

Animas River Spill

Problem

The EPA is in need of a solar-powered backhoe to obtain water samples on the Animas River.

Lesson Summary

Students will research the toxic spill that happened on the Animas River in Colorado. They will have to design a backhoe/tractor style machine that will be able to collect soil and water samples. These samples will need to be evaluated by the EPA to ensure proper cleanup of the 3 million gallons of toxic waste that went into the river. The tractor will be built with recyclable goods, and programmed with a Hummingbird Robotics Kit. Students will need to be able to lift approximately 1.5lbs of gravel/sand.

Major Topic and SOL

Math SOL (2009)

6.10 The student will *b)* solve practical problems involving circumference and area of a circle, given the diameter or radius; *c)* solve practical problems involving area and perimeter; and *d)* describe and determine the volume and surface area of a rectangular prism.

Science SOL (2010)

6.1 The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which *b)* precise and approximate measurements are recorded; *c)* scale models are used to estimate distance, volume, and quantity.

6.2 The student will investigate and understand basic sources of energy, their origins, transformations, and uses. Key concepts include *d)* renewable energy sources.

6.5 The student will investigate and understand the unique properties and characteristics of water and its roles in the natural and human-made environment. Key concepts include *e)* the importance of water for agriculture, power generation, and public health; and *f)* the importance of protecting and maintaining water resources.

Language Arts SOL (2010)

6.1 The student will participate in and contribute to small-group activities. *a)* Communicate as leader and contributor. *b)* Evaluate own contributions to discussions. *c)* Summarize and evaluate group activities. *d)* Analyze the effectiveness of participant interactions.

6.2 The student will present, listen critically, and express opinions in oral presentations. *e)* Use language and vocabulary appropriate to audience, topic, and purpose.

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6.6 The student will read and demonstrate comprehension of a variety of nonfiction texts. *b)* Use prior knowledge and build additional background knowledge as context for new learning. *g)* Identify main idea. *h)* Summarize supporting details. *k)* Identify cause and effect relationships.

Length of Time 6 weeks - 30 minutes per day.

Student Objectives

- The student will be able to create a scale model of a backhoe/tractor.
- The student will be able to calculate the surface area of the materials used in their projects.
- The student will be able to calculate building and shipping cost through multiplying and adding whole numbers and decimal numbers.
- The student will be able to round dollar amount to the nearest cent.
- The student will need to be able to describe the importance of protecting and maintaining water sources.
- The student will need to be able to describe the importance of water for public health.
- The student will be able to describe the cause and effect relationship of the toxic spill.
- The student will be able to summarize the toxic spill event.
- The student will be able to communicate in small groups and as an oral presentation.

21st Century Skills

- Critical-Thinking and Problem Solving
- Communication
- Creativity and Innovation
- Collaboration
- Information and Media Literacy
- Contextual Learning

Assessment Evidence

- Students will submit individual summaries of the Animas River spill.
- Students will submit individual summaries of the effects the river spill has had on the local ecosystem and why it is important to clean up the spill.
- The student will submit a summary report of their design and how their design could be used.
- Anecdotal notes will be made while students are collaborating in their groups.
- Grading rubric will be used to assess finished designs as a whole group.

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- Students will assess their partners with a given rubric.

Supplies/Materials/Technology

- Folder (per group)
- Computers and [Software](#)
- Construction paper
- Felt paper
- Foam paper
- Cardboard
- Hot glue guns
- Hot glue sticks
- Pom poms
- Styrofoam balls
- Googly eyes
- Pipe cleaners
- Size 10 thread (could be adapted with twine or yarn.)
- Popsicle Sticks
- Pencils
- Duct tape
- Zip ties
- [Hummingbird robotics kits](#) (motors, servos, sensors, vibration motors, led light, tri-color led lights)
- Animas River toxic spill informational resources
 - http://www.denverpost.com/news/ci_29817878/cadmium-lead-copper-levels-animas-headwaters-exceed-state
 - <http://www.cortezjournal.com/article/20160417/NEWS01/160419873/Storms-stir-up-pollutants-in-Animas-River>

Lesson 1:(To last as many days as necessary to complete rough idea of backhoe design.)

- Students will be broken up into groups determined by the teacher.
- Each group will be given a project folder that includes all the necessary material for the completion of their project.
- The first part of the project folder students need to look at is the student information sheet. The student information sheet outlines the challenge of creating a backhoe design and the purpose for creating the tractor.
- After students have read the student information sheet that will read an article regarding the toxic spill of cadmium, lead, and copper into the Animas River. The group may read independently or as a whole group.

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- After the students have completed reading the article they will discuss the effects the toxic spill has on the environment and the people living in the surrounding area. They should also be prepared to discuss the importance of cleaning the river immediately.
- Students from each group will share the ideas of their group, and their reason for why it is important for the water to be cleaned immediately.
- The teacher will introduce students to the challenge of creating a tractor/backhoe that can collect water samples to be tested by the EPA. The EPA is looking for a design that will be fully functional from a remote site. The model of the tractor needs to be able to pick up a minimum of 1.5 pounds of water/sand/gravel material. The design will have some kind of component that will allow it to be fully operational without the use of humans.
- Students will watch the videos in their project folders that demonstrate various functions of the backhoe/tractor.
- The students will review the material list in their project folders, at this time the students will receive their group totes with their project materials in them.
- As an ending to the lesson students will be asked to brainstorm as a group to share ideas for their backhoe design.

Lesson 2: (To last as many days as necessary to complete demonstration of all Hummingbird components.)

- The students will be introduced to the Hummingbird robotics kit. Each piece of the kit will be introduced and its function discussed. A long length of time will be dedicated to discuss each function and how to connect to the motherboard. As well as how to power the kit through the use of a battery pack and USB cable. Special attention will be given to the positive and negatives for connection.
- The students will be introduced to [Scratch](#) by the teacher demonstrating how to plug in the Hummingbird and open up [Scratch through Bird Brain](#).
- The students will watch the teacher demonstrate connected LED lights and programming the lights to turn on and off.
- The students in each group will take turns connecting and programming a LED light.
- This procedure will follow for all components of the kit except for the sensors. The sensor will be demonstrated on an individual group basis.

Lesson 3:

- The students will be given safety orientation regarding the use of the glue guns, wire cutters, and precision screwdrivers.
- The students will finalize their design solutions with a group conference with teacher.

Lesson 4: (This lesson will continue until all groups have completed the assembly and programming of their tractors.)

- The students will begin working on assembling their tractor once they are finished with their design solutions.
- The students will complete all assembling and programming, by testing their designs with the weighted plastic bag filled with gravel, sand and water.
- The students will finalize their budget summary.
- The students will create a presentation for demonstrating their working model, and explaining their budget.

Lesson 5:

- The student group will present their report.
- The student will be graded by the rubric the teacher provides.
- The student will grade one other group's presentation according to the grading rubric.



Tractor/Backhoe Problem-Based Project

Problem: The EPA (Environmental Protection Agency) needs an efficient design for a backhoe. It needs to be able to lift heavy loads of soil and water, to help monitor the toxic spill cleanup efforts on the Animas River.

Roles:

- 1) Project Manager- This person's role will include collecting materials used for the project, monitoring design criteria, and the timeline.
- 2) Publicist- This person's role will be putting together a presentation for the group's final product presentation to the EPA.
- 3) Design Engineer- This person's role will be the lead programmer and prototype tester of the group's model.
- 4) Accountant- This person's role will be to keep track of material costs and project waste.

Scenario: On August 5 2015, five EPA employees and a contractor attempted to collect poisoned water from a dormant gold mine in southwestern Colorado. As a result more than three million gallons of toxic waste were released into the Animas River. The EPA wants to assure residence along the Animas River and into the San Juan River that the water is testing at pre-event conditions, and it is 100% safe to resume river activities. The EPA is looking for a new design for a backhoe to be used along the Animas River to collect soil and water samples. To eliminate the cost of employing several EPA workers along the 200-mile stretch of river, the Environmental Protection Agency is looking for a company to design an efficient and economical solar-powered backhoe. The total budget for the project needs to include both the building costs and the shippings cost.

Resources: Equipment can be purchased from the EPA's material warehouse.

Assessment: You will be presenting your backhoe design to the EPA on "**a date to be determined**". You will need a "working" model to show them that it has at least 2 "functions" (one is lifting) that will assist in the process of collection of soil and water. In addition your team has to meet the EPA's expectations of an efficient and economical design.

Backhoe Material List

Item	Cost	Weight (lbs)				
Hot glue gun sticks (x	\$1,000	5				
Popsicle Stick	\$1,500	20				
Construction Paper	\$250	1				
Pipe Cleaners (x2)	\$300	5				
PomPoms (x2)	\$100	2				
Goggley Eyes (x2)	\$100	2				
Felt	\$200	2				
Foam Sheets	\$300	1.5				
Pencil	\$725	35				
String (1foot)	\$300	10				
Tape (1foot)	\$250	12				
Zip Tie	\$350	8				
Styrofoam Balls (x2)	\$275	10				
Cardboard (approx. sq	\$2,000	35				
Servo	\$10,000	50				
Motor	\$15,000	50				
Vibration Motor	\$5,000	15				
LED	\$1,000	2				
TriColored LED	\$1,500	2				
Sensor (any)	\$5,000	15				
Shipping (per pound)	\$575					

Animas River Spill Presentation/Model Rubric

Group Name:

Working Model					
Points Possible	Excellent 10 points	Very Good 8-9 points	Satisfactory 6-7 points	Needs Improvement 5 or less	Total
Simulation	Three functions were modeled. One heavy lifting.	Two functions were modeled. One heavy lifting.	Only heavy lifting was modeled.	No functions were modeled.	
Programming	Programming was done in demonstrated in standalone mode.	Programming was successfully done in Scratch.	Programming was done in Visual Programmer.	Little to no successful programming was complete.	
Heavy Lifting	Tractor was able to successfully lift 1.5 pounds.	Tractor was able to successfully lift 1.0 pounds.	Tractor was able to successfully pick up 0.5 pounds.	Tractor was not able to pick up any loads.	
Exhibition	Model worked on the Animas River with no human interaction.	Model would work on Animas River with human interaction.	Tractor was presented only as a machine and was not workable.	Incomplete or missing model.	
Building Cost	Building cost was accurate and presented. Project waste was included in building cost.	Building cost was accurate and presented.	Only part of the building cost was calculated and presented.	No building costs were presented.	
Shipping Cost	Shipping cost was accurate and presented.	Most of the shipping cost was accurate and presented.	Some of the shipping cost was accurate and presented.	None of the shipping cost was presented.	

Total Cost	Cost of tractor was the most economical and was the least of all models.	Total cost ranked within the 3 or 4 most economical and least expensive of all models..	Total cost ranked 2 when compared with other project designs.	Total cost ranked last when compared with other project designs.	
Delivery	Complete presentation, well prepared, engaged audience, professional delivery, clear voice, and eye contact.	Presentation well prepared, most went smoothly, engaged audience most of the time, clear voice, and eye contact most fo the time.	Presentation was somewhat prepared, went smoothly some of the time, audience engaged some of the time, sometimes spoke in clear voice, and made eye contact some of the time.	Presentation was unprepared or incomplete, difficulty hearing, and no eye contact made.	
Content	Group provided EPA with everything they needed to know.	Group provided more information than was needed to the EPA.	Group provided some of the information needed to the EPA.	Group provided little to no information to the EPA.	
Teamwork	Tasks divided equally between members. Assigned tasks performed to completion by each member.	Tasks divided equally between members. Assigned tasks completed by most of the members.	Tasks were somewhat divided between members. Most of work completed by one or two members of the group.	Little to no division of tasks. One person did all of the work.	
Teacher and Student Comments.					