is always appropriate for the task. Willing to learn and use technology for inclusion of charts, graphs, pictures, etc. to amplify the message. | Use of digital resources is appropriate for the task. Willing to use technology for inclusion of charts, graphs, pictures, etc. to amplify the message. | Use of digital resources is sometimes appropriate for the task. Inconsistent use of technology for inclusion of charts, graphs, pictures, etc. to amplify the message. | Use of digital resources is rarely appropriate for the task. Inconsistent use of technology for inclusion of charts, graphs, pictures, etc. to amplify the message. |
| **Collaboration Skills \|** | Consistently works effectively and respectfully with a diverse group of learners. Actively checks with others for understanding and how he or she may be of help. Student listens when others speak and incorporates or builds off of the ideas of others. | Works effectively and respectfully with a diverse group of learners. Checks with others for understanding and how he or she may be of help. Student listens when others speak. | Sometimes works effectively and respectfully with a diverse group of learners. Sometimes checks with others for understanding and how he or she may be of help. Student listens when others speak. | Has difficulty working effectively and respectfully with a diverse group of learners. Rarely checks with others for understanding and how he or she may be of help. Student may talk over other students or does not listen when others speak. |
| **Total Score:** _____ | **Comments:** | | | |

# How Large is Nautilus Nation?

*Tracking the reach of Ocean Exploration Trust's education programs is essential in ensuring we are funded to continue making discoveries and inspiring the next generation of explorers.*

**Name:** **My Community (City, State):**

**Email Address:**

**School's Name:**

**Instruction date:** **Grade level instructed:**

**Subject area:**

**My education space is a...**

- ❑ Classroom
- ❑ After school program / Club meeting
- ❑ Fair / Festival / Event
- ❑ Museum / Science Center
- ❑ Other. Tell us more:

**Who did you engage in your teaching?**

# Students

# Community Members

**Select all the OET materials you used in your instruction:**

- ❑ STEM Learning Modules. Which ones? _____
- ❑ Digital Resource Library materials. Which ones? _____
- ❑ Nautilus Live website: photo albums ❑ highlight videos ❑ live stream
- ❑ Meet the Team STEM mentor profiles
- ❑ Facebook (NautilusLive) ❑ Twitter (@EVNautilus) ❑ Instagram (@nautiluslive)
- ❑ Other. Tell us more: _____

_____

**What made working with OET resources valuable to your instruction (select all that apply)?**

- ❑ Hands-on activities ❑ STEM career connections
- ❑ Easy to use lessons ❑ Standards-based lessons
- ❑ Website resource access ❑ Real world application of curricula topics
- ❑ Excitement of cutting-edge discoveries / Unfamiliarity of deep ocean
- ❑ Another reason. Tell us more: _____

_____

| | | |
|---|---|---|
| Using OET resources increased my confidence in teaching my science, technology, engineering, or math subjects. | ❑ Yes | ❑ No |
| OET provided me with helpful and relevant teaching resources. | ❑ Yes | ❑ No |
| Using OET resources increased my awareness of STEM careers. | ❑ Yes | ❑ No |
| If yes, how so? How can we improve? | | |

Please scan this document or snap a picture of it with your phone. Email the feedback or questions to education@oet.org. You can also submit feedback online: http://nautl.us/2cp3PNu

**Thank You For All You Do!**