Oil Spill Solutions

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Lesson Focus

Lesson focuses on how engineers use various techniques to provide speedy solutions to oil spills or other threats to natural water resources. Through this lesson, students work in teams to analyse an "oil spill" in the classroom, then design, build, and test a system to first contain, and then remove the oil from the water. Students select from everyday items to build their oil containment and clean-up systems, evaluate the effectiveness of their solution and those of other teams, and present their findings to the class.

Lesson Synopsis

The "Oil Spill Solution" lesson explores how environmental engineers might approach solving the problem of an oil spill. Students work in teams of "engineers" to develop a system to contain and then remove oil from a classroom "spill." Teams decide on which materials they will use and how they will isolate the oil from the water. They then execute their plan with everyday materials, evaluate their results, observe the results of other student "engineering" teams, and present findings to the class.

Year Levels

Year 5 – Term 4; Year 7 – Term 1

Objectives

- Learn about environmental engineering.
- Learn about chemistry and chemical engineering.
- Learn about engineering design.
- Learn about planning and construction.
- Learn about teamwork and working in groups.

Anticipated Learner Outcomes

As a result of this activity, students should develop an understanding of:

- environmental engineering
- problem solving
- teamwork

Lesson Activities

Students learn how environmental engineers develop equipment and procedures to help reduce environmental impact from accidental oil spills. Students work in teams to design and build a system out of everyday items that will eliminate oil from a classroom waterway. They test their system, evaluate their own results and those of other students, and present their findings to the class.

Resources / Materials

- Teacher Resource Documents (attached)
- Student Worksheets (attached)
- Student Resource Sheets (attached)

Alignment to Curriculum Frameworks

See attached curriculum alignment sheet.

Internet Connections

- TryEngineering (www.tryengineering.org)
- Oil Spill Recovery Institute (www.pws-osri.org)
- NOAA's National Ocean Service Office of Response and Restoration (http://response.restoration.noaa.gov/)
- Curriculum links (www.acara.edu.au)

Supplemental Reading

- The Oil Spill Recovery Institute: Past, Present, and Future Direction (ISBN: 0309085144)
- The Basics of Oil Spill Cleanup (ISBN: 1566705371)
- Oil Spills (Our Environment Series) (ISBN: 0737726296)

Optional Writing Activity

- Write an essay or a paragraph about how systems developed by engineers in advance of a natural disaster (earthquake) or human-induced disaster (oil spill) can help speed recovery of both the environment and society.

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For Teachers:
Teacher Resource

◆ Lesson Goal

Lesson focuses on how engineers use various techniques to provide speedy solutions to oil spills or other threats to natural water resources. Through this lesson, students work in teams to analyse an "oil spill" in the classroom, then design, build, and test a system to first contain, and then remove the oil from the water. Students select from everyday items to build their oil containment and clean-up systems, evaluate the effectiveness of their solution and those of other teams, and present their findings to the class.

◆ Lesson Objectives

- Learn about environmental engineering.
- Learn about chemistry and chemical engineering.
- Learn about engineering design.
- Learn about planning and construction.
- Learn about teamwork and working in groups.

◆ Materials

- Student Resource Sheet
- Student Worksheets
- Classroom Materials
  - Water basin or sink for testing, and "Oil" (use ½ cup vegetable oil mixed with cocoa powder for more realistic oil)
- One set of materials for each group of students:
  - Rubber bands, paper towels, string, toothpicks, cotton balls, plastic wrap, popsicle sticks, shredded wheat cereal, balloons, cooked rice, garden peat moss, grass, cork, suction tube/cooking baster, spoon, other items.

◆ Procedure

1. Show students the various Student Reference Sheets. These may be read in class, or provided as reading material for the prior night's homework.

2. Divide students into groups of 2-3 students, providing a set of materials per group.

3. Explain that students must work as a team to design a system to clean-up after an oil spill. The spill will be a controlled ½ cup of vegetable oil that is poured into water which is held in a container such as a water trough, large bucket, or sink.

4. Students meet and develop a two tiered plan to first contain the oil and then to remove it. They can select from a range of everyday items provided to serve as their tools. Student teams will describe their plan in writing and with a drawing and

then present their plan to the class. Plans may be adjusted after feedback from the presentation stage.

5. Student groups next execute their engineered clean-up system step-by-step as described in their plan.

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For Teachers:
Teacher Resource (continued)

6. Student clean-up systems will be scored on the following scale indicating how "clean" the water is after clean-up:

Water is completely clear of all oil	About a quarter of the oil remains	About half of the oil remains	About three quarters of the oil remains	No change, water is as oily as at the beginning of the challenge
0	1	2	3	4

7. Teams then complete an evaluation/reflection worksheet, and present their findings to the class.

◆ Time Needed
Two to three 45 minute sessions

◆ Tips
- Be sure to stress that the "clean" water, no matter how clear, is not suitable for drinking.
- Teams may require additional materials which they will request of the teacher, or they may be encouraged to exchange building materials with other teams.

◆ Extension Ideas
- Consider setting a budget for the project, assigning a cost to each material, and requiring teams to "buy" materials from the teacher to create their filtration system.
- Consider timing the challenge….with the speed of the clean-up factored into the success of the design.
- Do a demonstration of the same oil spill where you add several drops of detergent to the oil. Have students observe what happens, and write an essay describing why they think the oil dispersed. Challenge them to consider whether adding detergent is a viable solution for a real oil spill. The reason dish soap is so effective is that the soap emulsifies and chemically reacts with the oil to hydrolyse it. This is referred to as the "saponification" reaction. The soap will chemically react with the oil to both make it water soluble and will emulsify it, or break it into smaller drops so it can be cleaned more effectively.

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Student Resource:
What is an Oil Spill?

An oil spill is an accidental release of liquid petroleum hydrocarbons (usually during transportation of oil) into the environment. Oil spills usually refer to the release of oils into water, but of course an oil spill can take place on land as well. While spills can take place quickly, as when a ship sinks, or a leak occurs in a pipeline, the cleanup can be a long term project. And, the longer the oil sits in the water, the greater the impact on the environment.

◆ Impact on the Environment

Birds are one of the creatures impacted by oil spills. Oil can sink into and reduce the functionality of bird feathers. A bird's feathers provide insulation, so a bird exposed to oil will be exposed to temperatures they are not used to. It also makes it difficult for a bird to float or fly…so the bird will be more vulnerable to animals of prey, or the bird may not be able to move to find food or clean water. Birds try to clean themselves, and if they do they are likely to ingest some of the oil which can cause damage to internal organs. Most birds impacted by an oil spill die unless humans step in and help clean them. Many organisations work to save these animals. More information is at the "The International Bird Rescue Research Center" (www.ibrrc.org). Birds are not the only creatures put at risk by oil spills. Marine mammals such as seals and otters gain insulation benefits from their fur. As oil permeates the fur, they are potentially exposed to temperatures beyond their normal range. It is important to act quickly when a spill occurs to lessen the impact of the spill on the natural environment. Environmental engineers are often called upon to come up with planned solutions in advance of a spill, or to customise systems bases on a specific event.

◆ Engineering Trade-offs

In order to reduce the chances of an oil spill, engineers have developed new ship designs with double -- and even triple hulls. The oil is stored in the most interior hull, so that if there was a leak, it would be captured in the next outer hull. Of course, these multiple hulled ships are more expensive to build and operate, so a company will have to weigh the advantages and disadvantages of ship engineering in order to come up with a plan that meets safety requirements, but also does not increase the cost of the shipped product more than the market can bear.

◆ Clean-up Methods

There are many types of cleaning methods used for spills, including:

- Bioremediation: using microorganisms or biological agents to break down or remove oil
- Dredging: some oils are actually denser than water, and would sink. These would require cleaning below the surface of the impacted water.

- Skimming: can be effective areas where the water is calm.
- Dispersion: materials such as some detergents can disperse oil into smaller clusters that may be easier to remove than larger areas. However, the detergents can sink deeper into the water than oil does, so it may cause harm deeper in the water while reducing negative environmental impact on the surface.
- Burning: controlled burning can often eliminate a large proportion of oil in water, but of course requires great care to avoid having the fire spread. The burning oil can also cause air pollution.

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Student Worksheet: Engineer Your Own Oil Spill Solution

You are part of a team of engineers who have been given the challenge of first containing, and then cleaning up an oil spill. You will have many materials available to you, but will have to come up with a strategy to remove as much oil as possible.

◆ Planning Stage

Meet as a team and discuss the problem you need to solve. Then develop and agree on a plan for your containment system. Next develop a plan for cleaning up the oil you have contained. You may have to consider stages or steps you might take and determine which order you will execute different steps. You have been provided with many items you may use for your system. You don't need to use all the items, and should only use those that you think will work the best. Write a description of your containment and clean-up systems in the boxes below. Draw a sketch of what you plan to do. Be sure to indicate the materials you anticipate using. Present your design to the class. You may choose to revise your teams' plan after you receive feedback from class.

Containment System	Clean-up System

Materials Required:	Materials Required:

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Student Worksheet (continued):

◆ Preparation Phase

Gather all the materials you plan to use, and consider how you will use them and what steps might need to be taken. You may need to ask for additional materials during this phase as you consider how much oil you have to clean-up!

◆ Testing Phase

Each team will have a chance to test their containment and clean-up systems on a similar "oil spill." Be sure to watch all the methods and observe the different approaches your classmates have "engineered." See which procedures worked best -- it may be that certain parts of a procedure worked better than others. Each system will be scored on the following scale to determine success.

Water is completely clear of all oil	About a quarter of the oil remains	About half of the oil remains	About three quarters of the oil remains	No change, water is as oily as at the beginning of the challenge
0	1	2	3	4

◆ Evaluation Phase

Evaluate your team's results, complete the evaluation worksheet, and present your findings to the class.

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Student Evaluation Sheet

1. Did you succeed in removing all the oil from the "oil spill?" What was the score your team achieved?

2. If your system failed, what do you think went wrong?

3. Describe a system another student team created that you thought worked well. What did you do differently?

4. How did your decisions on engineering trade-offs differ from that team? What goals or priorities for your system did you put above others?

5. Did you decide to revise your plan while actually doing the containment or clean-up? Why? How?

6. Why might a team of environmental engineers change their planned approach to an oil spill clean-up once they arrived on the site? Do you think it is common that professionals change their plans while on the job?

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Student Evaluation Form (continued):

7. If you had to do it all over again, how would your team have improved your containment system? Why?

8. If you had to do it all over again, how would your team have improved your clean-up system? Why?

9. Do you think that experience with prior oil spills would make a team of engineers more able to address the next unexpected one?

10. Now that you have learned about the different trade-offs engineers must factor into a product or system, if you were designing a new rail-based oil transportation system, what considerations would you have to balance in your new design (consider costs, environmental issues, public health, speed of transport)?
11. What other materials do you think would have helped speed up your containment or clean-up?

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For Teachers:
Alignment to Curriculum Frameworks

Year 5

Science Understandings
Solids, liquids and gases have different observable properties and behave in different ways **(ACSSU077)**

Science Inquiry Skills
With guidance, select appropriate investigation methods to answer questions or solve problems (**ACSIS086**)

Use equipment and materials safely, identifying potential risks (**ACSIS088**)

Suggest improvements to the methods used to investigate a question or solve a problem (**ACSIS091**)

Science as a Human Endeavour
Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena **(ACSHE081)**

Scientific understandings, discoveries and inventions are used to solve problems and directly affect people's lives **(ACSHE083)**

Year 7

Science Understandings
Mixtures, including solutions contain a combination of pure substances that can be separated using a range of techniques **(ACSSU113)**

Science Inquiry Skills
Collaboratively and individually plan and conduct a range of investigation types including fieldwork and experiments, ensuring safety and ethical guidelines are followed (**ACSIS125**)

In fair tests, measure and control variables, and select equipment to collect data with accuracy appropriate to the task **(ACSIS126)**

Reflect on the method used to investigate a question or solve a problem, including evaluating the quality of data collected, and identify improvements to the method **(ACSIS131)**

Science as a Human Endeavour

Science understanding influences the development of practices in areas of human activity such as industry, agriculture and marine and terrestrial resource management **(ACSHE121)**

Science knowledge can develop through collaboration and connecting ideas across the disciplines of science **(ACSHE223)**

People use understanding and skills from across the disciplines of science in their occupations **(ACSHE224)**

Mathematics Links with Science Curriculum (Skills used in this activity)	General Capabilities	Cross-Curriculum Priorities
• Process data using simple tables • Data analysis skills (graphs) • Analysis of patterns and trends • Use of metric units	• Literacy • Numeracy • Critical and creative thinking • Personal and social capacity • ICT capability	• Sustainability

Science Achievement Standards

Year 5

By the end of Year 5, students classify substances according to their observable properties and behaviours. They explain everyday phenomena associated with the transfer of light. They describe the key features of our solar system. They analyse how the form of living things enables them to function in their environments. Students discuss how scientific developments have affected people's lives and how science knowledge develops from many people's contributions.

Students follow instructions to pose questions for investigation, predict what might happen when variables are changed, and plan investigation methods. They use equipment in ways that are safe and improve the accuracy of their observations. Students construct tables and graphs to organise and identify patterns. They use patterns in their data to suggest explanations and refer to data when they report their findings. They describe ways to improve the fairness of their methods and communicate their ideas, methods and findings using a range of texts.

Year 7

By the end of Year 7, students describe techniques to separate pure substances from mixtures. They represent and predict the effects of unbalanced forces, including Earth's gravity, on motion. They explain how the relative positions of the Earth, sun and moon affect phenomena on Earth. They analyse how the sustainable use of resources depends on the way they are formed and cycled through Earth systems. ***They predict the effect of environmental changes on feeding relationships and classify and organise diverse organisms based on observable differences.*** Students describe situations

where scientific knowledge from different science disciplines has been used to solve a real-world problem. They explain how the solution was viewed by, and impacted on, different groups in society.

Students identify questions that can be investigated scientifically. ***They plan fair experimental methods, identify variables to be changed and measured. They select equipment that improves fairness and accuracy and describe how they considered safety. Students draw on evidence to support their conclusions***. They summarise data from different sources, describe trends and refer to the quality of their data when suggesting improvements to their methods. They communicate their ideas, methods and findings using scientific language and appropriate representations.