

What Happens After the Water Leaves the Sky?

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Abstract

Many students, even in the early years understand that water comes from the sky. They also understand that water pollution exists and we need to keep the water as clean as possible. Although students understand these concepts, they are unaware of how the two are connected in a much larger system. This unit serves to help students understand, analyze, think critically, model, and research to gain a better understanding of how the water cycle, watershed, and water filtration are connected. In this unit, students will understand how water comes from the sky to the ground and back into the atmosphere through modeling the hydrologic cycle, as well as, analyzing what happens to the rainwater after it comes from the sky to the ground. The students will build a model of the watershed flow to investigate how debris is carried into the water sewers. In addition, students will construct a model water filtration system that will clean “polluted” water. This model helps establish the understanding that water needs to go through a process to be filtered back into the water system. Students will also compare their model to the process of a real treatment plant. Lastly, students will discover the many ways that humans interact with the land to create pollution. In the end, students will compose ways to help keep our water as clean as possible.

Keywords:

The water cycle, hydrologic cycle, water quality, run-off, stormwater, storm drain, water pollution, water filtration

Unit Content

Introduction:

Water Quality in the urban area is typically not thought about in the younger grades because most times the adults creating the curriculum do not think that the students can understand the idea. The idea of water quality is also thought to be “over” the students’ heads. Teachers also tend to not cover water quality in the younger grades because students don’t have the background, they won’t understand, or teachers don’t have resources to teach this content in their schools.

In this resource, I aim to make water quality relevant in the lives of the students and make a resource that will ensure that teaching students this “higher level” idea are feasible and relevant. This resource contains easy-to-follow lesson plans along with hands-on activities that can be done in the classroom.

Problem Statement:

Many students do not understand the relationship between the Water Cycle, Watershed, and Drinking Water. This is content that most students learn in isolation. Learning about these concepts in isolation leads to misunderstandings and the inability to relate one concept to the next. Students will learn that the Water Cycle and Watershed affect their drinking water. Drinking water is an essential part of living a healthy life. Many pollutants and contaminants can enter our bodies through our drinking water and students must understand that they can support cleaning our drinking water as soon as it falls from the sky.

Unit Outline:

1. What is the Water Cycle?
 - a. This lesson will cover where the water begins. This is a key component to understanding how water comes from the sky to the ground, then to organisms for hydration, and back into the atmosphere.
2. Run-Off in the City.
 - a. This lesson will cover what happens to the rainwater after it comes from the sky to the ground. Also, where the water goes once it’s on the ground and the pollutants and debris it carries with it. This is important to understand how the water begins its journey to be cleaned and used.
3. How Is Water Cleaned and Treated?
 - a. This lesson covers how water is cleaned and treated in a sewer treatment plant. During this lesson students will also model how water is cleaned and also discuss the difference between a model cleaning of water compared to water going to the water treatment plant.
4. Why Is Our Water So Polluted?
 - a. This lesson explores the various contributions to poor water quality caused by humans and animals.

Teaching Strategies

Subject: Environmental Science

Unit of Study: What Happens After the Water Leaves the Sky?

Grade/Level: 4 and 5

Start and End Time: 45 minutes per session

Lesson 1: Observe Demonstration and Create a Foldable

Students will observe rainfall in a jar. The teacher will create a rain cloud in a jar. Students will watch colored water fall from the shaving cream cloud. Students will create a foldable identifying the stages of the water cycle.

Lesson 2: Hands-On Activity

Students will create, observe, and analyze a watershed model to have a visual representation of a functional watershed. This visualization will aid in the understanding of how rainwater interacts with matter as it falls from the ground and flows into the storm drains.

Lessons 3: Hands-On Activity and Writing Activity

Students will construct a water filtration model to observe the steps of cleaning storm drain water.

Lesson 4: Hands-On Activity

Students will create, observe, and analyze a water pollution model to have a visual representation of how water can be polluted by humans and animals. This visualization will aid in the understanding of how human and animal interactions with the land and water can cause pollution.

Science Standards:

- S8.A.3.1.1 Describe a system (e.g., watershed, circulatory system, heating system, agricultural system) as a group of related parts with specific roles that work together to achieve an observed result.
- S8.D.1.3.1a Recognize processes in the water cycle (limited to evaporation, condensation, precipitation, transpiration, runoff, and infiltration.)
- S7.B.3.2.3 Describe how human interactions with the environmental impact an ecosystem (e.g., road construction, pollution, urban development, dam building/removal).
- S8.A.1.1.3 Use evidence, such as observations or experimental results, to support inferences about a relationship.

- S8.A.1.1.4 Develop descriptions, explanations, predictions, and models using evidence.
- S8.A.1.2.2 Identify environmental issues and explain their potential long-term health effects (e.g., pollution, pest controls, vaccinations).

Writing Standards:

- E05.C.1.1.1 Introduce a topic or text for the intended audience, state an opinion, and create an organizational structure in which ideas are logically grouped to support the writer's purpose.
- E05.C.1.1.2 Provide logically ordered reasons that are supported by facts and details

Background

Lesson 1: What is the Hydrologic Cycle?

The hydrologic cycle, also known as the water cycle, shows the movement of water within the Earth's atmosphere. The cycle begins with water warming due to the heat from the sun. The water evaporates into water vapor. The water vapor cools condensing to form clouds. The clouds become full of water vapor and precipitate back to Earth. Examples of precipitation are rain, snow, hail, and sleet.

This cycle is important because this is the way that humans, plants, and animals receive the water needed to sustain life. This cycle also moves nutrients to organisms and sediment to create, destroy, or alter landforms. This NASA website has a useful diagram and information on the hydrologic cycle: <https://gpm.nasa.gov/education/water-cycle/hydrologic-cycle>

Lesson 2: Run-Off in the City

Stormwater runoff is the effect that water has on the Earth when precipitation happens. Rain and melted snow flows over paved streets, parking lots, rooftops, roads, etc., and does not become absorbed into the Earth. The water flows to drainage ways and carries chemicals, debris, animal waste, etc. along with it. This EPA website has information about pollutants in general and is searchable for your community.

<https://www.epa.gov/waterdata/hows-my-waterway>

The watershed is an area of land that collects rainfall and melted snow to waterways, such as rivers, creeks, ponds, etc.

Lesson 3: How Is Water Cleaned and Treated?

Water treatment plants are systems in city's that water flows through to be cleaned. The filter process removes debris and chemicals from the water. There are various stages that the water filters through to become clean. The first stage is collecting the water, then the water is screened and strained of all debris, chemicals are added to the water to remove pollutants and chemicals that are harmful, sediment is removed through another filtration process, the water is then disinfected and stored, then finally the water is distributed back into the city's waterways. Youtube video "How do Waste Water Treatment Plants Work?" explains this well.

Lesson 4: Why Is Our Water So Polluted?

Humans interact with the land every day and that interaction contributes to the pollution of water. This is known as nonpoint source pollution because it doesn't come from a pipe but rather from the activities that humans engage in. Because of this, there are different types of pollutants that are found in water:

- Sediment: Runoff of dirt and materials used in the building of buildings and the surrounding soils.
- Fertilizers/Nutrients: Waste from animals as well as materials used to help plants grow.
- Pesticides: Chemicals used to control, deter, or kill animals, plants, and insects.
- Oil/Gas: Chemicals used to heat buildings, run cars, and produce electricity.
- Toxic Waste: Any unwanted material that can cause harm. Some toxic waste can be batteries, waste products from landfills or industrial sites, etc.

This EPA website has more detail on Nonpoint source pollution of water:
<https://www.epa.gov/nps/basic-information-about-nonpoint-source-nps-pollution>

Classroom Activities

Lesson 1: What is the Hydrologic Cycle?

Objectives:

Students will be able to:

- observe and make a connection between a model of rainfall and the water cycle.
- Identify and describe the stages of the water cycle.

Resources:

- Water Cycle Article: <https://www.readworks.org/article/Weather---The-Water-Cycle/49c4f252-2cdb-492d-8247-84edf9757d2b#!articleTab:content/>
- How to make a Rain cloud in a jar:
<https://www.youtube.com/watch?v=x4GePPTUAjI>

Materials: Large jar, shaving cream, small pipette/dropper, water, and blue food coloring.

Chart Paper , Markers

Teacher: Model: Hydrologic Cycle in a jar

Student: Water Cycle article, white copy paper, colored pencils

Vocabulary:

Hydrologic Cycle (Water Cycle) ~ the path that all water follows as it moves around Earth in different states

Precipitation ~ water that falls to the earth as hail, mist, rain, sleet, or snow. precipitation

Evaporation ~ the process of changing from a liquid to a vapor

Condensation ~ process by which a substance changes from a gaseous state to a liquid state

Accumulation ~ an act of collecting or gathering

Procedure:

- 1) Think Tank: (Give students a few moments to think about a response to prompt. Have students turn to a neighbor and discuss a response. Call on students to respond in front of the class.)
Where does water come from?
- 2) Explain to students that today you are going to learn about the Hydrologic Cycle. (Ask students if they know what that is? Hydro-prefix meaning water, -Logic-root word meaning idea) Show the students all of the items and explain what each item symbolizes. Complete each step as you explain the items.
 - a. Jar symbolizes the world
 - b. Water symbolizes the atmosphere

- c. Shaving cream symbolizes the clouds
 - d. Ask what do they think the blue food coloring symbolizes (rain)
 - e. Ask what do they think is going to happen if you drop “rain” onto the “clouds”.
 - f. Drop blue food coloring into “clouds” in random spaces.
 - g. Watch the “rain” fall from the clouds.
- 3) Teacher asks students to think about what they noticed and what they are wondering after the demonstration. (Allow students to share out)
 - 4) Explain the rain fell from the clouds because the clouds became too heavy. When clouds become heavy the water falls out as precipitation. Precipitation can be rain, snow, hail, sleet, etc.
 - 5) Explain that we are now going to read an article on the Hydrologic Cycle.
 - 6) Read the article aloud with the students. Have students close their eyes as you read and have them visualize what is happening. After reading ask the students to open their eyes as you read the article again.
 - 7) Instruct students to fold the paper into 4 parts.
 - 8) Read the first 4 sentences in the second paragraph of the text. After reading give students 30 seconds to draw what they “see”.
 - 9) Continue with the next 2 sentences. After reading give students 30 seconds to draw what they “see”.
 - 10) Continue with sentences 2-5 in paragraph 3. After reading give students 30 seconds to draw what they “see”.
 - 11) Continue with sentences 6-7. After reading give students 30 seconds to draw what they “see”.
 - 12) After reading the students should have a visual of the Water Cycle stages.
 - 13) Now give students a few minutes to write information about each stage of the Hydrologic Cycle in each section.
 - 14) Assist students with labeling each section using the vocabulary words from the lesson.
 - 15) Give students the article to assist with spelling and anything that may be missing. Also, allow students this time to add any coloring that they may like.

Closure:

How was the model used in class today similar to the Hydrologic Cycle? Use 2 examples to support your response.

Use the sentence starters to frame your response.

The model used in class today was similar to the Hydrologic Cycle.

For example...

Also...

To conclude...

Lesson 2: Run-Off in the City

Objectives:

Students will be able to:

- Observe and analyze the model of the watershed
- Identify and describe how rainwater interacts with matter as it falls from the ground and flows into the storm drains

Resources:

- Water Education TV: What is a Watershed?:
<https://www.youtube.com/watch?v=GSAwmkYoCN4>
- What is a Watershed? PBS Learningmedia:
<https://www.pbslearningmedia.org/resource/ket09.sci.ess.water.wshed/what-is-a-watershed/>

Materials:

- disposable paint tray
- model animals
- small models of barns, houses, industrial buildings
- spray bottle
- red food coloring
- jimmies (sprinkles for ice cream)
- soy sauce/ oil
- jello mix
- small pieces of paper
- bucket for the cleanup
- Chart paper
- Markers

Model: Pollution carried by rainwater as it passes over the watershed into bodies of water.

Vocabulary:

Hydrologic Cycle (Water Cycle) ~ the path that all water follows as it moves around Earth in different states

Watershed ~ an area of land where all of the water that is under it, or drains off of it collects into the same place

Pollutant ~ a substance that is unsafe

Procedure:

- 1) Think Tank: (Give students a few moments to think about the response to prompt. Have students turn to a neighbor and discuss a response. Call on students to respond in front of the class.)
What happens to rainwater before it goes down a sewer or storm drain?
- 2) Explain to students that today you are going to learn about the Watershed. (Ask students if they have ever heard of a watershed and if they think they know what it is)
- 3) Explain the watershed is an area of land that drains into a river system. A watershed also includes water that flows over the surface of the land and flows underground. How we use the land also affects the watershed and quality of water. For example, if the water flowing into a drain pipe flows across oil from a gas station first or salt from the street first, the salt will dissolve in the water and the oil will travel to the drain along with the water. Pesticides, fertilizers, and animal excrement will also affect the water.
- 4) Teacher asks students “What kind of things are in our neighborhood that causes pollution in our water?” List the responses from the students on chart paper.
- 5) Ask students how models help them understand concepts in the real world.
- 6) Choose a pollutant from the list provided by the students. Ask them what real-life material can they use to model. (example: cooking oil or baby oil can be used to model gas and oil from gas stations.)
- 7) Explain that today we are going to create a model of the watershed. We will be using other materials to model pollutants in our water.
- 8) Separate students into groups of 2-4. Pass out supply bin.
- 9) Review very quickly where the rainwater comes from. (Students should be able to explain that rain is precipitation and comes from clouds that are full of water)

- 10) Call out the scenarios and have students place the corresponding “pollutants” into the tray.
 - a. Paint from the side of the house – red food coloring
 - b. Excrement from animals – jimmies (sprinkles for ice cream)
 - c. Gas and oil from Gas Stations – soy sauce
 - d. Chemicals from factories – jello mix
 - e. Garbage from homes – small pieces of paper
- 11) After all the pollutants have been placed into the paint tray, have the students use the spray bottle to model rain.
- 12) Ask the following questions.
 - a. What did you notice?
 - b. What are you wondering?
 - c. How did the pollutants affect the water?
 - d. Do you think the amount of rain will affect how polluted the water will be?
 - e. Where does the water collect after the rain? (The water will collect in the base of the paint tray)
 - f. What does the base of the paint tray model? (It can model a storm drain that flows under the city.)
 - g. What happens with stormwater after rain?
- 13) Ask the students to discuss with their group how this model helps them understand the watershed that they live in.
- 14) Explain that the water that has gone down the sewer meets in pipes with sewage from homes and flows to a water treatment plant. Explain that the water treatment plant cleans the water and flows the water back into a large body of water where water organisms are. Continue to explain that water treatment plants can only hold so much water. The “extra” water is diverted directly into our bodies of water.

Closure:

How does rainwater become polluted before going into the sewer? Use 2 examples to support your response.

Use the sentence starters to frame your response.

Rainwater can become very polluted before going into the sewer.

For example...

Also...

To conclude...

Lessons 3: How Is Water Cleaned and Treated?

Objectives:

Students will be able to:

- Observe and analyze a model of a water filtration station
- Identify and describe the function of the layers in the model

Materials:

- clear plastic soda or juice bottle (water bottles are too flimsy)
- 2 tall clear plastic cups
- gravel or small stones
- fine sand
- activated charcoal (optional: used to remove impurities and absorbs chemicals)
- cotton balls or coffee filter
- gardening dirt, leaves, twigs, paper pieces
- water
- scissors or knife (adult use only) Teacher cuts off the bottom of plastic bottle ahead of time
- Chart Paper
- Markers
- Notebook

Model: Water Filtration to remove pollutants

Vocabulary:

Filtration ~ process by which impurities or particles are removed from a fluid

Pollutant ~ a substance that is unsafe

Procedure:

- 1) Think Tank: (Give students a few moments to think about a response to prompt. Have students turn to a neighbor and discuss a response. Call on students to respond in front of the class.)
Is the water that we use to clean ourselves, cook, and clean with the same water from the sewer?
- 2) Explain to students that today you are going to learn how used water and storm drain water is cleaned and put back into the waterways and our homes.
- 3) Explain that the watershed filters all of the water into treatment plants. The purpose of the treatment plant is to clean the sewage water. The water must be purified and disinfected. This process happens by filtering, chemically cleaning, and using UV lights.
- 1) Lets's watch Concerning Reality "How Do Wastewater Treatment Plants Work?" to see what happens. <https://youtu.be/FvPakzqM3h8>
- 4) Now we are going to create our filtration systems. Please remember that the water is NOT consumable. Please do not drink the water after filtering. This is simply a model to show the steps.
- 5) Show the students the following and ask what they think each item will do.
 - a. large stones or pebbles
 - b. gravel or small stones
 - c. sand
 - d. cotton balls
- 6) Begin to construct the filtration system
 - a. Place the bottle upside down into the vase or tall drinking glass.
 - b. Place cotton balls inside the bottle as the first layer. The first layer should be about one to two inches thick.
 - c. Add 2 inches of sand as the second layer.
 - d. Next, add about 2 inches of gravel or small stones as the third layer.
 - e. Add about 2-3 inches of large stones or pebbles. Leave about a half-inch of space from the top of the upside-down bottle.
 - f. Now put the filter to the side.
- 7) Fold copy paper in half the short. (Should look like a book)
- 8) Create an ABCD drawing of your filter on white copy paper. (ABCD drawing is Accurate, Big, Colorful, and Detailed) Label each layer of the filter.

- 9) Let's review the watershed and pollute the water.
 - a. Pour water into a small cup and add pollutants (dirt, twigs, paper pieces, leaves)
- 10) Slowly pour the "polluted rain" water into the filter and watch what happens.
- 11) Record what happens to the water on the opposite side of the ABCD drawing of the filter. (Draw straight lines with a straight edge if needed)
- 12) Students will discuss with their group what each layer did.
 - a. large stones or pebbles ~ filters large debris
 - b. gravel or small stones ~ filters slightly smaller debris
 - c. sand ~ filters small impurities
 - d. cotton balls ~ filters smaller impurities
- 13) Explain although the water has been filtered it is not safe to consume.
 - a. Ask students why they should not drink the water.
 - b. Ask what happens in a real water filtration plant that we missed with our model. (Students should tell you chemical cleaning, UV rays, radiation, etc)
 - c. Go back to the Water Filter lab sheet and label how each layer "cleaned" the water.
 - d. Draw a Venn Diagram of the polluted water and filtered water.
- 14) Ask students what they noticed and wonder about the water filtration lab.

Closure:

Write a conclusion for the activity. Water filtration plants have many processes to clean, sanitize, and purify our water. Do you agree that the model we made today is a fair representation of a real water filtration plant process?

Use the sentence starters to frame your response.

I agree/ disagree that the model used today was a fair representation of an actual water filtration system.

I agree/disagree because...

Also...

Lastly...

I agree/disagree that the model represents...

Lesson 4: Why Is Our Water So Polluted?

*lesson adapted from streamsidescience.usu.edu

Objectives:

Students will be able to:

- Observe and describe the effect of land use on water quality
- Identify and describe types of pollutants found in water from land use

Resource:

- Water Pollution lesson and worksheets: https://streamsidescience.usu.edu/ou-files/pdfs/water-pollution-graphing_2017.pdf

Materials:

- colorful beads or colorful candies (not chocolate, they will melt)
- plastic sandwich bags
- graph paper
- colored pencils
- Chart Paper
- Markers
- Pollutant Labels
- Pictures of Land Uses

Vocabulary:

Microorganism ~ living things that are too small to be seen with the naked eye

Water Quality ~ measurement of the cleanliness and healthiness of the water

Procedure:

- 1) Think Tank: (Give students a few moments to think about a response to prompt. Have students turn to a neighbor and discuss a response. Call on students to respond in front of the class.)
Do you think that microorganisms can live in polluted water?
- 2) Explain to students that today you are going to learn how we use the land has negative effects on the quality of water for microorganisms.

- 3) Explain that microorganisms live in water and provide food for small water animals and in some cases help our ecosystem. Continue to explain that although microorganisms can sometimes be harmful to humans and other animals, they are living creatures that also need to live in safe water where they will thrive. Sometimes you can tell that water is clean if there is a vast number of microscopic lifeforms flourishing in water.
- 4) Now we are going to analyze a model water sample from a pond.
- 5) Divide 30-40 beads into the sandwich bags (manipulate the bags so that the assortment of candy represents a particular land-use area by adding more or less of a certain type of pollutant).
- 6) Each bag represents a water sample from a watershed.
- 7) Ask the class to define the word pollutant. Tell them that each color of bead represents a different kind of pollutant.
 - a. purple = sediment
 - b. red = pesticides
 - c. green = fertilizers
 - d. yellow = oil/gas
 - e. orange = toxic waste
 - f. Discuss each of these pollutants with the students. Ask them where they come from, what they are used for, how they can be beneficial, and how they may be harmful.
 - g. Discuss what land use means, and what kind of land use may cause the different kinds of pollution.
- 8) Distribute the graph paper to each group.
- 9) Explain to the students that they will be drawing a bar graph to show the number of pollutants found in their “water sample.”
- 10) Students will label the x-axis with the pollutant types and the y-axis with the number of pollutants.
- 11) Give each group a “water sample.”
 - a. Students will separate and count the number of each pollutant and graph them on paper.
 - b. Show the land use cards provided. Ask the students to try and determine what land-use activities are occurring in their watershed according to the “water sample.”
 - c. When students respond have them explain why they chose a particular land use.
- 12) Have each group display their chart and explain their land use.

- 13) Discuss how each water sample is different.
- 14) What did the students notice and what do they still wonder? (students should notice that almost all pollutants are each sample, although some may be in small amounts)

Closure:

Write a conclusion from the lab. Humans will always pollute water because of where we live and work, but we can help with the quality of water. Choose a land use and give two examples of what humans can do to help not pollute the water as much.

Use the sentence starters to frame your response.

(Land use) pollutes our water, but we can help.

One way to help is...

Another way to help is...

These are things we can do to help keep our water quality.

Resources

- Streamsidescience.usu.edu
- Dictionary.com
- Climatekids.nasa.gov
- Merriam-webster.com
- Earthlabs. watershed
- Youtube: Concerning Reality, “How Do Wastewater Treatment Plants Work?”
- Fs.fed.us
- How To: Build a Model Watershed Simple Project for Conservation
- Science. Lovetoknow.com
- Study.com
- Kids.kiddie.com
- Readworks.com Weather-The Water Cycle
- EPA searchable site for condition of local waterway:
<https://www.epa.gov/waterdata/hows-my-waterway>
- “Hydrologic Cycle.” NASA, NASA, <https://gpm.nasa.gov/education/water-cycle/hydrologic-cycle>

Appendix

Books to assist with the explanation of concepts.

- The Water Princess by Susan Verde:
<https://growingbookbybook.com/product/0399172580/US/groboobyboo-20/>
- Hope Springs by Eric Walters:
<https://growingbookbybook.com/product/1770495304/US/groboobyboo-20/>
- Four Feet, Two Sandals by Karen Lynn Williams & Khadra Mohammed:
<https://growingbookbybook.com/product/0802852963/US/groboobyboo-20/>
- The Water Hole by Graeme Base:
<https://growingbookbybook.com/product/0810945681/US/groboobyboo-20/>
- Prince William by Gloria Rand:
<https://growingbookbybook.com/product/080503384X/US/groboobyboo-20/>
- Focus on Water Science: Water Pollution by Melanie Ostopowich:
<https://www.amazon.com/Water-Pollution-Av2-Focus-Science/dp/1489658041>
- Science Matters: Water Pollution by Melanie Ostopowich:
<https://www.goodreads.com/book/show/5113936-water-pollution>
- The Mess We Made by Michelle Lord: <https://amzn.to/34UfFOX>
- Lobstah Gahden: Ali Brydon & EG Keller: <https://amzn.to/3mKj99j>