Meander *STEAM* Curriculum

Interim Report

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HIP Developments

Meander Grades 5 and 8 Curriculum has been developed by Philip Beesley Architect Inc.
and the Living Architecture Systems Group in association with the Institute where Creativity Empowers Education (ICEE) Success Foundation for HIP Developments

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Contents

Introduction

This preliminary report contains core curriculum documents related to the Meander sculpture at HIP Development's Tapestry Hall, Cambridge ON developed for Ontario Grades 5 and 8 students. The next stage of development includes pilot tests of this material with Grade 5 and 8 field trip visits as public health guidelines allow. Refinement of the material would be based on that next testing stage.

The Meander STEAM experience provides an Ontario curriculum standards-based educational experience where students engage, learn, and solve real-world problems using important critical, creative, and innovative thinking skills. This curriculum is designed to support today's students in their development of important workforce-related cognitive skills alongside mandated content learning. The material can be adjusted to meet curricular needs. The curriculum is intended for delivery both within the immersive environment of Meander and also within remote classroom locations. The interpretive display area that is positioned adjacent to the physical Meander sculpture within Tapestry Hall includes STEAM-oriented exhibition graphics and physical artifacts. The physical exhibit area includes animations and short film segments presented on digital displays. Those physical and digital media are intended to complement the curriculum. The video material would also be available online for remote classroom use.

The current material shows two sets of worksheets and curricular guides targeted at Grade 5 and Grade 8 students. The Grade 5 experience includes the following components for teachers preparing to deliver the curriculum: Summary, Overview, Pre-Visit Preparation, Science and Visual Arts Concepts, Post-Visit Extensions, Meander Experience Rubric, Supporting Documents for Provincial Achievement and Skills Comparison. It also includes the following sample worksheets for students to use: Installation Visit, "Flooding a Valley" worksheet, and Post-Visit Reflections and Invention Presentations. The Grade 8 experience includes the following components for teachers preparing to deliver the curriculum: Summary, Overview and Pre-Visit Preparation. It also includes the following sample worksheets for students to use: Pre-Visit Reflection, "Grand River Watershed" , "Testing Water Quality" worksheet, and "Watersheds" worksheet.

Appendices to the report include a 'frequently asked questions' section intended to orient potential educators, a geometry kit with open-source patterns for digital fabrication, and reference design documents for the exhibition display area including graphics, text and video storyboards.

Meander Grade 5 Curriculum

This Meander experience will promote student engagement and learning of standards-based content and vital higher-level thinking skills. It is based on how systems such as the Grand River and Meander constantly change and reorganize. It will solve the problem of how to minimize heavy flooding on the Grand River using an aesthetically pleasing sculpture. It will integrate science, visual art, and language with important thinking skills such as problem-solving, changing perspectives, synthesizing, and envisioning.

1. ***Overview***
    a. Big Idea
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    d. Expectations/Goals
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    g. Learning Environment

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    b. Problem for Students to Solve
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c. New Learning – Hands-on Activities
    i. External Forces Acting on Structures
    ii. Energy Transformations
d. Application – Making
e. Reflection
f. Supporting Documents
        i. Flooding a Valley

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a. Presenting, Reflecting, Defending, and Promoting the Invention
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        ii. Materials
        iii. Reflection
b. Extensions: Understanding Life Systems and Human Organ Systems while Emphasizing Research Skills
        i. Question 1
        ii. Question 2
        iii. Question 3
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5. ***Supporting Documents***

a. Rubric
b. Ontario Curriculum: Process Skills Comparison – Science/Visual Art
c. Process Skills Comparison: Scientific Inquiry, Engineering, Art Studio Habits of Mind, Neuroscience
d. Art images
e. Standards for Making – paraphrased from Overview
        i. Science Concepts
        ii. Visual Art Concepts
        iii. Thinking Skills

How to Adapt

This Grade 5 Meander experience will promote student engagement and learning of standards-based content and vital higher-level thinking skills. It is based on how systems such as the Grand River and Meander constantly change and reorganize. It will solve the problem of how to minimize heavy flooding on the Grand River using an aesthetically pleasing sculpture. It will integrate science, visual art, and language with important thinking skills such as problem-solving, changing perspectives, synthesizing, and envisioning

Designed for You

This curriculum is designed for you to adapt to your own curricular and campus needs. It is organized into sections that can be used in their entirety or abbreviated based on your time constraints. While three types of experience are listed below, you can choose further from within those the types of experiences you would like to focus on for your students. We are here to answer any questions and to design the Meander experience that best fits your needs.

Abbreviated Experience

— 1-hour Meander Visit

1. Problem – 5 minutes
2. Meander scavenger hunt – 15 minutes
3. Hands-on – 10 minutes
4. Making – 25 minutes
5. Wrap-up – 5 minutes

Moderate Experience

– Abbreviated 45-minute pre-visit with 1.25-hour Meander Visit

- Pre-visit
    1. Problem
    2. Investigation – Grand River flooding
- Meander Visit
    1. Problem – 5 minutes
    2. Meander scavenger hunt – 15 minutes
    3. Hands-on – 10 minutes
    4. Making – 25 minutes
    5. Reflection – 15 minutes
    6. Wrap-up – 5 minutes

Complete Experience

– Pre-visit, Meander Visit, Post-visit

- See Below

1. Overview
    a. Big Idea
    b. Essential Question
    c. Objectives
    d. Expectations/Goals
    e. Success Criteria
    f. Learning Context
    g. Learning Environment
2. Pre-visit – Preparation
    a. Materials
    b. Problem for Students to Solve
    c. Installation Experience Introduction
    d. New Learning
        i. Exhibit Scavenger Hunt
        ii. Investigation: Forms of Energy; Earth and Space
        iii. Investigation: Grand River and Flooding
    e. Reflection
3. Meander Installation Visit
    a. Introduction
        i. Materials
        ii. Welcome
        iii. Problem for Students to Solve
        iv. Overview – Guided Facilitation
    b. New Learning – Interpretive Area
        i. Materials
        ii. Interpretive Display Scavenger Hunt

    c. New Learning – Hands-on Activities
        i. External Forces Acting on Structures
        ii. Energy Transformations
    d. Application – Making
    e. Reflection
    f. Supporting Documents
        i. Flooding a Valley
4. Post-visit
    a. Presenting, Reflecting, Defending, and Promoting the Invention
        i. Standards
        ii. Materials
        iii. Reflection
    b. Extensions: Understanding Life Systems (Human Organ Systems) while Emphasizing Research Skills
        i. Question 1
        ii. Question 2
        iii. Question 3
        iv. Question 4
5. Supporting Documents
    a. Standards
        i. Science Concepts
        ii. Visual Art Concepts
        iii. Thinking Skills
    b. Rubric
    c. Ontario Curriculum: Process Skills Comparison – Science/Visual Art
    d. Process Skills Comparison: Scientific Inquiry, Engineering, Art Studio Habits of Mind, Neuroscience

Overview

Big Idea

The Meander installation is like a dissipative form that is constantly changing. Like a river, it continuously responds to its environment and changes as a result. Visually and conceptually, it can be compared to a local river, the Grand River. The Grand River has an impact on the humans in its path. This includes human health and well-being, due to the river's pollution and its tendency to flood. Interventions to address these problems, especially flooding, can be developed using concepts such as external forces acting on a structure, states of matter, forms of energy, and energy transformations.

Essential Question

Systems such as Meander and the Grand River constantly change and reorganize, based on what is happening. How can exploring Meander promote an understanding of how a disastrous Grand River change, such as flooding, can be prevented before it causes significant harm to humans?

Objectives

Use a complete Meander experience to promote student engagement and learning of standards-based content and vital higher-level thinking skills, in addition to an understanding of the importance of Meander in creating this understanding.

Expectations & Goals

Curriculum Expectations, Learning Goals, and Standards

In the Meander experience, the student will explore and use the following science concepts. Titles and numerical references refer to corresponding items within the Ontario Curriculum at the link: http://www.edu.gov.on.ca/eng/Curriculum/elementary/index.html

Understanding Life Systems and Human Organ Systems:

- 1.1 analyse the effects of social and environmental factors on human health, and propose ways in which individuals can reduce the harmful effects of these factors and take advantages of those that are helpful.

Understanding Structures and Mechanisms (Forces Acting on Structures and Mechanisms):

- 1.1 analyse effects of natural phenomena forces on natural and built environment;
- 1.2 evaluate impact of society and environment on structures and mechanisms, taking different perspectives into account and suggest ways in which structures and mechanisms can be modified to best achieve social and environmental objectives;
- 3.2 identify external forces acting on a structure and describe their effects on the structure, using diagrams;
- 3.3 explain the advantages and disadvantages of different types of mechanical systems;
- 3.4 describe forces resulting from natural phenomena that have severe consequences for structures in the environment and identify structural features that help overcome some of these forces.

Understanding Matter and Energy (Properties of and Changes in Matter):

- 3.2 identify properties of solids, liquids, and gases and state examples of each;
- 3.3 explain changes of states in matter and give examples of each.

Understanding Earth and Space Systems (Conservation of Energy and Resources):

- 3.1 identify a variety of forms of energy and give examples from everyday life of how that energy is used;
- 3.3 describe how energy is stored and transformed in a given device or system;
- 3.4 recognize that energy cannot be created or destroyed but can only be changed from one form to another.

- Student will integrate the following visual arts concepts:

Creating and Presenting:

- D1.1 create two- and three-dimensional art works that express feelings and ideas inspired by their own and other's points of view;
- D1.2 demonstrate an understanding of composition, using selected principles of design – contrast, repetition and rhythm, variety, emphasis, proportion, balance, unity and harmony, and movement – to create narrative artworks or art works on a theme or topic; D1.3 use elements of design – line, shape and form, space, colour, texture, and value – in art works to communicate ideas, messages, and understandings; D1.4 use a variety of materials, tools, and techniques to determine solutions to design challenges.

Reflecting, Responding, and Analysing:

- D2.2 explain how the elements and principles of design are used in their own and others' art work to communicate meaning and understanding;
- D2.4 identify and explain their strengths, their interests, and areas for improvement as creators, interpreters, and viewers of art.

- Students will integrate the following language concepts:

Writing:

- 1.1 identify the topic, purpose, and audience for a variety of writing forms;
- 1.2 generate ideas about a potential topic;
- 1.3 gather information to support ideas for writing, using a variety of strategies);
- 1.4 sort and classify ideas and information for writing in a variety of ways;
- 1.5 identify and order main ideas and supporting details;
- 1.6 determine whether the ideas and information are relevant, appropriate, and adequate for the purpose; 2.1 write longer and more complex texts using a variety of forms;
- 2.2 establish an appropriate voice in their writing, with a focus on modifying the language and tone to suit different circumstances or audiences;
- 2.3 use some vivid and/or figurative language and innovative expressions to add interest;
- 2.5 identify their point of view and other possible points of view, and determine, when appropriate,

if their own view is balanced and supported by evidence

Oral Communication:

- 2.1 identify a variety of purposes for speaking;
- 2.2 demonstrate an understanding of appropriate speaking behaviour in a variety of situations;
- 2.3 communicate orally in a clear, coherent manner; 2.7 use a variety of appropriate visual aids to support or enhance oral presentations.

- Students will use the following Science, Technology, and Arts Skills:

  Knowledge and Understanding:

  - Knowledge of content; understanding of content;

  Thinking:

  - Use of planning skills, use of processing skills, use of critical/creative thinking processes; Communication:
  - Expression and organization of ideas, communications for different audiences, use of conventions, vocabulary, and terminology in oral, visual, and written forms;

  Application:

  - application of knowledge and skills, transfer of knowledge and skills to new contexts, making connections with and between various contexts, (science) proposing courses of practical action to deal with problems relating to science, technology, society, and the environment.

- Students will use the following discipline-based process skills to develop a variety of understandings of the content:

  Science Inquiry/Experimentation:

  - Initiating and Planning: Asking questions, clarifying problems, planning procedures;

  Performing and Recording:

  - Following procedures, accessing information, recording observations and findings;

  Analysing and Interpreting:

  - Organizing data, reflecting on the effectiveness of the actions performed, drawing conclusions;

  Communicating:

  - Using appropriate vocabulary; communicating findings in a variety of ways

  Art Creative Process:

  - Challenging and inspiring, imagining and generating,

planning and focusing, exploring and experimenting (critical phase), producing preliminary work, revising and refining, presenting, performing, and sharing, reflecting and evaluating
    - Also: Art Habits of Mind (Hetland/Winner): Observing; stretching and exploring; engaging and persisting; envisioning; understanding the (art) world; developing craft; expressing; reflecting.

- Students also will use many of the following problem-solving and higher-level thinking skills:
    - Observing and asking questions, defining and clarifying a problem, acquiring and evaluating necessary information, generating ideas, changing perspectives, abstracting, transforming, synthesizing, comparing and contrasting, visually analyzing, evaluating ideas or statements, collaborating, creating, communicating, and responding.
- In their complete Meander experience, students will combine these concepts and thinking skills to solve a real-world problem based on the Grand River and Meander concepts.

Success Criteria

- Knowledge and understanding
    - Students will demonstrate knowledge and a working understanding of the content through the application of the concepts to their problem solution.

- Thinking and investigation
    - Students will use cross-disciplinary planning strategies, processing skills, in addition to creative and critical thinking skills.

- Application
    - Students will apply the science and art conceptual knowledge they have gained and/or reinforced during the Meander experience to solve a real-world Grand River challenge. In the process, they will transfer knowledge and skills to use in new contexts, will make connections between science, society, and the environment, and will propose a course of action to deal with environmental problems.

- Communication

- Students will convey their use and understanding of the science and art concepts and skills through their written defense/promotion of their solution that they will present to their class.

Learning Context

- ***Prior Knowledge/Preparedness***

- ***Skills:*** Students will bring the science, art, writing, and oral communication skills they have acquired in pre-visit activities to the Meander experience to facilitate success in their problem-solving.

- ***Vocabulary:*** Prior to viewing the installation, teachers will review the following vocabulary/concepts with students:
    - Science: Life Systems: Social and environmental factors affect human health; body systems; diseases and the organs they affect; Structures and Mechanisms: Natural phenomena; natural and built environments; impact of society and environment on structures; external forces acting on a structure; types of mechanical systems; Matter and Energy: Properties of solids, liquids, and gases; changes in states of matter; Earth and Space Systems: Forms of energy and everyday examples; energy transformation.
    - Art: Creating and Presenting: Composition; Principles of design; elements of design; variety of materials; Reflecting, Responding, and Analysing: Explaining how elements and principles are used in their own and others' art works; strengths and areas for improvement.

Learning Environment

- The learning environment at Meander will consist of viewing spaces and additional space for stand-up hands-on activities. In a separate classroom, there will be an inviting space where students can innovatively solve their real-world problem.

Pre-Visit Preparation

Standards Embedded in lesson

Materials

- □ Websites
- □ Information on the Meander installation
- □ Meander Saragasso kits
- □ Pencils
- □ Paper

Problem for students to solve using all Meander experiences

Flooding in the Grand River region is occurring due to heavy rainfall upstream or larger than normal snowmelt upstream. You have been tasked with developing a way to minimize the flooding that occurs during these periods of high water volumes. Your invention will be a device that, outside of flood season, would be an aesthetically pleasing sculpture, but during the flood season, would provide a way to minimize the flooding. You are inspired by sculptures that you are shown, by your experiences with the Meander installation, and by your hands-on investigations. As you develop this, think like an engineer, a scientist, and also like an artist. You will defend your invention from artistic, scientific, and engineering perspectives.

Installation Experience Introduction – 5 min.

Share with students:

- Information about Meander
- Behavior expectations at Meander
- No touching, be respectful of others, inside voices, have fun
- An overview of what students will be doing at Meander
    - They will be divided into rotating groups. One group will explore the installation. Another group will conduct hands-on activities. They will all problem-solve and Make as a group.
    - What cross-curricular experiences are like – These are meant to take away the boundaries between disciplines such as science and art so that the students don't know if they are doing science or art, but that they are just having a good time and processing the problem more effectively. These experiences are

what it's like in the real world, where disciplines aren't divided and a person has to bring in information from a variety of disciplines. Students will integrate what they have learned in Meander with art and engineering design thinking to solve a real-world environmental problem on the Grand River.
    - How these will involve problem solving – Students will be given a problem at the outset. All experiences will provide information and skills to help them solve their problem.
    - How these experiences will apply to their real lives outside the classroom – These problems will be based on scenarios they are familiar with. Research shows that the maximum effectiveness can be achieved in approach to problem solving.

New Learning

Exhibit Scavenger Hunt – 10 min

- Show students videos and images of Meander.
- Ask students where in the installation they notice the following, then ask them to draw a diagram of each of these concepts in action:
    - External forces acting on the structure - What is happening? Structures 3.2
    - Different types of mechanical systems - What are they doing? Structures 3.3
    - Energy transformations taking place - Pick one place and draw a diagram of the transformations that are occurring in that place. Earth 3.3

Use visual thinking.

Investigation:
Forms of Energy. Earth and Space 3.1 – 10 minutes

Materials

- □ AA battery
- □ Battery holder
- □ Switch
- □ 3 alligator clips
- □ Motor
- □ Buzzer
- □ LEDs
- □ Button batteries
- □ Metal washer
- □ Craft stick
- □ Penny
- □ Paper clip
- □ Plastic object

To Do:

- Students create their own circuit, using the battery holder, battery, alligator clips and motor. This creates mechanical or kinetic energy with the electrical energy.
- They will then use the circuit to create other forms of energy, such as sound and thermal energy.
- They can try the insulators and conductors to see which physical properties best conduct the electricity.
- They can then connect the LED and the button battery to create light energy.
- They then decide where they saw these transformations in the installation and how it affected the installation.

What's Happening:

- Circuit: The flow of electricity requires an uninterrupted path through which the electric charge can move. This current of electrical charges gives energy to the motor that makes its tip spin and to the buzzer that causes its sound-producing parts to vibrate and cause sound. Thermal energy is created when the motor is left on for a while.
- Insulators and Conductors: Some materials, such as metals, are formed by atoms with a loose hold on their electrons. Since these electrons aren't tightly bound to the atoms, they can be passed easily among neighboring atoms. This "passing" of the atoms forms a charge known as the electric current. Materials that allow this "passing" to happen are called conductors. Materials such as glass and plastic are formed by atoms that have a tight hold on their electrons and don't let the atoms pass from neighbor to neighbor. This resistance is from a material known as an insulator.

Investigation. Grand River and Flooding – 15 minutes

Share with students the websites below about the Grand River and flooding. Allow them to choose 2 and explore.

- Grand River Conservation Authority – their actions when record rainfall caused flooding in the region: https://www.grandriver.ca/en/our-watershed/Record-Rainfall-Flood-June-2017.aspx

- News reports on the 2017 floods: https://www.cbc.ca/news/canada/kitchener-waterloo/grand-valley-grca-grand-river-conservation-authority-kitchener-storm-1.4174860
- 2017 flooding in Cambridge: https://www.youtube.com/watch?v=Q7boMyB_65g
- Massive ice jam causes 2018 flooding in Grand River: https://www.youtube.com/watch?v=kPIlZLWlwao
- About the Grand River: https://www.therecord.com/news-story/8845585-the-watershed-ever-changing-grand-river/
- See Grand River watershed. Map (attached).
- Examples of flood prevention or mitigation products: Flood prevention products: https://www.design1st.com/5-innovative-flood-prevention-products-replace-sandbags/
- Ask student why they should care about flooding on the Grand River.
- Students will use this information as they address their problem in the Meander installation experience.

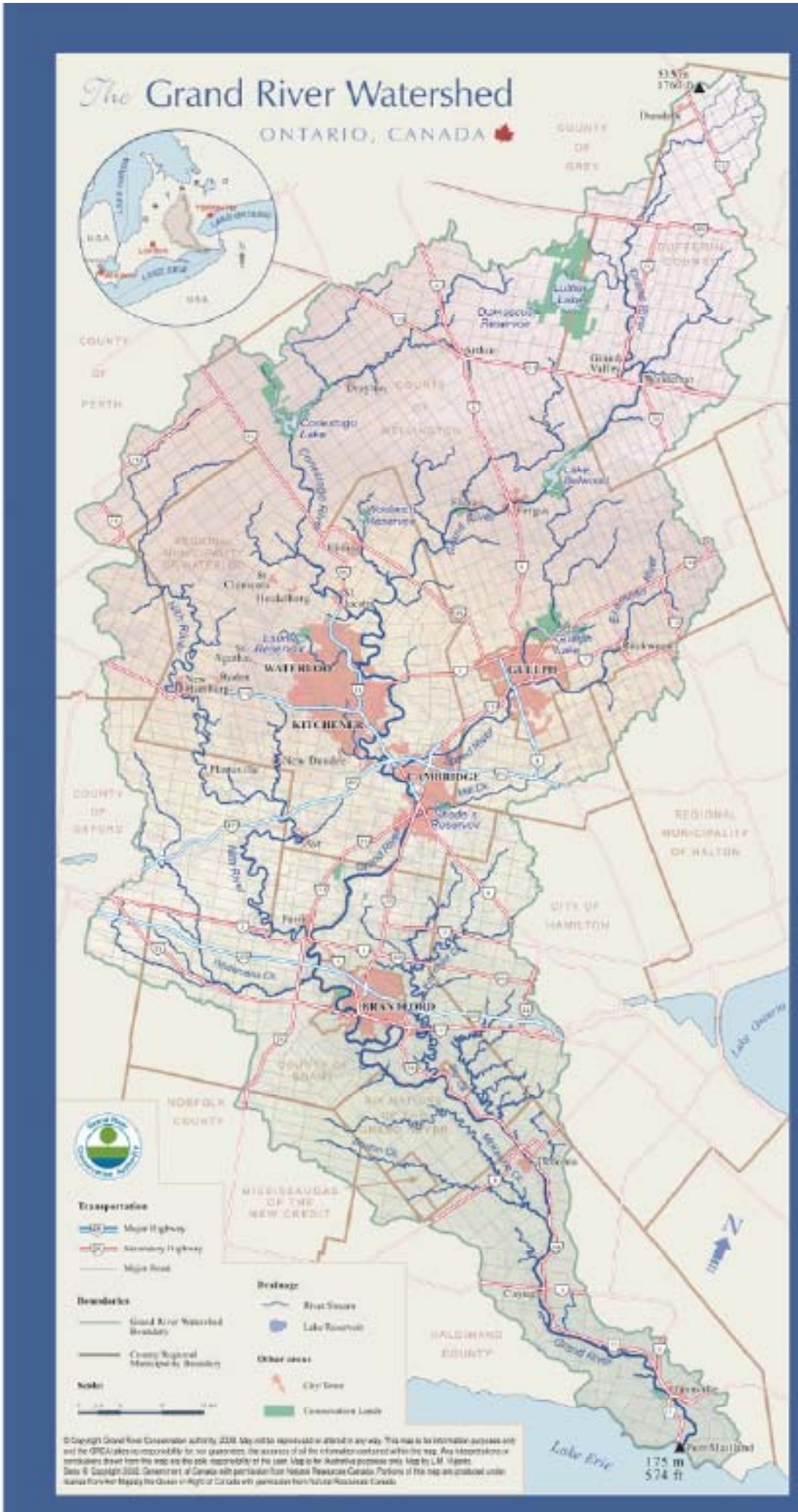
Geometry Kits

Invite students to use the Geometry kits to develop: 1) an interesting design; or 2) a mechanical system.

Reflection – 15 min.

Invite the students to write a brief reflection on what they have learned including:

- The main idea they have so far concerning the Meander installation, based on their observations.
- How one of the following is used in the Meander installation: Forces acting on a part of the structure; mechanical systems; energy transformations
- The impact of flooding on the Grand River and why they should care.
- Interesting ideas they got by creating their designs in the Sargasso kits.


The Grand River Watershed
ONTARIO, CANADA
WATERLOO
KITCHENER
GUELPH
CAMBRIDGE
BRANTFORD
Lake Erie
Lake Ontario
Transportation
Major Highway
Secondary Highway
Major Road
Boundaries
Grand River Watershed Boundary
County/Regional Municipality Boundary
Drainage
River/Stream
Lake/Reservoir
Other areas
City/Town
Conservation Lands
Scale
N
175 m
574 ft

Installation Visit

– 2 hours

Materials

- ☐ Paper handouts
- ☐ Pencils
- ☐ Clipboards

Standards – Embedded in lesson

Introduction –15 min.

Welcome and behavior expectations

Problem for students to solve, using all Meander experiences

- Flooding in the Grand River region is occurring due to heavy rainfall upstream or larger than normal snow melt upstream. You have been tasked with developing a way to minimize the flooding that occurs during these periods of high water volumes. Your invention will be a device that, outside of flood season, would be an aesthetically pleasing sculpture, but during the flood season, would provide a way to minimize the flooding. You are inspired by sculptures that you are shown, by your experiences with the Meander installation, and by your hands-on investigations. As you develop this, think like an engineer, a scientist, and also like an artist. You will defend your invention from artistic, scientific, and engineering perspectives.

Overview – Guided facilitation
Explore the installation using visual thinking and points of view

- Use Visual Thinking
- Look at Meander from an artistic point of view (color, line, shape, texture, form, space). Art D1.3
- Look at Meander from an engineering point of view (structure, external forces acting on the structure, types of mechanical systems, forms of energy, energy transformation). Structures. 3.2, 3.3; Earth and Space. 3.2, 3.3
- Look at Meander from an architectural point of view (living architecture – dynamic, adaptive, and responding to forces acting on it, for example, when 1 part "dies",

other parts are created)
- Decide how these 3 concepts overlap in the exhibit (The artistic elements contribute to the aesthetics but some elements, such as shape, texture, form, and space, also are the same as physical properties of matter used in the exhibit. The combination of the artistic elements/ physical properties and engineering concepts combine to create the installation's dynamism.)
- Discuss what you think the installation's Content (emotional or intellectual message to a person) is. How does it make you feel? If you were inside of it, how would you feel?
    - Discuss what Meander makes you think of, what it reminds you of in the natural world
    - There is no right or wrong answer

Materials

- □ Paper handouts
- □ Pencils
- □ Clipboards
- □ Computer tablets

New learning – interpretive area – 15 min.

Interpretive Display Scavenger Hunt

- Question #1: How do floods impact the communities along the Grand River?
- Question #2: Why should I care about the Grand River?
    - Ethics: Choices between right and wrong. How would you like to be treated? What are the consequences of your inaction? Is yours the only way or is it important to respect the diversity of opinions? Can you empathize with those who are more negatively impacted?

Materials

- □ Handouts
- □ Pencils
- □ Clipboards
- □ Water tank
- □ Pickle barrel or bucket to hold water
- □ Water
- □ Beakers to measure water
- □ Water receptacles in which water will flow
- □ Inclines for water tank
- □ Craft sticks
- □ Lego people
- □ Protractor to measure angle

New learning if these are new concepts – Hands-on activities – 40 min.

External Forces Acting on Structures. Structures 1.1, 1.2, 3.3, 3.4

To Do:

- Divide students into groups of 3.
- Have students make structures (or have them pre-made) out of craft sticks that would go in the water tank. OR Use a gate across the width of the tank (Question: Like

the idea of the gate, but should we include house as an option?)
- Create a hill and a valley in the water tank.
- Place the structure or gate in the valley in the water tank without water in it. Put Lego people outside the structure.
- Variable: Angle of flow
    - Hold the bucket at an angle of 10%.
    - Pour the water from the bucket into the tank so that it flows down the incline towards the house or gate.
    - Observe and record what happens to the house or gate.
    - Hold the bucket at an angle of 50%.
    - Pour the water from the bucket into the tank so that it flows down the incline towards the house or gate.
    - Observe and record what happens to the house or gate.
- Variable: Trusses
    - Add trusses to the house or gate.
    - Repeat the water flow at 10% angle.
    - Observe and record what happens to the house or gate.
    - Hold the bucket at an angle of 50%.
    - Pour the water from the bucket into the tank so that it flows down the incline towards the house or gate.
    - Observe and record what happens to the house or gate.
- Variable: Changes to the house or gate.
    - Invite students to think of what interventions they could provide to protect the house – put it on stilts, add a water gate, change the angle of the house to the water, etc. OR to protect the gate – change the angle to the water, add a water gate, change the materials, etc.
    - Pour the water from the bucket into the tank from the bucket at 50% angle so that it flows down the incline towards the house or gates.
    - Observe and record what happens to the house or gate.
- What's Happening
    - Angle of Flow: The greater force of water (from the greater angle of delivery) is more likely to knock down the house or gate.
    - Trusses: The force of the water knocks over the less stable house or gate, where the trussed house or

Materials

- □ Energy transformation cards
- □ Yarn
- □ Scissors

gate is more able to withstand the water longer.
    - Changes to house or gate: However, the most effective is the house with the water gate or the water gate, itself, which allows the force of the water to be dissipated through the water gate.

Energy Transformation Earth and Space 3.3, 3.4

To Do

- Students draw 5 cards and, working together, see if they can make an energy transformation sequence that can follow any of the energy transformations below.
- They next draw 5 cards, and, working together, see if they can make the energy transformation sequence without looking at the energy transformations list.
- They then decide where they saw these transformations in the installation and how it affected the installation.
- Transformations are:

Coal

↓

Thermal energy

↓

Mechanical energy (turbine)

↓

Electrical energy

↓

Light, mechanical, sound energy

___

Nuclear energy

↓

Thermal energy

↓

Electrical energy

↓

Light, mechanical, sound energy

___

Hydropower

↓

Mechanical energy (turbine)

↓

Electrical energy

↓

Light, mechanical, sound energy

Solar power

↓

Electrical energy

↓

Light, mechanical, sound energy

Wind energy

↓

Mechanical energy (turbine)

↓

Electrical energy

↓

Light, mechanical, sound energy

Biomass

↓

Steam (burning biomass)

↓

Mechanical energy (turbine)

↓

Electrical energy

↓

Light, mechanical, sound energy

Examples

1. An example of energy transformation is a flashlight. When it is turned on, chemical energy in the battery is transformed into electrical energy that travels to the light bulb and is then transformed into light energy.
2. Another example is NASA's Mars Curiosity Rover. The heat energy provided by the natural decay of its plutonium-238 nuclear generator generates electricity. This electricity powers the rover's systems and instruments. One instrument is the robotic arm, which transforms the electrical energy into kinetic energy as it moves and drills Mars' surface for samples of rocks and soil.

What's Happening

1. Energy can be neither created nor destroyed, but it can be transformed from one form of energy to another. Almost all useful processes transform one form of energy to another. This is different from energy transfer, where energy is transferred from one location to another without being transformed into another form of energy, such as heat energy transferring from a steaming pot onto your hand.

Materials

- □ Found objects
- □ Construction paper
- □ Pipe cleaners
- □ Brads
- □ Straws
- □ Cardboard
- □ Craft sticks
- □ Skewers
- □ Cloth
- □ Foil
- □ Plastic wrap
- □ Fishing line
- □ Florist wire
- □ Glue
- □ Scissors
- □ Hot glue guns
- □ Hot glue

Application – Making – 45 min.

Problem

Flooding in the Grand River region is occurring due to heavy rainfall upstream or larger than normal snow melt upstream. You have been tasked with developing a way to minimize the flooding that occurs during these periods of high water volumes. Your invention will be a device that, outside of flood season, would be an aesthetically pleasing sculpture, but during the flood season, would provide a way to minimize the flooding. You are inspired by sculptures that you are shown, by your experiences with the Meander installation, and by your hands-on investigations. As you develop this, think like an engineer, a scientist, and also like an artist. You will defend your invention from artistic, scientific, and engineering perspectives.

Standards – see Standards list in Overview

To Do

- ***Process***
  1. What is the problem you are solving – your Big Idea?
  2. Choose the science facts you have discovered about the Grand River's flooding that would influence your design
  3. List the science concepts you will use.
  4. List the art concepts you will use.
  5. Use other information you have learned as a part of the entire Meander experience.
  6. Generate ideas to solve the problem.
     - In doing this, take on a variety of perspectives (ecologist, engineer, artist, architect)
     - Synthesize your ideas and perspectives.
     - Consider how can you transform one idea or object into another to solve your problem (think of biomimicry, the use of animal and insect parts as part of your invention).
     - Visually represent your ideas and use visual thinking to help solve your problem.
     - Decide how you are going to use the materials available.
     - Draw and label your design with science and art concepts.
  7. Evaluate the possible solutions to choose your solution.
     - Compare and contrast solutions used in the past to your solution.
  8. Create your solution.
  9. Collaborate well as a team.
  10. Communicate and respond why your solution should be funded.

Reflection – 15 min.

- What was the big idea about Meander you take away from this experience?
- How did your Meander experience help you learn to solve real-world problems?

Meander Installation Visit

Flooding a Valley

Variables	Results	Evidence	Comments
Angle 10%			
Angle 50%			
Trusses and Angle 10%			
Trusses and Angle 50%			

Science Concepts

Life Systems

1.1 Assess the effects of social and environmental factors on human health, and propose says in which individuals can reduce the harmful effects of these factors and take advantage of those that are beneficial

Structures and Mechanisms

1.1 Analyse effects of natural phenomena forces on natural and built environment

1.2 Evaluate impact of society and environment on structures and mechanisms, taking different perspectives into account and suggest ways in which structures and mechanisms can be modified to best achieve social and environmental objectives

3.2 Identify external forces acting on a structure and describe their effects on the structure, using diagrams

3.3 Explain the advantages and disadvantages of different types of mechanical systems

3.4 Describe forces resulting from natural phenomena that have severe consequences for structures in the environment and identify structural features that help overcome some of these forces

Matter and Energy

3.2 Identify properties of solids, liquids, and gases and state examples of each

3.3 Explain changes of states in matter and give examples of each

Earth and Space Systems

3.1 Identify a variety of forms of energy and give examples from everyday life of how that energy is used

3.3 Describe how energy is stored and transformed in a given device or system

3.4 Recognize that energy cannot be created or destroyed but can only be changed from one form to another

Visual Arts Concepts

Creating and Presenting

D1.1 Create two- and three-dimensional art works that express feelings and ideas inspired by their own and other's points of view

D1.2 Demonstrate an understanding of composition, using selected principles of design – contrast, repetition and rhythm, variety, emphasis, proportion, balance, unity and harmony, and movement - to create narrative artworks or art works on a theme or topic

D1.3 Use elements of design – line, shape and form, space, colour, texture, and value - in art works to communicate ideas, messages, and understandings

D1.4 Use a variety of materials, tools, and techniques to determine solutions to design challenges,

Reflecting, Responding, and Analysing

D2.2 Explain how the elements and principles of design are used in their own and others' art work to communicate meaning and understanding

D2.4 Identify and explain their strengths, their interests, and areas for improvement as creators, interpreters, and viewers of art)

Thinking Skills

- Observing and asking questions
- Defining and clarifying a problem
- Acquiring and evaluating necessary information
- Generating idea
- Changing perspectives
- Abstracting

- Transforming
- Synthesizing
- Comparing and contrasting
- Visually analyzing
- Evaluating ideas or statements
- Collaborating
- Creating
- Communicating
- Responding

Post-Visit

Materials

- ☐ Meander handouts
- ☐ Pencils
- ☐ Paper
- ☐ Art materials as available to create visuals

Presenting, Reflecting, Defending, Promoting the Invention

Standards – see Standards list in Overview

Reflection – 1 hour

- Prepare a defense and/or promotion of your invention by writing to address the following:
  - My team's problem was _____.
  - How we used the following to solve our problem:
    - Our science and engineering concepts
    - Our art concepts
    - Science processes
    - Engineering processes
- Art processes
  - How our invention works
  - How our invention could be responsive to the changes in the environment like Meander is responsive to changes in its environment
  - How reducing the Grand River flood threat can positively impact humans in its path.
  - Persistence: How we failed and then overcame failure
  - How this invention can help my community
  - Why I should care about this problem
  - The 3 most important thinking skills I use and how I used them
- Each team then presents their invention to their class and other classmates discuss how science, engineering, art, and thinking skills helped to solve the problem.

Assessment

See Rubrics

Extensions – 1 hour

Understanding life systems and human organ systems while emphasizing research skills

1.1 Assess the effects of social and environmental factors on human health, and propose ways in which individuals can reduce the harmful effects of these factors and take advantage of those that are beneficial.

- Invite your students to sharpen their research skills and understanding of the relationship of science and technology to society and the environment by choosing at least 1 of the questions below and researching and then reporting on their solution.
    - Question 1: How has environmental action changed the impacts of the Grand River on human health? What other changes should be made? Life. 1.1
    - Question 2: How do these actions impact the human body and your own body? What other actions should be taken? Life. 3.3, 3.4
    - Question 3: Why should I care about the Grand River's impact on my health?
    - Ethics: Choices are made between right and wrong. How would you like to be treated? What are the consequences of your inaction? Is yours the only way or is it important to respect the diversity of opinions? Can you empathize with those who are more negatively impacted? Life 1.1
    - Question 4: Do the types of structures, such as water treatment plants, that are built in the Grand River flood path need to be limited? How would that impact human health? What steps would need to be taken to make this happen? Structures and Mechanisms 1.2

Rubric: Meander Experience

Great	***Solution:*** ● Solves the problem of in a new and creative way ● Uses at least 4 of the science concepts and 2 art concepts ● Shows how science concepts helped solve the problem ● Shows how the science, engineering, and art process skills helped solve the problem ***Applications:*** ● Shows how it could be used on locally ● Shows how the invention relates to what they learned about Meander and the Grand River ***Presentation - Talks About How:*** ● The science concepts were combined ● The team overcame failure ● The invention is not like anything done before ● The team used higher level thinking skills ● The invention could be combined with another team's invention
Good	***Solution:*** ● Solves the problem ● Uses at least 3 of the science concepts and 1 art concept ● Uses at least 2 science/engineering and 2 art processes ***Applications:*** ● Shows how the solution could be used locally ***Presentation - Talks About How:*** ● The science concepts were combined ● The team overcame failure
Poor	***Solution:*** ● Has a weak solution to the problem ● Uses 1 or fewer science concepts and no Elements of Art ***Applications:*** ● Doesn't show how the invention could help locally ***Presentation - Talks About How:*** ● Doesn't discuss the science, art concepts and processes used ● Doesn't discuss overcoming failure ● Doesn't solve the problem in a new way

Supporting Documents

– *Provincial Achievement*

	Science	***Visual Art***
See Rubrics		
Knowledge and Understanding	Knowledge of content	Knowledge of content
	Facts, terminology, safe use of equipment	Facts, genres, terms, definitions, techniques, elements, principles, forms, structures
	Understanding of content	Understanding of content
	Concepts, ideas, theories, principles, procedures, processes	Concepts, ideas, theories, principles, procedures, processes
Thinking	Use of initiating planing skills and strategies	Use of planning skills
	Formulating questions, identifying the problem, developing hypotheses, scheduling, selecting strategies and resources developing plans	Formulating questions, generating ideas, gathering info., focusing research, outlining, organizing an arts presentation or project, brainstorming, sketching,
	Use of processing skills and strategies	Use of processing skills
	Performing and recording, gathering evidence and data, observing, manipulating materials and using equipment safely, solving equations, proving	Analysing, evaluating, inferring, interpreting, editing, refining, forming conclusions, detecting bias, synthesizing
	Use of critical/creative thinking processes, skills and strategies	Use of critical/creative thinking processes
	Analysing, interpreting, problem solving, evaluating, forming and justifying conclusions on the basis of evidence	Creative and analytical processes, design process, exploration of elements, problem solving, reflection, metacognition, invention, critiquing, reviewing
Communication	Expressing and organization of ideas and information in oral, visual, and/or written forms	Expression and organization of ideas and understanding in art forms (visual arts) and in oral and written forms

	Clear expression, logical organization, diagrams, models	Expression of ideas and feelings using visuals, clear expression and logical organization in critical responses to art works
	Communication for different audiences and purposes in oral, visual, and/or written forms	Communication for different audiences and purposes throught the arts
	Peers, adults; to inform, to persuade	Peers, adults, younger children; clear expression and logical organization in critical responses to art works
	Use of conventions, vocabulary, and terminology of the discipline in oral, visual, and/or written forms	Use of conventions in visual arts and arts vocabulary and terminology in oral an written forms
	Symbols, formulae, scientific notation, SI units	Allegory, narrative or symbolic representation, style
Application	Application of knowledge and skills in familiar contexts	Application of knowledge and skills in familiar contexts
	Concepts and processes, safe use of equipment, investigation skills	Composition, elements, principles, processes, techniques, strategies, use of familiar forms
	Transfer of knowledge and skills to unfamiliar contexts	Transfer of knowledge and skills
	Concepts and processes, safe use of equipment, investigation skills	Concepts, strategies, propcesses, techniques, an original composition, an interdisciplinary or multidisciplinary project
	Proposing courses of practical action to deal with problems relating to science, technology, society, and the environment	Making connections within and between various contexts
		Between the arts; between the arts and personal experiences and the world outside the school; between cultural and historical, global, social, and/or environmental contexts; between the arts and other subjects

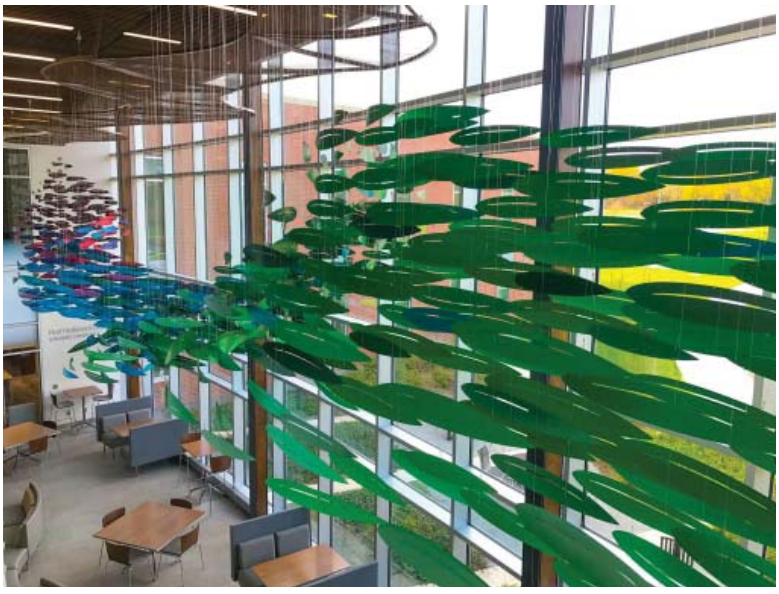
Supporting Documents

– *Skills Comparison*

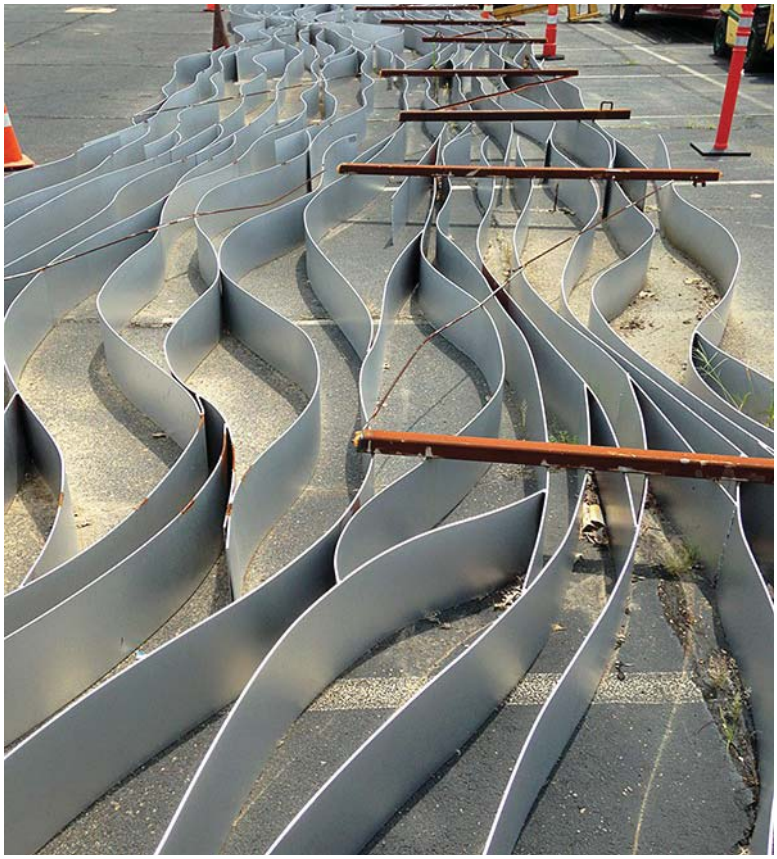
Process Skills	***Science - Inquiry***	***Engineering Design Process***	***Art Habits of Mind***	***SMART Thinking***
	(Dyasi et al)	(Teach Engineering)	(Hetland et al)	Chapman
	Observe	Identify need	Develop craft and skills	Strategic attention
	Question	Research the problem	Engage and persist	Integrated reasoning
	Hypothesize	Develop possible solutions	Envision	Innovation
	Conduct experiment	Select most promising solution	Express	
	Assess data	Construct prototype	Observe	
	Develop conclusion	Test and evaluate	Reflect	
	Ask new questions and hypothesizes based on observations	Communicate the design	Stretch and explore	
	Communicates observations, procedures, observations	Redesign	Understand the world	
			Take risks	
			Persevere	
			Exhibit confidence	

1. https://www.bostonglobe.com/lifestyle/travel/2017/11/09/peace-river-botanical-sculpture-gardens-opens-punta-forda-fla/W1sGBkkVzx5sWKih5DuNgN/story.html

2. http://joeneesonsculpture.ie/projects/the-river/



3. https://unknews.unk.edu/2017/03/08/river-at-dawn-sculpture-dedication-march-14-at-unk/



4. https://www.memphisflyer.com/memphis/river-sculpture-going-up-on-wolf-river-greenway/Content?oid=4555834

6. http://ilovememphisblog.com/event/wolf-river-greenway-sculpture-dedication/

7. https://www.bellemocat.com/public-art/river-peel/

8. https://www.dreamstime.com/fountain-sculpture-sail-volga-river-embankment-samara-russia-sunny-summer-day-fountain-sculpture-sail-image119913325

Meander Grade 8 Curriculum

This Meander experience will promote student engagement and learning of standards-based content and vital higher-level thinking skills. It is based on how systems such as the Grand River and Meander constantly change and reorganize. It will solve the problems of water quality and flooding on the Grand River using an aesthetically pleasing sculpture. It will integrate science, visual art, and language with important thinking skills such as problem-solving, changing perspectives, synthesizing, and envisioning

1. Overview
    a. Big Idea
    b. Essential Question
    c. Objectives
    d. Expectations/Goals
    e. Success Criteria
    f. Learning Context
    g. Learning Environment
2. Pre-visit – Preparation
    a. Materials
    b. Problem for Students to Solve
    c. Installation Experience Introduction
    d. New Learning
        i. Exhibit Scavenger Hunt
        ii. Investigation: Water Systems
        iii. Investigation: Grand River and Water Quality
        iv. Investigation: Grand river and Flooding
    e. Reflection
    f. Supporting Documents
        i. Watersheds
        ii. Grand River Watershed
        iii. Testing Water Qualtiy
        iv. What I Discovered
3. Meander Installation Visit
    a. Introduction
        i. Materials
        ii. Welcome

iii. Problem for Students to Solve
iv. Overview – Guided Facilitation

b. New Learning – Interpretive Area
    i. Materials
    ii. Interpretive Display Scavenger Hunt

c. New Learning – Hands-on Activities
    i. Mechanical Systems and Fluids
    ii. Water Quality

d. Application – Making
    i. Standards
    ii. Materials
    iii. To Do

e. Reflection

f. Supporting Documents
    i. Flooding a Valley
    ii. Testing Water Quality

4. Post-visit
    a. Presenting, Reflecting, Defending, and Promoting the Invention
        i. Standards
        ii. Materials
        iii. Reflection
    b. Extensions: Understanding Life Systems (Cells)
        i. Question 1
        ii. Question 2
        iii. Question 3
        iv. Question 4
        v. Question 5
        vi. Question 6
        vii. Question 7
5. Supporting Documents
    a. Rubric
    b. Ontario Curriculum: Process Skills Comparison – Science/ Visual Art
    c. Process Skills Comparison: Scientific Inquiry, Engineering, Art Studio Habits of Mind, Neuroscience
    d. Art Images
    e. Standards for Making – to be paraphrased from Overview
        i. Science Concepts
        ii. Visual Art Concepts
        iii. Thinking Skills

How to Adapt

Summary

This Grade 8 Meander experience will promote student engagement and learning of standards-based content and vital higher-level thinking skills. It is based on how systems such as the Grand River and Meander constantly change and reorganize. It will solve the problems of water quality and flooding on the Grand River using an aesthetically pleasing sculpture. It will integrate science, visual art, and language with important thinking skills such as problem-solving, changing perspectives, synthesizing, and envisioning

Designed for You

This curriculum is designed for you to adapt to your own curricular and campus needs. It is organized into sections that can be used in their entirety or abbreviated based on your time constraints. While 3 types of experience are listed below, you can choose further from within those the types of experiences you would like to focus on for your students.

Abbreviated Experience – 1-hour Meander Visit Only

1. The Problem – 5 minutes
2. Meander scavenger hunt – 15 minutes
3. Hands-on – 10 minutes
4. Making – 25 minutes
5. Wrap-up – 5 minutes

Moderate Experience – Abbreviated 45-minute pre-visit with 1.25-hour Meander Visit

- Pre-visit
    1. The Problem
    2. Investigation – Grand River flooding and water quality

- Meander Visit
    1. The Problem – 5 minutes
    2. Meander scavenger hunt – 15 minutes
    3. Hands-on – 10 minutes
    4. Making – 25 minutes
    5. Reflection – 15 minutes
    6. Wrap-up – 5 minutes

Complete Experience – Pre-visit, Meander Visit, Post-visit

- See Below

1. Overview
    a. The Big Idea
    b. Essential Question
    c. Objectives
    d. Expectations/Goals
    e. Success Criteria
    f. Learning Context
    g. Learning Environment
2. Pre-visit – Preparation
    a. Materials
    b. Problem for Students to Solve
    c. Installation Experience Introduction
    d. New Learning
        i. Exhibit Scavenger Hunt
        ii. Investigation: Water Systems
        iii. Investigation: Grand River and Water Quality
        iv. Investigation: Grand river and Flooding
    e. Reflection
    f. Supporting Documents
        i. Watersheds
        ii. Grand River Watershed
        iii. Testing Water Qualtiy
        iv. What I Discovered
3. *Meander* Installation Visit
    a. Introduction
        i. Materials
        ii. Welcome
        iii. Problem for Students to Solve
        iv. Overview – Guided Facilitation
    b. New Learning – Interpretive Area
        i. Materials

        ii. Interpretive Display Scavenger Hunt
    c. New Learning – Hands-on Activities
        i. Mechanical Systems and Fluids
        ii. Water Quality
    d. Application – Making
        i. Standards
        ii. Materials
        iii. To Do
    e. Reflection
    f. Supporting Documents
        i. Flooding a Valley
        ii. Testing Water Quality
4. Post-visit
    a. Presenting, Reflecting, Defending, and Promoting the Invention
        i. Standards
        ii. Materials
        iii. Reflection
    b. Extensions: Understanding Life Systems (Cells)
        i. Question #1
        ii. Question #2
        iii. Question #3
        iv. Question #4
        v. Question #5
        vi. Question #6
        vii. Question #7
5. Supporting Documents
    a. Standards for Making
        i. Science Concepts
        ii. Visual Art Concepts
        iii. Thinking Skills
    b. Rubric
    c. Watershed map
    d. Ontario Curriculum: Process Skills Comparison – Science/Visual Art
    e. Process Skills Comparison: Scientific Inquiry, Engineering, Art Studio Habits of Mind, Neuroscience
    f. Art Images

Overview

Big Idea

The Meander installation is like a dissipative form that is constantly changing. Like a river, it continuously responds to its environment and changes as a result. Visually and conceptually, it can be compared to a local river, the Grand River. The Grand River is part an environmental system that affects the people and societies in its watershed. It can impact the health of citizens in its watershed and also has a tendency to flood. So, it is important to assess its impact on populations in its watershed and to investigate ways in which the use of knowledge about cells, fluids, water, structures and mechanisms, and systems, themselves, can help minimize the negative impacts on populations in its path.

Essential Question

Systems such as Meander and the Grand River constantly change and reorganize, based on what is happening. How can exploring Meander promote an understanding of the negative impacts of the Grand River on populations in its watershed and also how these can be minimized?

Objectives

Use a complete Meander experience to promote student engagement and learning of standards-based content and vital higher-level thinking skills, in addition to an understanding of the importance of Meander in creating this understanding.

Expectations & Goals

Curriculum Expectations, Learning Goals, and Standards:

- In the Meander experience, the student will explore and use the following science concepts:
  Understanding Life Systems (Cells) (Used in Post-Extension):
  - 1.2 assess the potential that our understanding of cells and cell processes has for both beneficial and harmful effects on human health and the environ-

ment, taking different perspectives into account;
- 3.6 describe the organization of cells into tissues, organs, and systems

Understanding Structures and Mechanisms (Systems in Action):
- 1.2., assess the impact on individuals, society, and the environment of alternative ways of meeting needs that are currently met by existing systems, taking different points of view into consideration;
- 2.3 use scientific inquiry/experimentation skills to investigate mechanical advantage in a variety of mechanisms and simple machines;
- 2.4 use technological problem-solving skills to investigate a system that performs a function or meets a need;
- 3.1 identify various types of systems;
- 3.2 identify the purpose, inputs, and outputs of various systems;
- 3.3 identify the various processes and components of a system;
- 3.4 compare, using examples, the scientific definition with the everyday use of the terms work, force, energy, and efficiency;
- 3.6 calculate the mechanical advantage (MA = force needed without a simple machine divided by force needed with a simple machine) of various mechanical systems.

Understanding Matter and Energy (Fluids):
- 2.4 investigate applications of the principles of fluid mechanics (e. g. in….hydrodynamic engineering); 2.5 use scientific inquiry/experimentation to identify factors that affect the flow rates of various fluids (Sample problem: Devise an experiment to find out how the flow rate of a fluid is affected by changing… the angle or tilt at which it is poured…);
- 2.8 use a variety of forms (e.g. oral, written, graphic multimedia) to communicate with different audiences and for a variety of purposes

Understanding Earth and Space (Water Systems):
- 1.3 assess the impact on local and global water systems of a scientific discovery or technological innovation;
- 2.3 test water samples for a variety of chemical characteristics (e. g. pH, salinity, chlorine) (Sample problem: Test the pH, salinity, and chlorine content

of tap water, rain water, bottled water, filtered water, and water from a variety of other sources such as streams, rivers, ponds, or lakes. Record and compare the findings and draw conclusions from them.);
    - 2.4 use scientific inquiry/research skills to investigate local water issues;
    - 2.5 use technological problem-solving skills to design, build, and test a water system device that performs a practical function or meets a need (Sample problem: Design, build, and test a filtration device that makes unclean water clean…..);
    - 2.7 use a variety of forms (e. g. oral, written, graphic, multimedia) to communicate with different audiences for a variety of purposes;
    - 3.2 demonstrate an understanding of the watershed as a fundamental geographic unit and explain how it relates to water management and planning;
    - 3.3 explain how human and natural factors cause changes in the water table (e.g. floods).
- Student will integrate the following visual arts concepts:
  Creating and Presenting:
    - D1.1 create art works using a variety of traditional forms and current media technologies that express feelings, ideas, and issues and that demonstrate an awareness of multiple points of view;
    - D1.2 demonstrate an understanding of composition, using multiple and other layout considerations such as compositional triangles to create narrative artwork or artworks on a theme or topic;
    - D1.3 use elements of design in art works to communicate ideas, messages, and understandings for a specific audience and purpose;
    - D1.4 use a variety of materials, tools, and techniques to determine solutions to increasingly complex design challenges.

  Reflecting, Responding, and Analysing:
    - D2.2 analyse the ways in which elements and principles of design are used in a variety of art works to communicate a theme or message, and evaluate the effectiveness of their use on the basis of criteria generated by the class;
    - D2.4 identify and explain their strengths, their interests, and areas for improvement as creators, interpreters, and viewers of art.

- Students will integrate the following language concepts:
  Writing:
  - 1.1 identify the topic, purpose, and audience for more complex forms;
  - 1.2 generate ideas about more challenging topics and identify those most appropriate to the purpose;
    1.3 gather information to support ideas for writing, using a variety of strategies and a wide range of print and electronic sources;
  - 1.4 sort and classify ideas and information for their writing in a variety of ways that allow them to manipulate information and see different combinations and relationships in their data;
  - 1.5 identify and order main ideas and supporting details and group them into units that could be used to develop a summary, a debate, or a report of several paragraphs, using a variety of strategies;
  - 1.6 determine whether the ideas and information are relevant, appropriate, and sufficiently specific for the purpose, and do more planning and research if necessary;
  - 2.1 write complex texts of a variety of lengths using a wide range of forms;
  - 2.2 establish a distinctive voice in their writing appropriate to the subject and audience;
  - 2.3 regularly use vivid and/or figurative language and innovative expressions in their writing.
  - 2.5 identify their point of view and other possible points of view, evaluate other points of view, and find ways to respond to other points of view, if possible.
  - Oral Communication:
  - 2.1 identify a variety of purposes for speaking in a variety of situations, both straightforward and more complex, and explain how the purpose and intended audience might influence the choice of speaking strategies;
  - 2.2 demonstrate an understanding of appropriate speaking behaviour in most situations, using a variety of speaking strategies and adapting them to suit the purpose and audience;
  - 2.3 communicate in a clear, coherent manner, using a structure and style appropriate to the purpose, the subject matter, and the intended audience;
  - 2.7 use a variety of appropriate visual aids to support or enhance oral presentations.

Media Literacy:
  - 1.2 interpret increasingly complex or difficult media texts, using overt and implied messages as evidence for their interpretations;
  - 1.5 demonstrate understanding that different media texts reflect different points of view and that some texts represent multiple points of view;
- Students will use the following Science, Technology, and Art skills:
  Knowledge and Understanding:
  - Knowledge of content; understanding of content; Thinking: Use of planning skills, use of processing skills, use of critical/creative thinking processes; Communication: Expression and organization of ideas, communications for different audiences, use of conventions, vocabulary, and terminology in oral, visual, and written forms;

  Application:
  - Application of knowledge and skills, transfer of knowledge and skills to new contexts, making connections with and between various contexts, (science) proposing courses of practical action to deal with problems relating to science, technology, society, and the environment.
- Scientific and artistic skills
  Science Inquiry/Experimentation:
  - Initiating and Planning: Asking questions, clarifying problems, planning procedures; Performing and Recording:
  - Following procedures, accessing information, recording observations and findings;
  - Analysing and Interpreting:
  - Organizing data, reflecting on the effectiveness of the actions performed, drawing conclusions;

  Communicating:
  - Using appropriate vocabulary; communicating findings in a variety of ways

  Art Creative Process:
  - Challenging and inspiring, imagining and generating, planning and focusing, exploring and experimenting (critical phase), producing preliminary work, revising and refining, presenting, performing, and sharing, reflecting and evaluating

Also: Art Habits of Mind (Hetland/Winner):
    - Observing; stretching and exploring; engaging and persisting; envisioning; understanding the (art) world; developing craft; expressing; reflecting.
- Students also will use many of the following problem-solving and higher-level thinking skills:
    - Observing and asking questions, defining and clarifying a problem, acquiring and evaluating necessary information, generating ideas, changing perspectives, abstracting, transforming, synthesizing, comparing and contrasting, visually analyzing, evaluating ideas or statements, collaborating, creating, communicating, and responding.
- In their complete Meander experience, students will combine these concepts and thinking skills to solve a real-world problem based on Grand River and Meander concepts.

Success Criteria

- Knowledge and understanding
    - Students will demonstrate knowledge and a working understanding of the content through the application of the concepts to their problem solution.
- Thinking and investigation
    - Students will use cross-disciplinary planning strategies, processing skills, in addition to creative and critical thinking skills.
- Application
    - Students will apply the science and art conceptual knowledge they have gained and/or reinforced during the Meander experience to solve a real-world Grand River challenge. In the process, they will transfer knowledge and skills to use in new contexts, will make connections between science, society, and the environment, and will propose a course of action to deal with environmental and health problems.
- Communication
    - Students will convey their use and understanding of the science and art concepts and skills through their written defense/promotion of their solution that they will present to their class.

Learning Context

Prior Knowledge/Preparedness

- Skills: Students will bring the science, art, writing, and oral communication skills they have acquired in pre-visit activities to the Meander experience to facilitate success in their problem-solving.
- Vocabulary: Prior to viewing the installation, teachers will review the following vocabulary/concepts with students:
    - Science: Cells: Understanding of cells' and cell processes' effects on human health; organization of cells into tissues, organs, and organ systems; Systems in Action: Types of systems, various systems' purposes, inputs, and outputs, a system's processes and components; Fluids: hydrodynamic engineering, flow rate affected by angle by which it is poured; Water Systems: Testing water samples of pH, salinity, chlorine, watershed as a fundamental geographic unit, human factors affect the water table
    - Art: Creating and Presenting: Composition; Principles of design; elements of design; variety of materials; Reflecting, Responding, and Analysing: Explaining how elements and principles are used in their own and others' art works; strengths and areas for improvement.

Learning Environment

- The learning environment at Meander will consist of viewing spaces and additional space for stand-up hands-on activities. In a separate classroom, there will be an inviting space where students can innovatively solve their real-world problem.

Pre-Visit Preparation

Materials

- ☐ Websites
- ☐ Information on the *Meander* Installation
- ☐ Meander Geometry kits
- ☐ Pencils
- ☐ Paper

Standards embedded in lesson

The readings about watersheds, the Grand River watershed, and testing water quality are from *Teachers Pay Teachers: Water Systems.* Some activities are also adapted from this source.

Problem students will solve

- While much of the local water used by humans comes from groundwater in wells, with some water coming from the Grand River, there are communities in the region that get all of their water from the Grand River. So, water quality in the river is very important. This water quality can be affected the river's flooding, which can occur when there is heavy rainfall upstream or larger than normal snow melt upstream.
- You have been tasked with developing a device to erect in the Grand River that would:
  - Tests for turbidity, acidity, chlorine, and salinity and then notifies water authorities if levels become unhealthy.
  - Minimizes flooding that occurs at periods of high water volumes.
- Your invention will be a device that, outside of flood season, is an aesthetically pleasing sculpture that can constantly measure water quality, but that during the flood season, also would provide a way to minimize the flooding.
- You are inspired by sculptures that you are shown, by your experiences with the Meander installation, and by your hands-on investigations.
- As you develop this invention, you will think like an engineer, a scientist, and also like an artist. You will defend your invention from artistic, scientific, and engineering perspectives.

Installation experience introduction – 10 minutes

Share with students:

- Information about Meander
- Behavior expectations at Meander – No touching, be respectful of others, inside voices, have fun
- An overview of what students will be doing at Meander
    - They will be divided into rotating groups. One group will explore the installation. Another group will conduct hands-on activities. They will all problem-solve and Make as a group.
    - What cross-curricular experiences are like – These are meant to take away the boundaries between disciplines such as science and art so that the students don't know if they are doing science or art, but that they are just having a good time and processing the problem more effectively. These experiences are what it's like in the real world, where disciplines aren't divided and a person has to bring in information from a variety of disciplines. Students will integrate what they have learned in Meander with art and engineering design thinking to solve a real-world environmental problem on the Grand River.
    - How these will involve problem solving – Students will be given a problem at the outset. All experiences will provide information and skills to help them solve their problem.
    - How these experiences will apply to their real lives outside the classroom – These problems will be based on scenarios they are familiar with. Research shows that the maximum effectiveness can be achieved in approach to problem solving.

New Learning

- Exhibit Scavenger Hunt – 10 min.
    - Show students videos and images of Meander.
    - Ask students where in the installation they notice the following, then ask them to draw a diagram of each of these concepts in action:
        - Cell Theory: Where do you notice cells in this system? Are they unicellular or multicellular? How do they meet their needs? – Cells. 3.1, 3.4
        - Mechanical System: Where do you notice a mechanical system in the installation? What are the purpose, inputs, and outputs in that part of

the installation? What are the components of that system? Structures 3.1, 3.2, 3.3
    - Fluids: Where do you notice solids, liquids, and gases in the installation? How does each of these components affect the installation? Cells 3.3
    - Water Systems: How can the Meander installation be an analogy like a water system? Water Systems 3.1
    - Use visual thinking!
- Investigation. Water Systems. 3.2 – 20 minutes
    - Materials
    - Information about watersheds, Grand River watershed, water quality, and reflection sheet
      To Do:
        - Invite students to read about watersheds, the Grand River watershed, and water quality (see attached information pages) and to research the source of their local water.
        - Ask them to fill out the reflection sheet with the knowledge they gained from the readings and local water research.
        - There is additional information in the websites listed below where your students can learn more about the Grand River, its water quality and its flooding. Ask them to select at least 2 to explore and then take notes on what they learned.
        - Students will use this information as they address their problem in the Meander installation experience.
- Grand River and Water Quality
    - Grand River floods and turbidity: https://apps.grandriver.ca/waterdata/kiwischarts/wq_turbidity.aspx
    - Grand River floods and contamination: https://www.grandriver.ca/en/our-watershed/Preparing-for-floods.aspx
    - Grand River water management plan https://www.grandriver.ca/en/our-watershed/Water-management-plan.aspx
    - Grand River conductivity/salinity https://apps.grandriver.ca/waterdata/kiwischarts/wq_conductivity.aspx
    - Grand River water resource https://www.grandriver.ca/en/our-watershed/Municipal-water-supplies.aspx

- Grand River surface water resources https://www.grandriver.ca/en/our-watershed/Surface-water-resources.aspx
- Grand River groundwater resources https://www.grandriver.ca/en/our-watershed/Groundwater-resources.aspx
- "Grand River Not So Grand" https://www.cambridgetimes.ca/opinion-story/5338419-it-s-back-to-the-river-and-not-so-grand-/
- Grand River – Keeping it healthy – Univ. of Waterloo https://uwaterloo.ca/science/news/importance-keeping-grand-river-healthyO
- Original Article https://www.therecord.com/news-story/7975783-a-grand-challenge/#.WiLC4UWSoko.twitter
- How Infections Work – National Academies of Sciences http://needtoknow.nas.edu/id/infection/how-pathogens-make-us-sick/
- Grand River and Flooding
- Grand River Conservation Authority – their actions when record rainfall caused flooding in the region: https://www.grandriver.ca/en/our-watershed/Record-Rainfall-Flood-June-2017.aspx
- News reports on the 2017 floods: https://www.cbc.ca/news/canada/kitchener-waterloo/grand-valley-grca-grand-river-conservation-authority-kitchener-storm-1.4174860
- 2017 flooding in Cambridge: https://www.youtube.com/watch?v=Q7boMyB_65g
- Massive ice jam causes 2018 flooding in Grand River: https://www.youtube.com/watch?v=kPIlZLWIwao
- About the Grand River: https://www.therecord.com/news-story/8845585-the-watershed-ever-changing-grand-river/
- Examples of flood prevention or mitigation products: Flood prevention products: https://www.design1st.com/5-innovative-flood-prevention-products-replace-sandbags/

GeometryKits

- Invite students to use the Geometry kits to develop: 1) an interesting design; or 2) a mechanical system.

Reflection – 15 minutes

- Invite the students to write a brief reflection on what they have learned including:
  - The main idea they have so far concerning the Meander installation, based on their observations.
  - How one of the following is used in the Meander installation: Cells, mechanical systems, or fluids.
  - Where their water comes from and why they should care about its quality.
  - The impact of flooding on the Grand River and why they should care.
  - Interesting ideas they got by creating their designs in the Sargasso kits.

Pre-Visit Preparation

– Reflection

What I Discovered

1. Research your water source and answer the following:
   The water we use (in Ontario or in our town) comes from

   1) Water source

   2) Description of water source

   3) Example of the water source

   4) How I use it

2. Read about watersheds and the Grand River Watershed and answer the following:
   Watershed

   1) What is a watershed

   2) Why a watershed is important to me

   3) Where do I live in the Grand River watershed

3. Read about testing water quality.
   What are 4 characteristics of water that are tested and what do they tell about the water?

   1)

   2)

   3)

   4)

Grand River Watershed

What is the Grand River watershed?

The Grand River watershed includes all of the land drained by the Grand River and its tributaries. It is 6,800 square kilometres and is the largest watershed in southern Ontario. The Grand River watershed is home to close to one million people and includes the cities of Brantford, Cambridge, Guelph, Kitchener and Waterloo. It is also an intensive agricultural area, with farm making up to 70% of the watershed.

What type of wildlife can be found in the watershed area?

There are 80 at-risk species found in the watershed. More than 90 species of fish are found in the river system and this is about half of all species in Canada. Close to 250 species of birds have been reported at a marsh wildlife management area. Forest cover in the watershed was as low as five percent in the early 1900s, but today forests cover about 19 percent of all land.

This is an image of where the Grand River ends. The Grand River flows into Lake Erie. Can you see the tributaries that drain into the Grand River? A tributary is a river or stream, that flows into a larger river or lake. A tributary does not flow directly into a sea or an ocean.

The Grand starts in the Dufferin Highlands and flows south to Lake Erie at Port Mainland. Four other rivers feed into the Grand: the Conestogo, Nith, Speed and Eramosa. The co.rnbined length of all of the rivers and streams is about 11,000 kilometres. The Grand River Conservation Authority manages floods and keeps the rivers flowing in dry weather with a network of seven reservoirs. A reservoir is a large natural or artificial lake used as a source of water supply.

Worksheet source: Teaching in a Wonderland, Grade 8 Unit 4: Water Systems Activity Packet
Web Site: https://www.teacherspayteachers.com/Product/Grade-8-Unit-4-Water-Systems-Activity-Packet-3207949

Testing Water Quality

Water quality

Water quality refers to the chemical, physical and biological characteristics of water. It is a measure of the condition of water relative to the requirements of one or more biotic species. The most common standards used to assess water quality relate to health of ecosystems, safety of human contact, and drinking water.

Turbidity

Sediment makes water turbid. Turbid means to be not clear. Clear water is usually of better quality than turbid water. We can tell the turbidity of water by simply looking at it.

Temperature

Warm water contains less dissolved oxygen than cold water. If the water does not contain enough oxygen, aquatic organisms will die. Increasing the temperature of water by artificial means is called thermal pollution.

Acidity

Water becomes acidic if it contains certain dissolved chemicals, such as sulfuric acid or nitric acid. We measure the acidity of water with an indicator that turns different colours in acidic and basic solutions. Water is acidic if its pH is below 7 and basic if its pH is above 7. Good quality fresh water has a pH between 6.5 and 8.5. Most fish cannot reproduce in acidic water.

Salinity

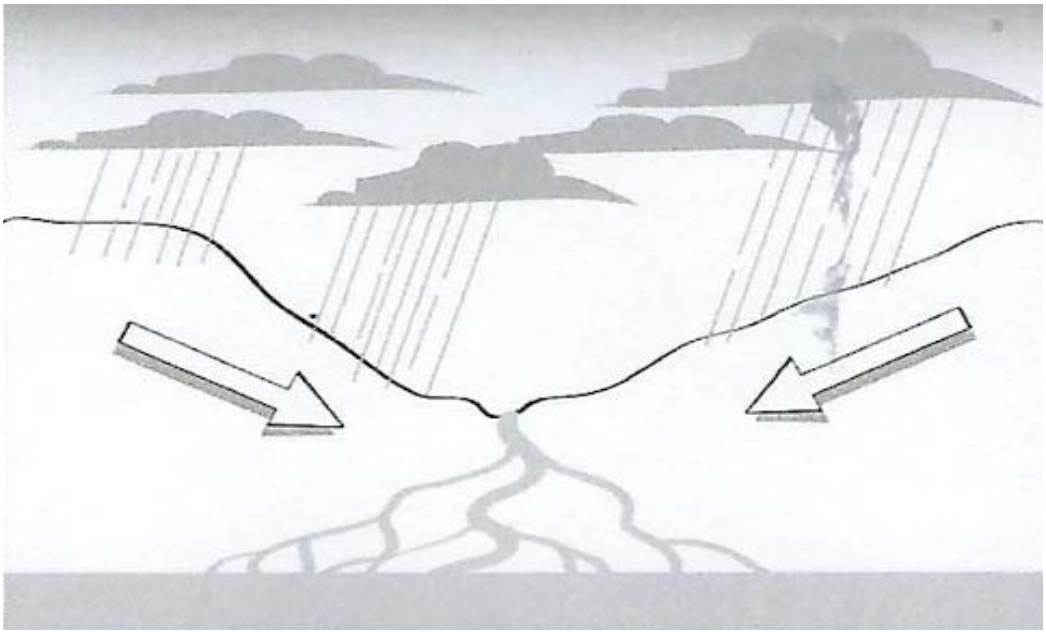
A conductivity apparatus is used to determine whether a solution can carry an electrical current . Salt water is a good conductor of electricity. The dissolved salt in a salt solution completes the circuit and lights up the bulb.

Other dissolved substances

Dissolved substances in water include chlorine which is added to kill unwanted organisms in drinking water. Nitrates come from fertilizer runoff from fields, golf courses and gardens. Iron and copper are dissolved as water flows over certain rocks. Calcium and magnesium also come from rocks, making the water hard.

We can use chemically treated paper test strips to show whether a chemical is present in the water. Too much of one substance might be toxic, but sometimes we need some of the substances to help treat the water.

Watersheds



What is a watershed?

A watershed is the area of land where all of the water that falls in it and drains off of it goes into a common outlet. Watersheds can be as small as a footprint or large enough to encompass all of the land that drains water into rivers that drain into bays that drain into the ocean.

A watershed is an area of land that drains all of the streams and rainfall to a common outlet. Think about a local river or creek. Where does it start? Where does it pass through and where does it end up? All of the area covered is a watershed.

Where can watersheds be found?

Homes, farms, cottages, forests, small towns, big cities and more can make up watersheds. Everything is connected in a watershed and what happens upstream impacts the conditions downstream.

Watersheds can be urban, rural, wild and anywhere in between. Toronto contains seven river watersheds. Each of these watersheds drain into Lake Ontario. Lake Ontario is part of the Great Lakes Basin watershed.

What features can be found in watersheds?

Watersheds are populated with freshwater features such as lakes, ponds, reservoirs, groundwater aquifers, snowpacks, glaciers and icefields.

Watersheds include all the land, plants, air, and animals within its borders. Landforms such as hills or heights of land determine the boundaries of watersheds and direct the speed and path of its rivers. Each watershed has a unique mixture of land and water habitats.

What is the purpose of a watershed?

A watershed fulfills three primary functions. The first is to capture water. The second is to filter and store the water in the soil. The third function is to release the water into a water body.
As precipitation falls, it is stored in the watershed's land and waterbodies. This water is slowly released through shallow water discharge into the river.

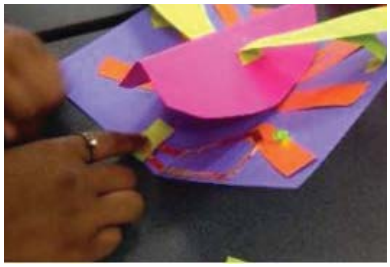
Open and closed watersheds

There are two major types of watershed: *open* and *closed*. An open watershed eventually drains into the ocean. A closed watershed can escape only by evaporating or seeping into the earth. Most watersheds in Canada are open. For example, the rain that falls in the St. Lawrence River watershed, winds up in the St. Lawrence, which flows into the Atlantic Ocean.

Downstream issues

All of the water in a watershed shares the same fate and flows to the some place. As a result, watersheds are sensitive to pollution and land use. Industrial pollution, agricultural runoff, erosion and untreated sewers can not only affect water quality in one watershed, but in all others downstream.

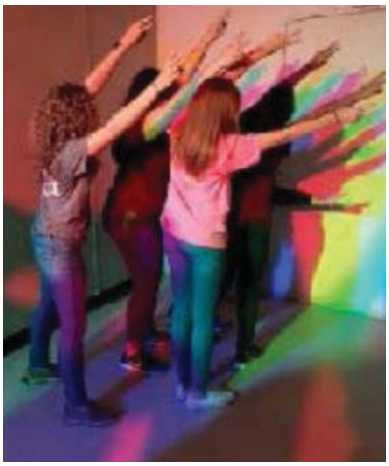
Worksheet and image source: Teaching in a Wonderland, Grade 8 Unit 4: Water Systems Activity Packet
Web Site: https://www.teacherspayteachers.com/Product/Grade-8-Unit-4-Water-Systems-Activity-Packet-3207949



Pop-up bug with circuit

APPENDIX Frequently Asked Questions

Teachers explaining their art/science transdisciplinary product they made in STEAM professional development youtu.be/cMc6ehu71k4



Colored Shadows

What are the objectives?

The objectives of the Meander K-12 experience are to provide an immersive, Ontario standards-based STEAM experience where students engage, learn, and solve real-world problems using important critical, creative, and innovative thinking skills.

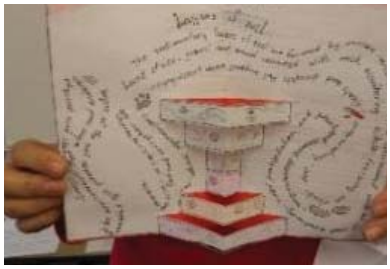
Why is this important?

- Nationally recognized researchers, educators, businesses, and government studies point out that a country's future in the global economy could be significantly impacted by how well today's students are taught to think innovatively as they learn the mandated standards.
- This project meets that need by providing these important research-based cognitive skills side-by-side with knowledge and understanding of the mandated content, its application, Pop-up bug with circuit and communication throughout the process.
- To implement best practices, this project is conducted in collaboration with The Innovation Collaborative, which researches STEAM effective practices.

What is in the Meander experience?

The Meander experience is comprehensive and adjustable. It includes the following stages (times and extent of the experiences are adjustable):

- ***Overview.*** Includes the topic, essential question, objectives, expectations/goals, success criteria, learning context (skills and vocabulary), and learning environment



Popup explaining sedimentary layers

- ***Pre-visit Introduction*** (~1-1.5 hrs.). Includes list of materials for these pre-visit activities, the problem for the students to solve during the entire Meander experience, the exhibit experience introduction, a virtual exhibit scavenger hunt, hands-on investigations, virtual investigations of the Grand River, possible use of Meander kits, and a writing reflection on these pre-visit experiences
- ***Exhibit Visit*** (~2 hrs.). Includes introduction, where the students are reminded of the problem they will be solving; guided facilitation of viewing the exhibit; a scavenger hunt of the interpretive display; hands-on activities focused on grade-level objectives; Making activities where the students work collaboratively to solve their problem, creating their own working prototype; and a reflection on their experience and their learning at the exhibit
    - ***Grade 5 Science Focus:*** Integrating life systems (human organ systems), structures and mechanisms, properties and changes in matter, and forms of energy and their transformation
    - ***Grade 8 Science Focus:*** Integrating life systems (cells), structures and mechanisms, fluid mechanics, and water systems.
    - ***Skills for Both Grades:***
        - ***Visual Art:*** Creating, presenting, reflecting, analyzing, and responding
        - ***Language:*** Reading, writing, oral communication, and media literacy
        - ***Science, Technology, and Art:*** Knowledge and understanding, thinking, communication, and application
- ***Post-visit - Presenting, Defending, and Promoting their Solution, Then Reflecting*** (~2 hrs.). Includes students' preparation of their invention's presentation, defense, and promotion; student assessment; extensions into other disciplines such as life systems; and student reflections
- ***Curricular Concepts and Thinking Skills***. Listing of the standards' concepts used in science and visual arts, in addition to critical and problem-solving skills used
- ***Rubric.*** States what constitutes great, good, and poor solutions, applications, and presentations
- ***Provincial Achievement Categories:*** Comparisons of Science and Visual Art in Grades 5 & 8. A side-by-side listing of achievement categories from the Ontario curriculum in

science and visual art that demonstrates the commonalities among knowledge and understanding, thinking, communication, and application in the use of the standards

- ***Overall Process Skills.*** A side-by-side listing that demonstrates the commonalities among general process skills in science inquiry, the engineering design process, art habits of mind, and neuroscience strategies. This enhances the Ontario Achievement Categories and helps drive the curriculum.

How could I be involved?

- You can help in planning this project, volunteer your class as a pilot class for these experiences, and be willing to offer input as to ways to make this curriculum as strong as possible for teachers and students.

What are benefits for me?

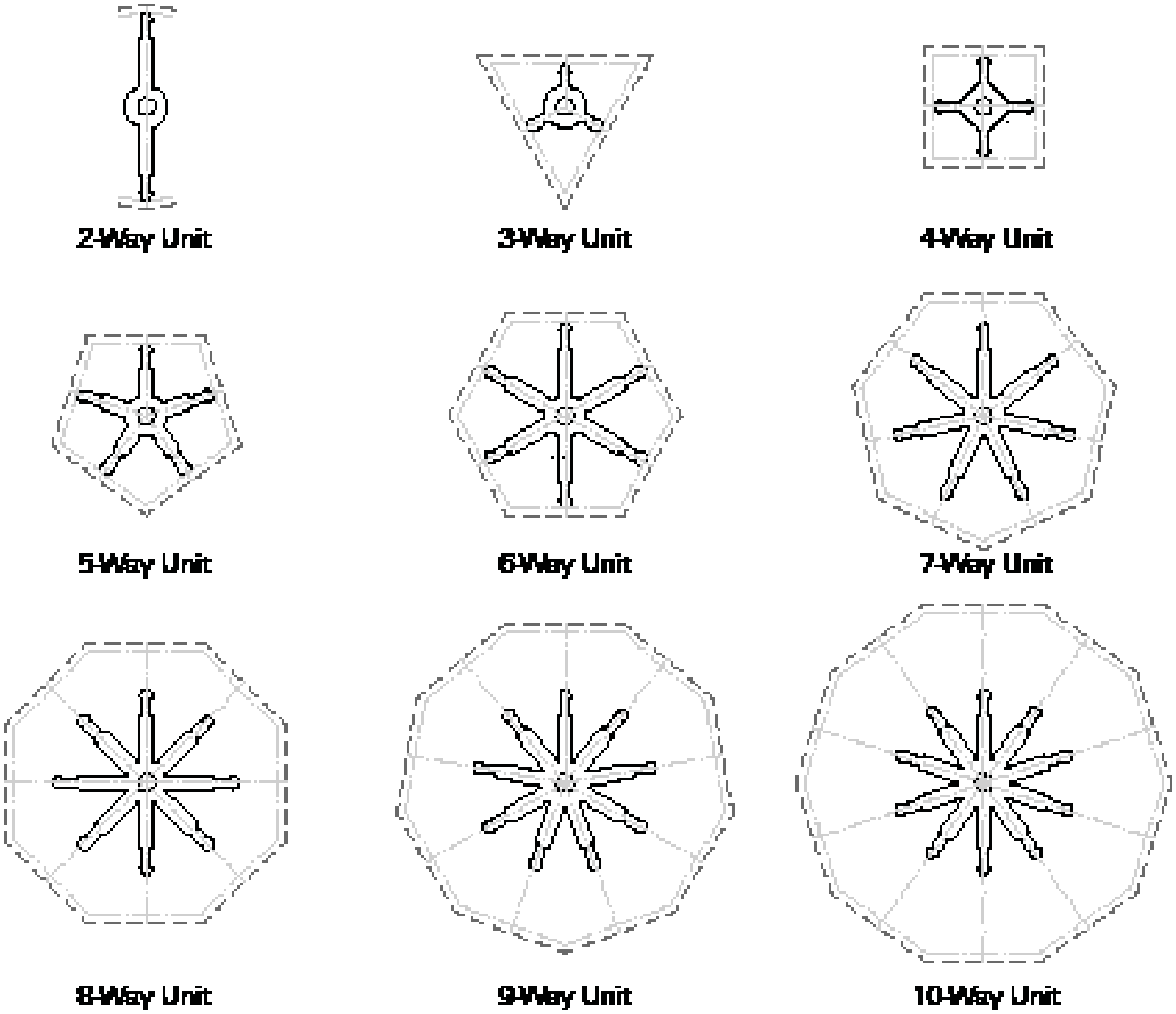
- Professional development that implements and organizes STEAM in your classroom, with applications ranging from basic arts integration to deep problem-based learning

- See your students grow as a result of these experiences

APPENDIX Geometry Kit

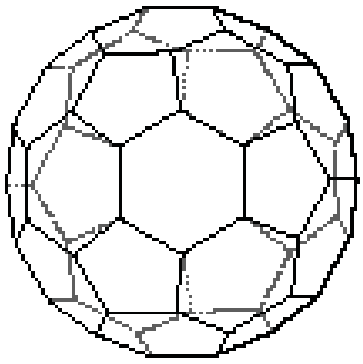
A downloadable set of patterns including open-source laser cutting files may be found at https://www.dropbox.com/sh/hcqbwqoy38ptf1AAA4V6jI406VKbBmEj8v5Gu3a?dl=0

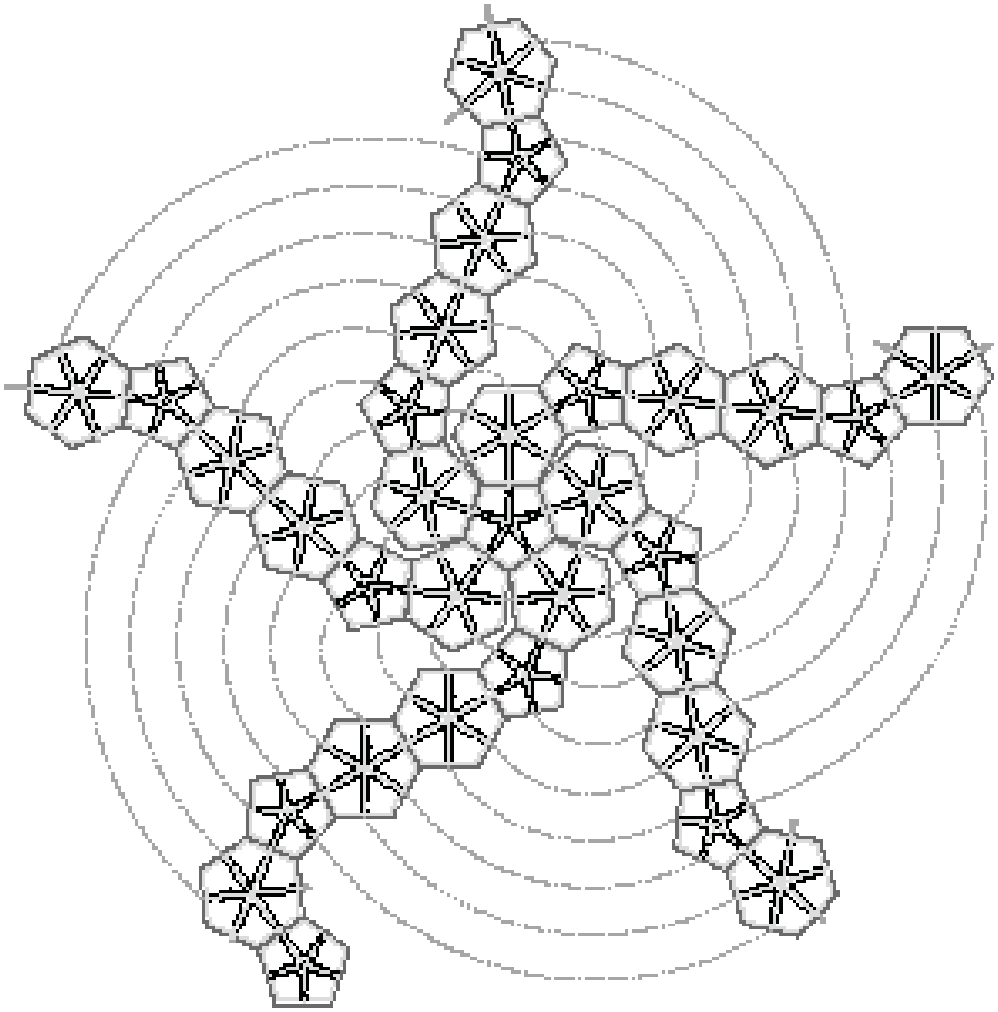
Lexicon



Geometry Kit

Truncated Icosahedron Assembly





Geometry Kit

Cutsheets