FLINN STEM

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IMSA Fusion— Dive in: Ocean-graphic STEM Curriculum Module

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Curriculum Overview

Although some is known about oceans, many believe that there is still a majority that remain unexplored. The oceans are home to wide variety of organisms and are constantly changing. Humans rely on the ocean for a multitude of reasons including food, products, recreation, and energy. Engineering is involved in all aspects of harnessing these resources. During ***Dive In: Oceanographic Engineering***, students will be engaged in identifying problems, designing, testing, and evaluating potential solutions pertinent to the ocean.

Curricular Objectives

- Engage in and evaluate modeling and simulations.
- Use real world data.
- Develop an awareness of engineering opportunities provided by the oceans.
- Gain a global perspective on the importance of the oceans.

Unit Summaries

Oceans cover a major part of the Earth's surface and, due to their extreme diversity, are used by humans for a variety of their resources. A general introduction to the ocean occurs through the game ***Dive In: It's Trivia.***

Accessibility and availability of clean, fresh water are becoming increasingly critical for humans. Modeling of desalination in ***A-Salt on Water*** provides opportunities to explore the processes behind possible solutions.

Aquaculture can be explained as farming in the water- in this case, the oceans. One aspect of this industry, pearl farming, will be explored by students in ***C Pearl Farms.***

Millions of dollars of consumer goods are traveling on the ocean at any given time. ***You've Got to Move It*** explores the use of the ocean for transportation, tracking the shipping industry, and ocean currents.

Many new products, including medications, are being inspired by life in the ocean. ***Bioprospecting*** introduces students to the processes involved in the phases of ocean-based medicine development.

What are the optimal conditions for selecting a building site for an island? Many factors, both biotic and abiotic, affect that decision. Choosing the location for the construction of an island will be a problem solved during ***Over the Ocean.***

Dive In: Oceanographic Engineering

Alternate energies come in many forms, including harnessing energy from the ocean. Wave energy converters may be used to achieve this goal. ***Crash Waves*** engages students in exploration of these concepts.

Islands are surrounded by water and may be natural or artificial. Many materials can be used in the construction of an island, but the primary component is sand. ***Island Engineer-ity*** explores characteristics of the materials that could potentially be used in this process.

There are many applications for different pressure systems. Work can be completed by harnessing the forces and effects of air. One application of these systems is a crane. Exploration of these effects and applications will occur in ***Power Up.***

Tourism is a large part of many island economies. Thoughtful city planning must be completed in order to maximize the benefits of the island. Determining the location of housing and parks and recreation centers will be challenges posed during ***City Development.***

The ocean has long been used for recreation and sport. Certain geographical locations provide greater challenges than others when it comes to surfing. Through investigation of the surfboards, topographical features, and Mavericks, students gain an understanding of the science and math involved in ***Surf's Up***.

Unit Objectives

Dive In: It's Trivia:

- Determine the importance of oceans on human life.
- Explore marine life.

A-Salt on Water:

- Compare salinity, or salt content (in terms of fractions and percentages) in salt water, ocean water and freshwater.
- Model the distribution of salt to fresh water, and the availability of potable water on the planet.
- Model the difficulties associated with separating salt from ocean water.
- Investigate the process of desalination.

C Pearl Farms:

- Design, build, and evaluate a prototype.
- Observe, collect, analyze data.
- Describe conditions needed for pearl oyster farming.
- Make decisions based on facts.
- Evaluate trade-offs.
- Explore optimal solutions.
- Work collaboratively to solve a problem.
- Develop strategies for solving a problem.
- Identify properties of pearls.
- Develop and employ criteria.
- Come to a consensus.

You've Got to Move It:

- Research using a data base
- Create a presentation
- Identify and evaluate strategies to solve a problem
- Employ latitude and longitude to solve a problem
- Interpret ocean currents map
- Use evidence to develop an explanation
- Design a scale drawing
- Define a solution to a problem based on materials and time
- Develop a plan for scaling up production of a product
- Evaluate trade-offs of product development

Bioprospecting:

- Identify products made from aquatic organisms.
- Design a method for a population count.
- Sample a population.
- Work collaboratively within a group.
- Evaluate a model.
- Develop and follow a procedure.
- Collect, analyze, interpret, and present data.
- Determine latitude and longitude.
- Convert between measurement units.
- Use data to make and defend decisions.

Over the Ocean:

- Evaluate the pros and cons of a situation and make a decision based on evidence.
- Evaluate order of operations mathematical problems.
- Locate ordered pairs on a circular sonar grid.

Crash Waves:

- Discover that oceanic waves involve the movement of energy, not the forward movement of water.
- Explore devices that harness the energy from oceanic waves.
- Analyze wave energy devices (WEC's) to determine their benefits and challenges.
- Redesign an existing WEC with specific conditions in mind.

Island Engineer-ity:

- Observe different types of sands and categorize based on textural differences.
- Test the various sand samples to determine which sand type can be used to build the most stable structure.
- Test a variety of additive materials to see which materials work best to reinforce the stability of sand structures.

Power Up:

- Explore and analyze the behavior of air pressure in a system.
- Build and test a pressure-controlled mechanical system model.
- Explore the closed system pressure principal.
- Construct a model of a closed system air pressure.
- Evaluate the performance of the closed air pressure system.

City Development:

- Evaluate, assess, and apply factors involved in city map development including conceptual residential and commercial potential development.
- Investigate social responsibility concept toward the community.
- Design, build, test, and analyze infrastructure creation and development according to climate conditions.
- Calculate costs based on supply and demand.

Surf's Up:

- Calculate averages.
- Construct a scale drawing.
- Read and analyze data.
- Interpret and graph data.
- Work collaboratively.
- Construct a topographic model of ocean floor.
- Follow a procedure.
- Collect and analyze data.
- Build, test, and evaluate a model.
- Identify problems to be solved.
- Communicate ideas.
- Develop a solution to solve a problem

Standards

NGSS Scientific and Engineering Practices:

SEP1: Asking questions and defining problems
SEP2: Developing and using models
SEP3: Planning and carrying out investigations
SEP4: Analyzing and interpreting data
SEP5: Using mathematics and computational thinking
SEP6: Constructing explanations and designing solutions
SEP7: Engaging in argument from evidence
SEP8: Obtaining, evaluating, and communicating information

Next Generation Science Standards (NGSS):

4-ESS2-2: Analyze and interpret data from maps to describe patterns of Earth's features.

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

5-ESS2-2: Describe and graph the amounts and percentages of water and fresh water in various reservoirs to provide evidence about the distribution of water on Earth.

MS-ESS3-3: Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

3-5-ETS1-1: Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

3-5-ETS1-2: Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

3-5-ETS-3: Plan and carry out fair tests in which variable are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

MS-ETS1-1: Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

MS-ETS1-3: Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

3-LS3-2: Use evidence to support the explanation that traits can be influenced by the environment.

3-LS4: Make a claim about the merit of a solution to a problem by citing relevant evidence about how it meets the criteria and constraints of the problem.

MS-LS1-2: Develop and use a model to describe the function of a cell as a whole and ways the parts of cells contribute to the function.

MS-LS1-4: Use argument based on empirical evidence and as scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.

MS-LS2-2: Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.

MS-LS2-4: Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

4-PS-4-3: Generate and compare multiple solutions that use patterns to transfer information.

5-PS1-3: Make observations and measurements to identify materials based on their properties.

MS-PS1-3: Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.

Common Core State Standards Mathematical Practices:

MP1: Make sense of problems and persevere in solving them.
MP2: Reason abstractly and quantitatively.
MP3: Construct viable arguments and critique the reasoning of others.
MP4: Model with mathematics.
MP5: Use appropriate tools strategically.
MP7: Look for and make use of structure.

Common Core State Standards Mathematics:

4.MD.A.1: Know relative sizes of measurement units within one system of units including km, m, cm; kg, g; lb, oz.; l, ml; hr, min, sec. Within a single system of measurement, express measurements in a larger unit in terms of a smaller unit. Record measurement equivalents in a two-column table. For example, know that 1 ft is 12 times as long as 1 in. Express the length of a 4 ft snake as 48 in. Generate a conversion table for feet and inches listing the number pairs (1, 12), (2, 24), (3, 36)…

4.MD.A.2: Use the four operations to solve word problems involving distances, intervals of time, liquid volumes, masses of objects, and money, including problems involving simple fractions or decimals, and problems that require expressing measurements given in a larger unit in terms of a smaller unit. Represent measurement quantities using diagrams such as number line diagrams that feature a measurement scale.

5.G.A.1: Use a pair of perpendicular number lines, called axes, to define a coordinate system, with the intersection of the lines (the origin) arranged to coincide with the 0 on each line and a given point in the plane located by using an ordered pair of numbers, called its coordinates. Understand that the first number indicates how far to travel from the origin in the direction of one axis, and the second number indicates how far to travel in the direction of the second axis, with the convention that the names of the two axes and the coordinates correspond (e.g., x-axis and x-coordinate, y-axis and y-coordinate).

5.MD.A.1: Convert among different-sized standard measurement units within a given measurement system (e.g., convert 5 cm to 0.05 m), and use these conversions in solving multi-step, real world problems.

5.NF.A2: Solve word problems involving addition and subtraction of fractions referring to the same whole, including cases of unlike denominators, e.g., by using visual fraction models or equations to represent the problem. Use benchmark fractions and number sense of fractions to estimate mentally and assess the reasonableness of answers. For example, recognize an incorrect result $2/5 + 1/2 = 3/7$, by observing that $3/7 < 1/2$.

5.OA.A2: Write simple expressions that record calculations with numbers, and interpret numerical expressions without evaluating them. For example, express the calculation "add 8 and 7, then multiply by 2" as $2 \times (8 + 7)$. Recognize that $3 \times (18932 + 921)$ is three times as large as $18932 + 921$, without having to calculate the indicated sum or product.

6.NS.C.5: Understand that positive and negative numbers are used together to describe quantities having opposite directions or values (e.g., temperature above/below zero, elevation above/below sea level, credits/debits, positive/negative electric charge); use positive and negative numbers to represent quantities in real-world contexts, explaining the meaning of 0 in each situation.

6.RP.A.3.C: Find a percent of a quantity as a rate per 100 (e.g., 30% of a quantity means 30/100 times the quantity); solve problems involving finding the whole, given a part and the percent.

6.RP.A.3.D: Use ratio reasoning to convert measurement units; manipulate and transform units appropriately when multiplying or dividing quantities.

7.RP.A.3: Use proportional relationships to solve multistep ratio and percent problems. Examples: simple interest, tax, markups and markdowns, gratuities and commissions, fees, percent increase and decrease, percent error.

Common Core State Standards English Language Arts:

RI.4.1: Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text.

RI.6.7: Integrate information presented in different media or formats (e.g., visually, quantitatively) as well as in words to develop a coherent understanding of a topic or issue.

RST.6-8.3: Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

RST.6-8.4: Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6–8 texts and topics.

RST.6-8.7: Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

RST.6-8.9: Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.

SL.5.1: Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 5 topics and texts, building on others' ideas and expressing their own clearly.

SL.5.4: Report on a topic or text or present an opinion, sequencing ideas logically and using appropriate facts and relevant, descriptive details to support main ideas or themes; speak clearly at an understandable pace.

SL.6.1: Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 6 topics, texts, and issues, building on others' ideas and expressing their own clearly.

SL.6.4: Present claims and findings, sequencing ideas logically and using pertinent descriptions, facts, and details to accentuate main ideas or themes; use appropriate eye contact, adequate volume, and clear pronunciation.

SL8.5: Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest.

W.4.2: Write informative/explanatory texts to examine a topic and convey ideas and information clearly.

W.4.9: Draw evidence from literary or informational texts to support analysis, reflection, and research.

Unit 1: Dive In: It's Trivia

Notes

Objectives:

- Determine the importance of oceans on human life.
- Explore marine life.

Background Information

What do food, fuel, land, medicines, transportation, commerce, entertainment, recreation, and economics all have in common? The answer is oceans. They compose the world's largest living space. Up to 3 billion people depend upon the oceans for food. Over half of the world's GNP comes from within 100 kilometers of the coastline. The world's population spends over $50 billion a year on marine recreation. Millions across the globe depend upon the oceans for their livelihood. Many consider the oceans the last frontier.

Inquiry Overview

In this unit, students will explore interesting facts related to the oceans. Working in small groups, student teams will complete a series of trivia questions evaluating their knowledge on many facets of the ocean. Upon successfully answering each question, students will receive a **puzzle** piece or an ocean label. Once each student team has collected all of their puzzle pieces and ocean labels, they will work together to solve the ocean map.

Activity

Activity 1: It's Trivia

Objectives:

Determine the importance of oceans on human life.
Explore marine life.

Standards:
NGSS: SEP8
CCSS Mathematics: 6.RP.A.3.C, MP1
CCSS ELA/Literacy: RI.6.7, RST.6-8.4, RST.6-8.9

***Estimated Time*:**
5 Minutes – Introductory Discussion
40 Minutes – Trivia Activity
15 Minutes – Debrief

It's Trivia
Materials:
for the teacher:
- It's Trivia Cards
- It's Trivia PowerPoint
- Tape

for each team of 2:
- 1 Set of Puzzle Pieces and Ocean Labels
- Calculator (Optional)

for each student:
- Student Pages

Notes

Advanced Preparation:

Prior to beginning the activity, prepare the trivia cards by folding them in half so the number is visible on the outside and the question is hidden inside the card. It is suggested that you secure each card to an area of the classroom where students can easily read each card.

Also, prepare the puzzle and ocean label sets. Each set consists of twelve pieces (6 pieces of the ocean puzzle and 6 ocean labels). Students will work in ten teams, with each team having their own set of puzzle pieces and ocean labels. You may choose to number each set (1-12) and then designate each team a corresponding number.

Finally, determine where you will be located within the classroom. This should be an area that is easily accessible to all students (such as the center of the classroom).

Suggested Inquiry Approach:

To begin, arrange the students into small groups of 2. At this time, you may choose to assign each team the number that corresponds with their puzzle and label set. Distribute the student pages to each learner and ask for a volunteer to read the Introduction aloud.

Explain to the students that they will begin their study of Ocean Engineering by completing a trivia challenge. At this time, review the procedure with each team. By correctly answering a series of trivia questions about the oceans, students will collect puzzle pieces and ocean labels that will then be used to complete a world map with six bodies of water correctly labeled.

Finally, before students begin their challenge, take several minutes to review the rules of the activity. Answer any questions that students may have regarding the regulations of the game at this time. Also, verbally set your expectations in terms of student behavior.

Allow plenty of time for students to complete the activity. When student teams have collected all of their pieces, encourage them to work collaboratively to solve the ocean puzzle.

Finally, when all teams have completed the ocean puzzle, take several minutes to debrief their experience. Direct students back to their student pages to answer the included questions.

Notes

Debrief Activity 1:

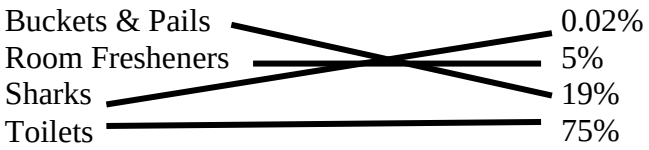
As a whole class, have students discuss the following questions:

> ***What trivia fact surprised you the most?***
> ***After answering all of the trivia questions, what would you like to learn more about?***
> ***What do you think the title of this curriculum (Dive In: Oceanographic Engineering) means?***

This final debrief question allows students to make predictions and reference their prior knowledge to define a potentially unfamiliar concept. You may choose to record student ideas on chart paper to refer back to at the end of this curriculum. This would provide students with an opportunity to evaluate the knowledge they have gained by participating in this program.

Answer Key with hints:

Question One: Approximately 90%
Question Two: 1048.76 km^2
Question Three:



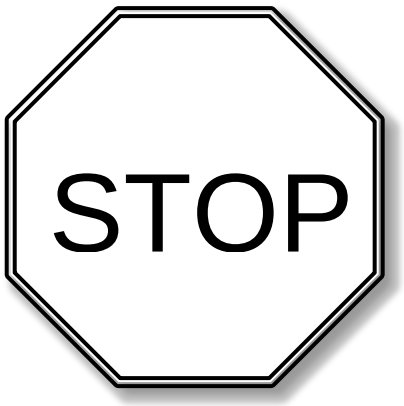
Question Four: 3
Question Five: (Based on length) Manta ray, Giant squid, Whale shark, Blue whale, Lion's mane jellyfish
Question Six: SCUBA
Question Seven: One Quintillion, Four Hundred Fifty Quadrillion
Question Eight: Volume of Earth's Moon = Volume of Pacific Ocean,

Volume of Sun ≠ Volume of Pacific Ocean
Question Nine: 52 feet, 6 inches
Question Ten: 315,931 miles
Question Eleven: 128,000,000,000
Question Twelve: Hawaii

Notes

Resources:

http://blogs-images.forbes.com/jennifereum/files/2014/03/0311_find-and-keep-your-dream-job_1024.jpg
http://channel.nationalgeographic.com/wild/shark-attack-experiment-live/articles/shark-attack-facts/
https://en.wikipedia.org/wiki/Artificial_island
https://en.wikipedia.org/wiki/List_of_island_countries
https://en.wikipedia.org/wiki/Surfboard
http://images.clipartpanda.com/mountain-peak-clip-art-mountain-clipart.gif
https://img1.etsystatic.com/000/0/5425890/il_fullxfull.116483447.jpg
http://media.salon.com/2013/09/moon.jpg
http://miriadna.com/desctopwalls/images/max/Rising-gold-sun.jpg
http://news.discovery.com/animals/the-10-longest-animals-in-the-ocean-150113.htm
http://pgarcheng.com/images/new-design.jpg
http://see-the-sea.org/facts/facts-body.htm
http://voices.nationalgeographic.com/2011/11/22/nat-geo-wild-what-are-the-odds-some-surprising-shark-attack-stats/
http://www.allfree-clipart.com/Sports/weightlifting.jpg
https://www.google.com/search?q=what+does+scuba+stand+for&ie=utf-8&oe=utf-8
https://www.google.com/search?q=pirate+image&tbm=isch&tbo=u&source=univ&sa=X&ved=0ahUKEwjwxorDv-PLAhWGpB4KHYQBALcQ7AkIOw&biw=1232&bih=644#tbm=isch&q=ocean+image&imgdii=ynHXhNu4YV-mEM%3A%3BynHXhNu4YV-mEM%3A%3B7qKIpGi9U5dcLM%3A&imgrc=ynHXhNu4YV-mEM%3A
http://www.map-of-canada.org/canada-map-795.jpg
http://www.nature.org/ourinitiatives/habitats/oceanscoasts/explore/five-reasons-we-are-all-connected-to-oceans.xml
http://www.popularmechanics.com/science/animals/g210/strange-sea-animals-2/
http://www.tikisoul.com/images/Sufboard%20Row.jpg



Before moving on to the next unit, be sure to submit your feedback to the Content Classroom at https://learning.imsa.edu/

Dive In: Trivia

Activity 1: It's Trivia

Question One

Write your answer.

_____

Question Two

Solve:

Question Three (Draw lines to the correct answer.)

Buckets & Pails	0.02%
Room Fresheners	5%
Sharks	19%
Toilets	75%

Question Four

Write your answer.

_____

Question Five

_____

_____

_____

_____

_____

Question Six

Write your answer.

_____

Dive In!

Activity 1: It's Trivia

Question Seven

Write your answer.

_____

_____

_____

_____

Question Eight

1. _____

_____

2. _____

_____

Question Nine

Solve:

Question Ten

Solve:

Question Eleven

Write your answer.

_____

_____

_____

Question Twelve

Write your answer.

_____