Grade 8 Learning Experiences: Innovative Irrigation: The Value of Water to Food Security

Experience 2: Explore the factors that affect the flow of fluids using syringes and tubing

Experience 1 Explore the value of water regarding food production across cultures and technologies.

Experience 2 Hands-on activities that demonstrate some factors that affect the flow of fluids.

Experience 3 Design Challenge: Build and test a prototype for an irrigation system based on student research from Experiences (Activities) 1 and 2.

Long Range Plan: Grade 8 Model 1 (February/March)

Overview of learning experiences – why these activities	This set of experiences looks at the importance of water use (irrigation) in crop production. Students research the variety of irrigation methods there are in farming around the world. Using a variety of syringes and tubing of various lengths and gauges, the will then explore properties of fluids. Finally, they will apply that knowledge to the creation of their own irrigation model. Students will be guided by engineering design process (Strand A: Engineering design), the concepts of water flow (Strand C: Matter and Energy - Fluids), and the value and importance of water in our environment (Strand E: Earth and Space Science – Water systems). Long Range Plan: Grade 8 Model 1 (February/March)
Prior Knowledge / Prior Skill Set(s)	Background Knowledge and Concepts (Teacher) ● Basic understanding of Systems (inputs, outputs, side effects) Background Knowledge and Skills (Students) ● Strategies for determining the area of an odd shape (or simply calculating the area of rectangles)

	• Rudimentary knowledge of behaviour that is expected in a laboratory situation. Review and posted list of lab expectations may be helpful
Strand A - STEM Investigation and Communication Skills	**A1.2** use a scientific experimentation process and associated skills to conduct investigations **A1.3** use an engineering design process and associated skills to design, build, and test devices, models, structures, and/or systems (Experience 3) **A1.4** follow established health and safety procedures during science and technology investigations, including wearing appropriate protective equipment and clothing and safely using tools, instruments, and materials (Experience 2, 3) **A1.5** communicate their findings, using science and technology vocabulary and formats that are appropriate for specific audiences and purposes (Experience1, 2, 3)
Overview / Big Ideas/Fundamental Concepts	Experience 2 teaches the Fundamental Concept of Matter. Students are discovering the structural and behavioural characteristics of water by moving water through piping. These stations address a variety of variables that affect flow.
Learning Goals / Success Criteria	During Experience 2, students will be doing the following: • Following procedures to test the properties of water under a variety of conditions • Working cooperatively with colleagues • Recording data • Analyzing and interpreting data • Making conclusions and summarizing their own data This activity integrates several of the ten **Ministry of Education Key Topics** introduced in Science and Technology (2022): • **Research and Experimentation Processes:** Provides students with the scientific literacy skills needed to approach scientific questions that are becoming a part of everyday life. • **Hands-on, Experiential Learning:** Includes hands-on, experiential learning opportunities to support classroom activities that encourage curiosity.

	● **Contributions to Science and Technology**: Showcases the important contributions made to science and technology from people with diverse lived experiences. Students also explore real-world issues by connecting scientific and technological knowledge systems and perspectives from various cultures, including connecting Indigenous sciences and technologies and Western science and technology. ● **Climate Change:** Students will develop the skills and knowledge needed to understand the causes and potential solutions and mitigation strategies related to climate change and other environmental issues, and how they can make the most environmentally responsible decisions possible, given the choices they have.
Learning Experience **A1.1, A1.2, A1.5**	**Experience 2 (1-2 classes)** **Minds On** ● In Experience 1, students learned about different irrigation methods. Looking at their research, have students think about and share with a partner which type of irrigation might most accurately reflect each of the following statements (be sure responses are supported by the evidence they have found) ○ Which might be best where a pond is the source of water? ○ Which might have the least water evaporate from the leaves of plants? ○ Which might have the most volume of wasted water that doesn't reach the soil? ● One of our goals is to irrigate crops in an efficient way (that there is minimal drainage off the farmland and loss to evaporation) so that irrigation is a sustainable use of our water resources. (Aligning with UN Sustainable Goals E1 – 1.1 and 1.3). ● Presenting the Design Challenge: (You can access this slideshow: Design Challenge that will be shown in Experience 3). Our goal is to connect the knowledge of our research about irrigation (in Experience 1) to the tools that we have available to design and build a prototype irrigation system. Students will combine the strengths of existing systems with ideas of their own to create an efficient irrigation system that will be sustainable. ● The next step is to develop an understanding of the factors that control how fast, far, and turbulently water flows under a variety of conditions.

Action

- Today, students will be exploring some of these factors at different stations, recording their data, and summarizing trends in their results.
- **This is an outdoor activity.** The purpose of some of these explorations is that students try to propel the water as far as they can. The 60ml syringes have a range of over 3m.
- **Note:** If you are following the suggested delivery plan, this experiment may have you outside in the wintertime. You can adapt by adding a few drops of food colouring to the water that will be used in the syringes. When it is sprayed on snow, it will be easy to see the pattern and distance of spray.
- Depending on other resources you may have, you can set this up as a rotation of stations activities at a recommended 15 minutes per station. (see Appendix A: Exploring Factors that Affect Fluids : Station Cards and Appendix B: Explore Data Tables)**.** Set up as few or as many stations (or repeats) as you like.
- **Classroom management tip:** By setting a time limit, posting a running timer, and giving a 5 minute warning, students might not make the first deadline, but they are more likely to get down to business and work through the subsequent stations.
- You can run these stations for more than one class period. The important part is to have the students reflect and summarize on what the general trends are – this will help them to consolidate their ideas of how fluids work. Not all students will get the same results (as in real life), but they should be able to talk through and come to a general consensus. These understandings will help them to choose materials to design their irrigation system for the consolidation of concepts phase of the activity.

A1.3, A.15

Consolidation

- Review the situations below with students. They should be referring to their data sheets from the previous classes to help them make decisions. Have students discuss the situations in small groups:
  - If I wanted to spray water as far as I could, what syringe, volume, pressure might I use?
  - If I wanted to spray the biggest area of water, what tubing configuration might I use?

	○ If I wanted to control changing from a large volume to low volume spray, what might I do? ○ What are some other configurations could I try and what might they do? ● The teacher may have students submit a summary sheet as to their findings to see if they have the understanding of how these factors affect the flow of water. They will be applying this knowledge in Experience 3.
Science and Technology Expectations	**Overall & Specific Expectations from the Science and Technology curriculum** **Strand C: Matter and Energy (Fluids)** **Overall Expectation** **C1**. Relating Science and Technology to Our Changing World: analyse uses of various technologies that rely on the properties of fluids, and assess the impact of these technologies on society and the environment (Experiences 1,2,3). **Overall expectation** **C2**. Exploring and Understanding Concepts demonstrate an understanding of basic fluid mechanics, including the properties and uses of fluids (Experiences 2, 3) **C2.6** Explain in qualitative terms the relationship between pressure, volume, and temperature when a liquid or a gas is compressed or heated (Experience 2 addresses the relationship of pressure and volume of water when it is compressed, Experience 3 applies this concept to the design challenge) **C2.7** describe how forces are transferred in all directions in fluids, including using Pascal's law to quantify the transfer of forces in fluids (Experience 2, 3) **C2.8** describe factors that affect the flow of fluids (Experiences 1, 2, 3) **Strand D: Structures and Mechanisms (Systems in Action)** **Overall Expectation** **D2**. Exploring and Understanding Concepts demonstrate an understanding of different types of systems and the factors that contribute to their safe and efficient operation (Experience 1, 2, 3)

	D2.2 describe the purpose, inputs, and outputs of various systems, including systems related to food processing (Experience 1,3) **D2.3** identify the various processes and components of a system that allow it to perform its function efficiently and safely (Experience 3) **D2.7** identify ways in which energy can dissipate from mechanical systems, and describe technological innovations that make these systems more efficient (Experience 3) **D2.9** describe technological innovations involving mechanical systems that have increased productivity in various industries (Experience 1, 3) **D2.10** identify social factors that influence the evolution of a system (Experience 3) **Strand E: Earth and Space Systems (Water Systems)** **Overall Expectation** **E1.** Relating Science and Technology to Our Changing World assess the impact of human activities and technologies on the sustainability of water resources (Experience 1, 3) **E1.1** assess the social and environmental impact of the scarcity of fresh water, and propose a plan of action to help address fresh water sustainability issues (Experience 1, 3) **E1.3** assess the impact of scientific discoveries and technological innovations on local and global water systems (Experience 1, 3)
Science and Technology Vocabulary	Irrigation system – inputs, outputs, side effects. Area of a rectangle, independent variable, dependent variable, fixed variable, prototype.
Equipment and Materials	bucket for water optional (for winter): different colours of food colouring variety of syringe sizes (5ml, 10ml, 20ml, 30ml, 60ml) variety of tubing/straw options popsicle sticks twist ties pins and screws for drilling holes in tubing adhesive tape (or glue guns) clipboards meter sticks / tape measures
Timeline and Preparation	

	Approximately 2 classes (pre-assembling the stations and sorting components into a bucket for each station is recommended – 1 hour of prep time the first time you do it). ● Stations exploring factors that affect water flow (1 class) ● Extra time for stations – extension station 5 – designing own exploration, and discussing results and summary with others (1 class)
Safety Considerations	Safety considerations include the following: ● Students wear safety goggles when using the syringes filled with water ● Demonstrate proper use of syringes for students ● Demonstrate using pins to poke holes in straws (e.g., pointing the pin away from you and keep fingers clear of the path of the pin on the other side of the straw). Refer to these safety resources: ● Safety in Elementary Science and Technology (STAO) ● Safe Activity Foundations in Education Document (SAFEdoc) Science and Technology, Grades 1-8 (OCTE) ● Ontario Curriculum Program Planning – Health and Safety
Opportunities For Assessment	Below are suggestions for opportunities for assessment during Experience 2. Inside the ellipses is the section of the Achievement Chart from Science And Technology (2022) that corresponds. **Assessment AS learning** ● At the beginning of the Action phase of this lesson (Experience 2), circulate through the class to observe how students are answering the questions that you've posed about the different types of irrigation. Are they making strong arguments about why they've chosen a certain type of irrigation? (Thinking and Investigation) Your examples are providing new context to something they've researched. Are they able to transfer that knowledge to the new situation with reasonable support? (Application) ● As students are working through the stations, during the action section, observe how they are following procedures and recording the data in the data tables (Thinking and Investigation).

	Assessment OF learning • When students have finished the stations, how have they summarized their interpretation of the results of each investigation? (Thinking and Investigation)
Instructional Strategies and Adaptability	To encourage teamwork and student focus on a single task, you can assign roles for students during a lab. These roles can be switched at each station, giving each student a chance at each task. For example, in a group of 4: • Lead experimenter: fills and discharges the syringes • Distance marker: uses the chalk to mark and label the distance of each discharge • Measurer: Uses the tape measure to measure the distances • Data recorder: Marks the distances on the data sheet. For a visual reminder of who is responsible for which job, students can stick a dot sticker to the shoulder of their shirt. It's a quick and easy way to see who is performing which role. You can also observe and assess how they are performing it.
Additional Supporting Resources	• Drought and Agriculture - Predict, Plan and Prepare: Stop Drought Becoming Famine - YouTube • Home | Sustainable Development (un.org)
Cross-Curricular Opportunities	Cross-curricular opportunities include the following: **Mathematics** Measurement (compare, estimate and determine measurements in various contexts) **Language** Oral Communication • Listen in order to understand and respond appropriately in a variety of situations and a variety of purposes • Use speaking skills and strategies appropriately to communicate with different audiences for a variety of purposes

Future Opportunities / Next Steps	● Any students who complete the first four stations are encouraged to try multiple configurations for testing in Station 5. The more factors that are tested in different ways, the better the understanding students will have of the properties of fluids. ● Students can also consider other materials to test for Station 5.

Appendix A: Exploring Factors that Affect Fluids : Station Cards

Exploring Factors that Affect Fluids

Station Cards

Set up stations outside on a hard surface where the water is going to be seen when it lands, so it can be measured.

Be sure to review safety and that the syringes are not used to spray water at classmates.

Explore 1 (volume vs. distance)

Equipment :

- bucket of water
- 60ml syringe
- Tape measure
- Clipboard
- Pencil
- Explore 1 Data sheet
- Cube links or piece of wood to elevate the syringe to a consistent height from the ground (5-10 cm works well) – it will also keep the syringe level
- Sidewalk chalk to draw the start line and mark distances
- calculator

Procedure

1. Draw a starting line with the chalk
2. Place the block to support the syringe at the line
3. Using a 60 ml syringe, fill with water to the 20 ml mark
4. Line the nozzle up with the start line on the block
5. Depress the syringe quickly
6. Mark the furthest drop of water on the ground with the chalk and label T1 for Trial 1
7. Repeat for trials 2 and 3
8. Use the tape measure to find the distance of each trial and record on the data sheet

9. Repeat using increasing volumes (30ml, 40ml, 50ml, 60ml) for 3 trials each
10. Calculate the mean distance for each set of trials
11. Look at your data. How would you summarize the effect of initial volume on the distance of spray in a syringe?

Explore 2 (Barrel Diameter vs. Distance)

Equipment:

- bucket of water
- 60ml, 30ml, and 20ml syringe
- Tape measure
- Clipboard
- Pencil
- Explore 2 Data sheet
- Cube links or piece of wood to elevate the syringe to a consistent height from the ground (5-10 cm works well) – it will also keep the syringe level
- Sidewalk chalk to draw the start line and mark distances
- calculator

Procedure

1. Draw a starting line with the chalk
2. Place the block to support the syringe at the line
3. Using a 60 ml syringe, fill with water to the 20 ml mark
4. Line the nozzle up with the start line on the block
5. Depress the syringe quickly
6. Mark the furthest drop of water on the ground with the chalk and label T1 for Trial 1
7. Repeat for trials 2 and 3
8. Use the tape measure to find the distance of each trial and record on the data sheet
9. Repeat using the same volume of water for the 30ml and 20ml syringes for 3 trials each
10. Calculate the mean distance for each set of trials
11. Look at your data. How would you summarize the effect of the barrel diameter on the distance of spray in a syringe?

Explore 3 (pressure = speed of depression vs. distance)

Equipment:

- bucket of water
- 60ml syringe
- Tape measure
- Clipboard
- Pencil
- Explore 2 Data sheet
- Cube links or piece of wood to elevate the syringe to a consistent height from the ground (5-10 cm works well) – it will also keep the syringe level
- Sidewalk chalk to draw the start line and mark distances
- calculator

Procedure

1. Draw a starting line with the chalk
2. Place the block to support the syringe at the line
3. Using a 60 ml syringe, fill with water to the 60 ml mark
4. Line the nozzle up with the start line on the block
5. Depress the syringe quickly
6. Mark the furthest drop of water on the ground with the chalk and label T1 for Trial 1
7. Repeat for trials 2 and 3
8. Use the tape measure to find the distance of each trial and record on the data sheet
9. Repeat by pushing the plunger at a moderate and slow speed for 3 trials each
10. Calculate the mean distance for each set of trials
11. Look at your data. How would you summarize the effect of plunger speed on the distance of spray in a syringe? What would be the effect of speed on volume of water in a given area?

Explore 4 (number of holes vs. area of coverage)

Equipment:

- bucket of water
- 60ml syringe
- Tape measure
- Clipboard
- Pencil
- Explore 2 Data sheet
- Cube links or piece of wood to elevate the syringe to a consistent height from the ground (5-10 cm works well) – it will also keep the syringe level
- Sidewalk chalk to draw the start line and mark distances
- Calculator
- 20 cm Straw or flexible tubing
- Safety pin or screw to puncture the straw or tubing
- Waterproof tape (masking tape will work)

Procedure

1. Draw a starting line with the chalk
2. Place the block to support the syringe at the line
3. Using a 60 ml syringe, attach 20 cm of flexible tubing or a standard straw to the end of the nozzle using tape
4. Fill with water to the 60 ml mark
5. Line the nozzle up with the start line on the block
6. Depress the syringe quickly
7. Mark a rectangular area that includes the furthest drop of water lengthwise, and the width of drops on each side on the ground with the chalk and label T1 for Trial 1
8. Repeat for trials 2 and 3
9. Use the tape measure to find the length and width of each trial and record on the data sheet
10. Repeat after poking 5 sets of holes, 1 cm apart, all the way through the straw closest to the nozzle. (Add five more holes each time until reaching the end of the straw) for 3 trials each
11. Calculate the mean area for each set of trials

12. Look at your data. How would you summarize the effect of addition of holes the area of spray in a syringe for a) the distance of spray and b) the total area of spray

Explore 5 (Extension)

- Using the other Explore materials and procedures, design and perform an activity that changes a single variable that will allow you to better understand the factors that affect the flow of fluids
- Consider such factors as changing the tubing diameter, increasing the distance between holes in the tubing, etc.

Appendix B: Explore Data Tables

Explore Data Tables

Explore 1 (Volume vs. Distance)

Volume of water	Trial 1 (cm)	Trial 2 (cm)	Trial 3 (cm)	Mean distance (T1+T2+T3) /3
20 ml				
30 ml				
40 ml				
50 ml				
60 ml				

Analysis: Look at your data. How would you summarize the effect of initial volume on the distance of spray in a syringe?

Explore 2 (Barrel diameter vs. distance)

Syringe	Trial 1 (cm)	Trial 2 (cm)	Trial 3 (cm)	Mean distance (T1+T2+T3) /3
60 ml				
30 ml				
20 ml				

Analysis: Look at your data. How would you summarize the effect of barrel diameter on the distance of spray in a syringe?

Explore 3 (pressure = speed of depression vs. distance)

Speed of plunger depression	Trial 1 (cm)	Trial 2 (cm)	Trial 3 (cm)	Mean distance (T1+T2+T3) /3
Fast				
Moderate				
Slow				

Look at your data. How would you summarize the effect of plunger speed on the distance of spray in a syringe? What would be the effect of speed on volume of water in a given area?

Number of holes	Trial 1 (cm) Length	Trial 1 (cm) Width	Trial 1 Area (A=lxw)	Trial 2 (cm) Length	Trial 2 (cm) Width	Trial 2 Area (A=lxw)
0						
5						
10						
15						

Look at your data. How would you summarize the effect of addition of holes the area of spray in a syringe? The overall distance of the spray?

Explore 5 (Extension _______________ v.s ______________)

Independent variable:	Trial 1 (cm)	Trial 2 (cm)	Trial 3 (cm)	Mean (T1+T2+T3) /3

Look at your data. How would you summarize your results?