**Water, Water, Everywhere!**

**Overview:**

In this inquiry project, students will investigate how to assess water quality and learn about the impact of unclean water on human activities.

**Grade Level:** 8

**Strand and Topic: Understanding Earth and Space Systems:** Water Systems

**Inquiry Focus:**

*What makes water unclean for human consumption?*

*What are the sources of water pollution?*

*What can be done to make water safe to drink?*

 **Big Ideas**:

* Water is crucial to life on earth
* Water is an important resource that needs to be managed sustainably

**Overall Expectations:**

**Science and Technology**

1. assess the impact of human activities and technologies on the sustainability of water resources
2. investigate factors that affect local water quality

**Specific Expectations:**

**Science and Technology**

* 1.3 assess the impact on local and global water systems of a scientific discovery or technological innovation
* 2.2 investigate how municipalities process and manage water
* 2.3 test water samples for a variety of chemical characteristics
* 2.4 use scientific inquiry/research skills to investigate local water issues
* 2.6 use appropriate science and technology vocabulary in oral and written communication
* 2.7 use a variety of forms to communicate with different audiences and for a variety of purposes
* 3.3 explain how human and natural factors cause changes in the water table

**Mathematics:**

* express repeated multiplication using exponential notation
* multiply and divide decimal numbers by various powers of ten
* represent linear patterns graphically
* model linear relationships using tables of values, graphs, and equations
* collect data by conducting a survey or an experiment
* read, interpret, and draw conclusions from primary data

**Language**

* generate, gather, and organize ideas and information to write for an intended purpose and audience
* use editing, proofreading, and publishing skills and strategies, and knowledge of language conventions, to correct errors, refine expression, and present their work effectively
* create a variety of media texts for different purposes and audiences, using appropriate forms, conventions, and techniques

**Geography**

* formulate questions to guide and synthesize research on the study of population characteristics and patterns
* summarize the factors that affect patterns of urbanization, industrialization, and transportation.

**Key Concepts**:

Water chemistry, filtration, local water issues, water in the media, sustainability and stewardship, change and continuity

**Prior Skill Sets:**

* able to ask questions that demonstrate curiosity about what was observed during the ‘Engage’ activities
* able to look for and select information that relate to water and water quality from various sources, including the internet and/or print resources
* acknowledges use of information sources appropriately
* can propose an answer to the inquiry focus question(s)and can describe steps to take to answer question(s)
* able to design and carry out a plan to test water quality using the scientific method
* able to recount the steps taken and share the results of the investigation in a variety of ways

**Prior Knowledge:**

**Grade 2**

* 1.2 - assess personal and family uses of water as responsible/efficient or wasteful, and create a plan to reduce the amount of water used, where possible
* 3.5 identify the three states of water in the environment, give examples of each, and show how they fit into the water cycle when the temperature of the surrounding environment changes
* 2.3 investigate, through experimentation, the characteristics of water

**Grade 4**

* 3.10 - describe ways in which humans are dependent on natural habitats and communities (e.g., for water, medicine, flood control in wetlands, leisure activities)

**Materials and Equipment:**

* water samples from various sources, e.g., pond, stream, lake, tap, bottled, distilled, etc. *(Teacher can add various substances to distilled water to create “polluted” water, e.g., salt, oil, sand)*
* thermometer
* acidity Indicators (e.g., pH testing strips)
* conductivity apparatus
* chemical paper test strips or test kits (purchased from scientific suppliers, aquarium/pool stores or loaned from the board)
* iPad apps for water analysis with hardware, e.g., JBL Proscan, Hydrocolor (no hardware)
* internet connected devices

**Safety:** Ensure safe usage of tools and glassware (STAO Safety review). Refer to “Using Specialized Equipment” and “Chemicals” from the STAO Elementary Safety resource, pp. 77, 82 <http://stao.ca/res2/unifElemSafety/>

**Instructional Planning and Delivery:**

This inquiry project can be done after introductory lessons on water. Students might need to first understand what water is, where it is found, and why it needs to be cleaned for consumption. This inquiry specifically addresses the testing of water and analysis of the results. Alternatively, the teacher can start with the inquiry and then address concepts as they are brought up during the inquiry process.

**Engage -> Explore -> Explain -> Extend -> Evaluate**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Type** | **Structured or Directed** | **Guided** | **Coupled** | **Open or Full** |
| **Participant** | Teacher Initiated and Performed | Teacher Initiated, Students Performed | Teacher Initiated | Student Initiated |

**Teacher Directed Student Directed**

**Path to Inquiry**

**Engage (I SEE)**

Begin by reading a story or news article concerning water use or water pollution. Examples are “*An Aboriginal Water Story*” (Nelson’s Science and Technology Perspectives, page 265), the story book “*One Well: The Story of Water on Earth*” by Rochelle Strauss, or choose a news story from National Geographic’s, “Water Crisis News” website <http://news.nationalgeographic.com/water-crisis/>

Engage students to ask questions they might have about water. Use a KWL chart to determine what students know, want to know, and have learned as the activity progresses.

**Questioning (I WONDER)**

|  |  |
| --- | --- |
| Teacher-led | Student-led |
| What would happen if…Why is \_\_\_\_\_\_ a problem? Who is affected? How?How can we find out about \_\_\_\_\_\_? What experiment can we do to find out about \_\_\_\_\_?Who has done this before? | Where does water come from? How much water is there?What percent of the earth’s surface is water? What is the difference between freshwater and saltwater? Can we use saltwater? If not, why not?What makes water unusable? How is water polluted? What are pollutants? How are pollutants harmful? How can I prevent pollution of the water supply? What is a watershed? What is runoff? How much water is used in agriculture? In manufacturing? In mining? Where does my tap water come from? How polluted is our lake? |

**Explore / Inquiry activity: (I DO)**

**Option 1: teacher-directed, student perform**

Students are provided with the water samples and the outline of the experiment to test the water samples in a laboratory experiment (refer to “Water Testing” from Nelson’s Science and Technology Perspectives, page 304 for an example, or see the science fair web article <http://plrplr.com/70335/science-fair-project-on-testing-drinking-water/> for an outline). The actual activity will depend on how much structure the teacher wants, the classroom setup, and management skills. In the experiment, students will test the various water samples and record their results. They will analyse the results and share their findings with the class and/or submit a laboratory report.

**Option 2: student-led**

Students are provided with internet-connected devices to conduct research in order to answer their questions concerning water. In addition, students may want to conduct experiments to determine just how clean their local water sources are. The teacher may facilitate a visit to the closest water body to obtain samples for testing, e.g., a stream, river, or lake. Students design and conduct their testing of the water, collect and organize their findings, and share their conclusions. For safety guidelines, refer to STAO safety document “Nature Study”, page 96, and pages 77 - 85 for specialized equipment use. <http://stao.ca/res2/unifElemSafety/>

**Explain**

Students will need to relate their results to established scientific facts and data. In this section of the inquiry, students interpret, analyse, and compare their findings, using acceptable formats for their work. Charts, tables, and graphs can be used for data analysis. Various presentation software can be used to show their work, e.g., PowerPoint, Google Slides. For example, students might produce a chart like the one shown below:

|  |  |
| --- | --- |
| Source | Test |
| Temperature | Conductivity | Hardness | Turbidity | Chlorine | Nitrates |
| *Lake* | 10 | x | ✓ | ✓ | x | ✓ |
| *Tap* |  |  |  |  |  |  |

In this chart, some numerical values are recorded, and the presence or absence of other factors are noted. Actual entries will be determined on the level of sophistication of the kits used (and on the grade level of the students).

Students need to make connections with what they find to their own lives, and to understand how water is integral to the lives of many other groups and communities. For example, the following questions can be posed by the teacher:

* *What do your results indicate about the quality of water from various sources? How would this impact you?*
* *Why are there differences among the samples? Which sample is “cleaner”? How do you know?*
* *Explain whether any of the contaminants you tested for pose a threat to humans or wildlife.*
* *What activities or processes could have provided some or all of the contaminants? Which communities could be most affected, and in what ways?*
* *Propose ways in which the water quality from the various sources can be improved.*

**Indigenous Perspective:**

* *What are indigenous views on water management? What techniques are used for conservation by various native groups?*
* *How is water viewed by various Aboriginal groups? What role does water play in the lives of these groups?*

Teacher Tips:

* More information on the integration of the Indigenous philosophies and practices can be found at

 <https://www.edu.gov.on.ca/eng/literacynumeracy/inspire/research/WW_Teaching_Ecological.pdf>

* Provide opportunities for students to learn about indigenous ways of water management. For more information, visit the Assembly of First Nations website at <http://www.afn.ca/index.php/en/honoring-water>
* Engaging videos relating to the Aboriginal perspective can be found at <http://www.sacredrelationship.ca/videos/>
* A Medicine Wheel can be adapted to teach about water. Learn about the pedagogy related to this method of incorporating Aboriginal teachings at <http://www.cea-ace.ca/education-canada/article/teaching-medicine-wheel>

**Student Support Resources:**

Environment Canada’s site on water pollution

[www.ec.gc.ca/eau-water/default.asp?lang=En&n=E86BC86A-1](http://www.ec.gc.ca/eau-water/default.asp?lang=En&n=E86BC86A-1)

Canadian Encyclopedia site on water pollution

<http://www.thecanadianencyclopedia.ca/en/article/water-pollution/>

Canadian Wildlife Federation on pollution

<http://cwf-fcf.org/en/discover-wildlife/canada-waters/threats/water-pollution.html?referrer=https://www.google.ca/>

Environment Canada on water quality

[www.ec.gc.ca/eau-water/default.asp?lang=En&n=F2F43FC7-1](http://www.ec.gc.ca/eau-water/default.asp?lang=En&n=F2F43FC7-1)

**Related Background Resources and/or Links:**

KWL

<http://www.exploratorium.edu/ifi/resources/lifescienceinquiry/usingkwl.html>

<http://www.nsta.org/elementaryschool/connections/201502EngineeringEncounters.pdf>

Rubric for Data Collection

<http://www.nsta.org/elementaryschool/connections/201403Sterling.pdf>

Water Quality Year Long Project

<http://science.nsta.org/enewsletter/2007-07/sc0705_18.pdf>

Story books:

# Strauss, Rochelle. (2007) *One Well: The Story of Water on Earth*. Kids Can Press

Mary Hoff and Mary M. Rodgers. (1991). *Our Endangered Planet: Groundwater*. Minneapolis, Minn.: Lerner Publications Co.

Lynne Cherry. (1992). *A River Ran Wild: An Environmental History.* San Diego: Harcourt Brace.

# Meredith Hooper. (2012). *The Drop in My Drink: The Story of Water on Our Planet.* London, England: Frances Lincoln Children's Bks.

Textbook Reference:

Pare, Dennis et.al (2009). *Science and Technology Perspectives 8*. Toronto, ON.: Nelson Education

**Extensions**

* Create a website/blog/wiki to show their findings. Consider comparing well water samples, if that is possible, or compare results after natural occurrences, e.g., before/during/after rainfall
* collaborate with other students from other jurisdictions to compare their findings via SKYPE or online database, e.g., the Global Water Sampling Project (<http://www.k12science.org/curriculum/waterproj/> )
* conduct a “town hall” meeting representing various stakeholders, e.g., the monitoring group (e.g., Toronto and Region Conservation Authority), government, First Nations/Metis/Inuit, farmer, etc.

**Evaluate (I REMEMBER)**

**Possibilities for Assessment As/For/Of Learning**

|  |  |  |
| --- | --- | --- |
| **Assessment ‘As’ Learning** | **Assessment ‘Of’ Learning** | **Assessment ‘For” Learning** |
| Journals/ Self-ReflectionObservations Records of InvolvementSelf/peer Assessments Homework  | Observations Journals/Reflections Performance/skill Rubrics Tests/quizzesAnecdotal Records Exit Slips Self/peer Assessments Homework Tests Projects e.g., a poster to promote their product, online adPortfolios Writing Pieces Celebration of Learning e.g., mini conferenceAssignments involving synthesis and evaluation | Anecdotal Records KWL/RAN Pre-testing Observation Checklists Discussions Journals/Reflections Talking Circles Mind Maps BrainstormInquiry Lab BooksCalculations and evolution of design portfolios |

*Final products that can be assessed:*

* create a poster about how to protect the local water source(s)
* design and build a water filtration unit using simple materials (pop bottle, sand, cloth)

(<http://pbskids.org/zoom/activities/sci/waterfilter.html>)

* design and build a model of a water filtration plant using readily available materials (wood, straw, glue)
* design, create, and build a model watershed (preferably using a topographic template of the local area watershed) showing water sources and potential points of contamination. See how to use papier mache here http://www.howcast.com/videos/391402-How-To-Make-Papier-Mache/
* create a brochure to show how water is contaminated and how to prevent this from happening

Teacher Tip: This inquiry can lead to a ‘design-and-build’ project by adding one of the projects listed above. Students can further experience the integration of science, technology, engineering, and mathematics (STEM) by using the data they obtain from the water testing inquiry to drive the development of a solution to the problem of water pollution, e.g., build a water filtration unit using easily obtainable materials after finding out what pollutants are present. Students can be asked to build the project using either the least amount of materials possible, the cheapest materials, (or even the lightest, simplest materials) in order to provide a higher order design challenge.

**Technology Possibilities:**

* use of internet-connected devices
* use of software and hardware for water analysis
* PowerPoint and other presentation tools
* using a global/national water monitoring database