

EASTERN ONTARIO  
**CATHOLIC**  
CURRICULUM CORPORATION

*Working Together for Catholic Education*

[www.eoccc.org](http://www.eoccc.org)

# *Global Issues—Code to Learn*

## *Grades 7 & 8*

*Includes 8  
“how-to”  
videos*



*in partnership with*

ONTARIO ENGLISH

**Catholic**  
**Teachers**  
ASSOCIATION

**2020**

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Courtesy of St. Matthew Catholic Secondary School

Cornwall, Ontario

CDSBEO

## Global Issues – Code to Learn

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## Prayer

Let us unite our prayers with the Lily of the Mohawks, St. Kateri Tekakwitha, as we pray to our Creator.

Great Spirit,  
Whose voice we hear in the winds,  
and Whose breath gives life to all the world, hear us!  
We are small and weak.  
We need your strength and wisdom.  
Let us walk in beauty,  
and make our eyes ever behold the red and purple sunset.  
Make our hands respect the things you have made  
and our ears sharp to hear your voice.  
Make us wise  
so that we may understand the things you have taught our people.  
Let us learn the learning experiences you have hidden in every leaf and rock.  
We seek strength, not to be greater than our brothers and sisters,  
but to fight for Justice and Mercy for all.  
Make us always ready to come to you with clean hands and straight eyes.

*Adapted from Princess Pale Moon, Ambassador of Friendship*



## LAND ACKNOWLEDGEMENT

### **For the Ottawa area:**

We acknowledge that the Catholic District School Board of Eastern Ontario and the Ottawa Catholic School Board is situated on the unceded, traditional Algonquin territory of the Anishinaabe people. We respect both the land and the people of this land including all Indigenous people who have walked in this place.

### **In Mohawk territory (Cornwall, Brockville, Smith Falls, Gananoque):**

We acknowledge that the Catholic District School Board of Eastern Ontario is situated on the Mohawk territory of the Haudenosaunee/Rotinohsho'n:ni people. We respect both the land and the people of this land including all Indigenous people who have walked in this place.

### **In the Kingston and Belleville Area:**

“The Algonquin and Lakeshore Catholic District School Board is situated on the traditional and ancestral territories of the Anishinaabe and the Haudenosaunee. We acknowledge their enduring presence on this sacred land, as well as the presence of the Métis, Inuit, and other First Nations from across Turtle Island. We honour their cultures and celebrate their commitment to this land.”

### **In the Renfrew County Area:**

The Renfrew County Catholic District School Board is situated on the traditional, unceded territories of the Algonquin Nation and we are grateful to be able to live, learn, pray and share with all creation on these lands.

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## RATIONALE: WHAT IS CODE? WHY NOW?

Competency-based learning with a focus on the integration of code occurs when students construct their learning examining multiple perspectives and by valuing their own thinking. When students are immersed in a task, they reflect on the process of the what, the how and the why of learning. Students' reflections on competencies during the process allows the authenticity of seeing themselves as designers of their learning. They need to know their voices matter, and when they problem solve and communicate effectively, they are able to take action. This is where the action of coding fits in. Prime Minister Justin Trudeau recently said, "We need to do a better job of getting young people to understand what coding is and how it's important, how to program, how to problem solve, how to create the most elegant algorithm possible." [http://www.edu.gov.on.ca/eng/literacynumeracy/inspire/research/Computer\\_Coding\\_K8\\_en.pdf](http://www.edu.gov.on.ca/eng/literacynumeracy/inspire/research/Computer_Coding_K8_en.pdf)

Simply put, computer code is a set of rules or instructions. It is made up of words and numbers, that when you put them in the right order will instruct your computer to do something. Today's learners are living, learning, and growing in the midst of a technological revolution. Coding skills provide opportunities for learners of all ages to be innovative which ultimately leads them to become empowered creators and innovators. As a fundamental computational thinking skill, coding is becoming necessary in the workforce. K-12 students' proficiency in STEM is essential for preparing them for careers in rapidly growing sectors in our economy and perhaps in fields that may not yet exist. Research indicates that in the coming years Canada will need an additional one million skilled workers with 70% of those expected to be in STEM-related fields. Teaching students to code improves problem-solving and thinking skills and allows them to understand the world around them.

## STUDENT AS LEADER, EDUCATOR AS GUIDE

Coding in a low-floor and a high-ceiling environment supports student agency and gives students ownership of their learning. In doing so, teachers become guides throughout the problem-solving process. From an empowerment standpoint, students writing code to model a pattern, or a relationship are in control. There are various ways to solve a problem with code and students can use methods that personally and logically make sense. They can also choose to deviate from the task to investigate related problems across the curriculum, which encourages curiosity, creativity, critical thinking, and deeper engagement.



Fullan speaks of six global competencies, known as the six Cs: character, citizenship, collaboration, communication, creativity, and critical thinking. (Reference: *Deep Learning: Engage the World Change the World*, Fullan, M. 2018).

These competencies encompass compassion, empathy, social-emotional learning, entrepreneurialism, and other related skills to becoming successful in our complex world. Fullan warned, “We will fail to spark the passion of our students if we are not teaching the six C’s.” (<https://michaelfullan.ca/articles/>)

Computational thinking is a problem-solving process that is essential across all disciplines, including the humanities, mathematics, and science. Students who learn computational thinking across the curriculum will begin to see a relationship between academic subjects, as well as between life inside and outside of the classroom.

Modern Catholic social teaching, rooted in Scripture and articulated through a tradition of written documents, has evolved over time in response to the challenges of modern living. As Catholics, we are called to be problem solvers and advocates for those in need.

The Ontario Catholic School Graduate Expectations (OCSGEs) were developed to provide a framework to represent the distinctiveness and purpose of Catholic education in Ontario. In particular, to be an effective communicator who uses and integrates the Catholic faith tradition, in the critical analysis of the arts, media, technology and information systems to enhance the quality of life. (<https://iceont.ca/resources/ontario-catholic-school-graduate-expectations/>)

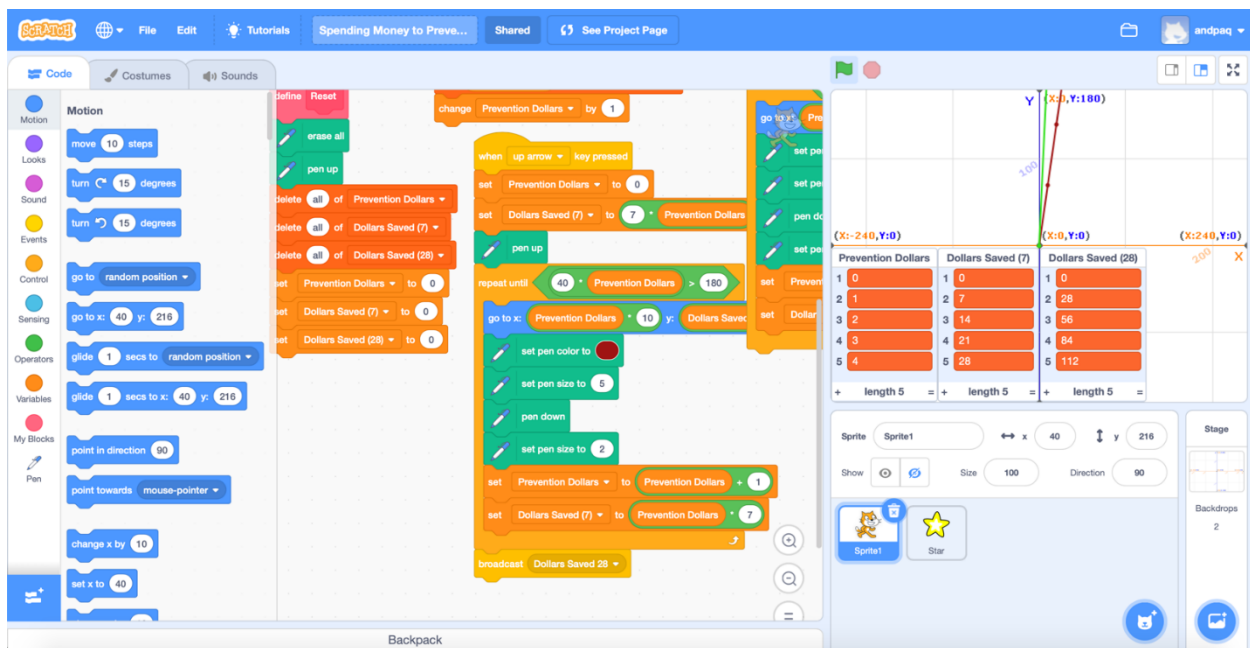
In addition, the Church has pronounced itself in favour of integration of technology into daily life as it enables people to communicate globally. Technology can help us to understand one another better and thus contribute to world peace and prosperity and ultimately to model and share the Good News to all. While immersed in the action of designing and developing code, students will begin to establish a positive attitude toward building not just consuming technology. Through the language of code students are encouraged to use their skillset and knowledge to change the conversation about social justice issues.

As you embark on this coding journey with your students, it is hoped that you and your students will experience the powerful and deep connections to critical thinking, creativity, communication, collaboration, character, and citizenship.



## WHAT IS SCRATCH AND HOW DOES IT WORK?

Scratch is a block-based coding language and website created and maintained by the MIT Media Lab (<https://www.media.mit.edu/>). It allows users, who are playfully known as “Scratchers”, to create projects through the ordering of colour-coded blocks. They do this by selecting blocks from the block palette and dragging them into the scripting area where they are ordered and modified. When the Scratch project is ready, he/she runs the code and watches the action unfold on the stage.



## WHY SCRATCH AND NOT ANOTHER PLATFORM?

Scratch is one of many block-coding environments. Like other platforms of this type, Scratch offers users an easy entry into coding. The highly visual nature of the blocks removed the need to understand the syntax involved in text-based programming languages like HTML, Python, C, and JavaScript. Beginning coders can focus on computational thinking skills and concepts without worrying about the intricacies of complex languages in environments like Scratch.

Scratch is a free program that operates easily on most devices commonly found in schools. Teachers can create free class accounts. This allows them to monitor their students’ work within this environment.



Coding communities tend to have very open philosophies toward intellectual property, and Scratch is no exception. What might be considered plagiarism in other contexts is often considered sharing and flattery within coding communities. A Scratcher who has run into a problem with code can easily search within Scratch for a solution. In fact, the Remix function which is available on all shared projects allows a user to create a carbon copy of another Scratcher's work and then modify it for his/her own purpose. This ability provides another avenue for Scratchers to learn more coding skills.

## VIDEOS – AN INTRODUCTION TO CODING

In June 2020, the Ontario Ministry of Education released a new mathematics curriculum document for grades 1 to 8. One of the biggest changes is the inclusion of expectations around coding. For the first time in Ontario, elementary teachers are required to teach coding to their students. Many teachers are wondering how they might guide their students toward mastery of their grade level coding expectations.

The following series of videos is meant to serve as an introduction to coding for teachers. After a short introduction to the Scratch coding environment, these videos trace the evolution of a single mathematical idea, for example the creation of polygons. At the beginning, the code is quite simple and limited. As one moves from video to video, new functions are introduced to make the code more elegant, efficient, engaging, and functional. As you watch these videos, you will learn how to use motion blocks, loops, variables, conditionals, and nested events.

**Introduction to Scratch:** This video starts by describing both the layout and the basic functionality of the Scratch coding environment. It goes on to create a simple code to draw a square using motion, pen, and control blocks.

Video Link: [video](#)

**Scratch Intro – Loops:** Your codes can be made more streamlined and efficient by placing repeated blocks/actions inside a loop. This video shows you how.

Video Link: [video number 2](#)

**Scratch Intro – Variables and Operators:** When you have several codes that do the same general thing but with different values, it is often possible to create a single code, using variables and operators, that will work in any event much like a formula.

Video Link: [Scratch Intro - Variables](#)

**Scratch Intro – Variables Part 2:** This video shows how you might solicit numerical input from a user and assign that value to a variable.

Video Link: [Scratch Intro - Variables Part 2](#)

**Scratch Intro – Variables Part 3:** This video shows how you might incorporate variables more fully in your codes.

Video Link: [Scratch Intro - Variables Part 3](#)

**Scratch Intro – Conditionals:** This video shows you how you might build your code to ensure that desired actions only occur under conditions that you define.

Video Link: [Scratch Intro-Conditionals](#)

**Scratch Intro – Nested Events:** This video shows you how to create nested events (e.g., a loop inside a loop) to increase the efficiency of your code.

Video Link: [Scratch Intro-Nested Events](#)

**Scratch Intro – Use, Modify, Create:** This video details a scaffolding framework that can be used with students to ensure that learning and engagement remain high while keeping frustration low.

Video Link: [Scratch Intro-Use Modify Create](#)



## LEARNING EXPERIENCE OVERVIEW

A brief overview of the format of the learning experience plans in this resource.

### LEARNING EXPERIENCE OVERVIEW AND LINK TO UNITED NATIONS THEME:

In this section, links will be made between the focus of the learning experience and the United Nations Sustainable Development Goal(s). There may also be mention of the specific targets being addressed. The UNSDGs are 17 overarching goals with explicit achievement targets for 2030. Looking at issues of equity, improvement in quality of life, including raising current worldwide standards of living, the UNSDGs represent an authentic and contemporary jump-off for inquiry learning. The United Nations Sustainable Development Goals can be viewed [here](#).

Figure 1: Sustainable Development Goals (United Nations, 2015)



### CODING CONSIDERATIONS:

This section provides teachers with the degree of difficulty students will encounter when working with code throughout the learning experience. The learning experience will make use of the **Use-Modify-Create** continuum of learning to code.

At an introductory level, students will **Use** existing Scratch code to achieve a particular goal. As students progress, they may be required to **Modify** existing code to serve a different purpose or improve code efficiency. Beyond this, students may be asked



to **Create** new code to serve a specific purpose, which may require more familiarity with Scratch than the previous two sections of the continuum.

### LEARNING GOALS:

The learning goals listed in this section will describe, for students, what they should know, understand, and be able to do by the end of this learning experience.

### LOOK-FORS:

The look-fors will describe an observable teaching or learning behaviour, strategy, outcome, product, or procedure.

### INSTRUCTIONAL COMPONENT:

In this section, you will see any learning or materials that need to be prepared before the outset of the learning experience. This may include any or all of the following:

- **Prior Knowledge:** What do students need to know before participating in the learning experience? Will they need strong conceptual knowledge or a general understanding? (beginner, intermediate, advanced)
- **Terminology:** What specific language, drawn from curriculum or otherwise, will students be using to develop an understanding of the learning experience? These are the key terms of the learning experience.
- **Resources:** What websites, audio/visual/ infographics, or other resources will be required for this learning experience? These are in addition to distinct physical resources required for the learning experience that are listed at the bottom.

### ENVISION (MINDS ON):

How are you going to hook your students or introduce them to the learning experience in an engaging way? Framing resources, framing questions, using engaging resources or other content that will serve as introductory matter to the learning experience will be found here.



### **ACTION (SOWING):**

This is where the bulk of the learning experience and learning will happen. In this section, you will have instructions for learning experience implementation, guiding questions, potential observations, etc.

### **CONSOLIDATION (NURTURING):**

This is the culmination of the learning experience where students will reflect on their work, make informed decisions, and engage in discussion with their class, etc. This part of the learning experience is an opportunity for students to restate the initial objective of the learning experience, reflect and apply new learning.

### **DISCERN (MONITORING):**

This section provides suggestions for questions asked throughout the learning experience, or potential look-fors that may elicit a certain response from the educator. This section is not meant to replace the educator's classroom judgment, as teachers know the ebb and flow of their own class best!

### **EXTENSIONS:**

In this section, there may be suggestions for what can be done with this learning after the learning experience has been completed, or what early-finishers/motivated learners may wish to explore.

### **CURRICULUM CONNECTIONS:**

What overall, specific, and integrated curriculum expectations are addressed in this learning experience? You will see these listed in this section.

### **FAITH CONNECTIONS:**

In this section of each learning experience, connections will be made between the material being covered and a Catholic Social Justice Lens. This section is meant to provide teachers with

the opportunity to think and reflect about how the content is representative of transformative understandings about the world. Explicit reference to themes of Catholic Social Teaching may be present here.

### ONTARIO CATHOLIC SCHOOL GRADUATE EXPECTATIONS:

Teachers will find connections for each learning experience to our Catholic Graduate Expectations in this section. As a reference, the list of Catholic Graduate Expectations can be found [here](#).

### NOTES:

Additional information, considerations, or reframing/reflection notes may be found here.

### RESOURCES NEEDED:

In this section, the specific resources, handouts, reading material, graph paper, etc., that may be required for each learning experience will be presented. Here you will see the resources required for you and your students.

### REFERENCES:

Any references used in the creation or consultation of this learning experience will be listed here.

## WHO ARE THESE LEARNING EXPERIENCES FOR?

These learning experiences have been informed by the following resources:

[The United Nations Sustainable Development Goals](#)  
[The Ontario Catholic School Graduate Expectations](#)  
[The Ontario Curriculum](#)  
[Elementary Mathematics Document \(2020\)](#)

The resources above are provided for the creation of grade 7 and 8 mathematics' learning experiences using the new expectations found in the Elementary Mathematics Curriculum – specific but not limited to,

**OVERALL EXPECTATION C3.** solve problems and create computational representations of mathematical situations using coding concepts and skills.

Though coding has been implemented in varying degrees of impact in Ontario classrooms, this may be new subject matter which is somewhat uncomfortable for many teachers. This is okay! These learning experiences exist as a supplemental entry point to coding and provide meaningful connections between coding, mathematics, and other curriculum objectives. It is intended for grade seven and eight teachers seeking additional resources that address coding in the classroom. Mentioned in each learning experience is the **Use-Modify-Create** continuum of learning to code – as a personal entry point to learning and instruction it may be prudent to have you and your students get in the space (Scratch) and use the code. Build familiarity. There are also many resources and tutorials available in the Scratch community, found at [Scratch Studios](#).

These learning experiences are only guides, intended to be adapted and personalized for each classroom by the educator. Many of these learning experiences have student self-guided components, which could be adapted for a whole class, with the educator serving as model.

## REFERENCES:

Wing, Jeannette. Computational Thinking. Communications of the ACM (March 2006) Volume 49, No. 3.



Sterling, Leon. Coding in the Curriculum: Fad or Foundational? Accessed from: [https://research.acer.edu.au/cgi/viewcontent.cgi?article=1297&context=research\\_conference](https://research.acer.edu.au/cgi/viewcontent.cgi?article=1297&context=research_conference) on July 13, 2020.

Flynn, Maria. Students Need Coding in Schools - and more - to Fill STEM Jobs of Future. Tech and Learning (Nov2017), Vol. 38 Issue 4, p19-19.

Ontario Ministry of Education. Computer Coding in the K-8 Mathematics Curriculum. Accessed from: [http://www.edu.gov.on.ca/eng/literacynumeracy/inspire/research/Computer\\_Coding\\_K8\\_en.pdf](http://www.edu.gov.on.ca/eng/literacynumeracy/inspire/research/Computer_Coding_K8_en.pdf) on July 13, 2020.



## FAIR PAY

**“No country can ever truly flourish if it stifles the potential of its women and deprives itself of the contributions of half its citizens”**

*Michelle Obama*

### LEARNING EXPERIENCE OVERVIEW AND LINK TO UNITED NATIONS THEME:

In this learning experience, students examine the imbalance between a man and a woman’s paid and unpaid work, as well as the difference between maternity leave and paid paternity leave, in a variety of countries. Together, these sets of data reveal a stark inequity in the extent to which men’s work and women’s work are valued in many (if not all) countries. As such, this learning experience addresses United Nations Sustainable Development Goal #5 – Gender Equality. This learning experience addresses the following targets;

- 5.4 Recognize and value unpaid care and domestic work through the provision of public services, infrastructure and social protection policies and the promotion of shared responsibility within the household and the family as nationally appropriate.
- 5.5 Ensure women’s full and effective participation and equal opportunities for leadership at all levels of decision-making in political, economic, and public life.

This learning experience also addresses aspects of UNSDGs;

- #8 - Decent Work and Economic Growth; Sustained and inclusive economic growth can drive progress, create decent jobs for all and improve living standards.
- #10 - Reduced Inequalities; Reducing inequalities and ensuring no one is left behind are integral to achieving the Sustainable Development Goals.

### CODING CONSIDERATIONS:

When teachers guide students to learn to code, they often employ the **Use-Modify-Create** continuum. Students who have little coding experience are best suited to the **Use** stage of the continuum. In the **Use** stage, students run a pre-created code, witness the results, then analyze the code to learn how the ordering of commands creates the results.

As students develop a stronger understanding of coding, the **Modify** stage becomes appropriate. In the **Modify** stage, students make changes to existing codes (or, in some cases,





they add on to existing codes) to create results that differ from (or add onto) those of the original. This stage introduces the computational thinking skill of debugging. Invariably, first attempts at creating a desired result with code may not work out as hoped, thus necessitating a period of tinkering during which the code inches closer to perfection. This process can be frustrating for students who are new at coding and have a narrow coding skill set, so plenty of time in the **Use** stage is advised before moving on to **Modify**.

In the **Create** stage, students envision a desired result and then build the code from scratch. They harness the skills and concepts learned in the previous two stages.

This learning experience provides students at the beginning stage of coding with a gentle introduction. It positions students in the first two stages of the **Use-Modify-Create** continuum of learning to code. In step 5, students *use* a provided Scratch code to determine women's paid and unpaid work minutes as percentages of men's minutes. They can compare the block coding script with the actions on the stage and see how the construction of the first dictates the results on the second. In step 8, students *modify* the given code by remixing it so that it will work for a similar set of data.

### LEARNING GOALS:

At the end of this learning experience, students will know, understand, and/or be able to:

- That women, by virtue of having historically done more unpaid work within the home and less paid work outside of the home, are likely to do more elder care than men as our population ages.
- Connect ideas related to gender work equity to Catholic Social Teaching.
- Create and use percentages to uncover social justice inequities.
- Use variables effectively in code.
- Develop (either through modification or creation) Scratch codes to compare maternity and paternity leaves in a variety of nations.

### LOOK-FORS:

- Student ability to read, understand, modify and/or create code to represent the mathematics underlying a social justice issue.
- An emotional and faith-informed response (on the part of the students) to inequities involved in men's and women's work.



## INSTRUCTIONAL COMPONENT:

- **PRIOR KNOWLEDGE:** In Grade 8 Geography, students learn about quality of life indicators. Life expectancy is one of these indicators. Students will need a clear understanding of this term as well as an understanding of how countries' life expectancies have changed over the last 200 years. The life expectancy visualization from [ourworldindata.org](http://ourworldindata.org) can help convey this understanding.
- **TERMINOLOGY:** life expectancy, paid work, unpaid work, percentage, variable.
- **RESOURCES:** Life expectancy visualization from [ourworldindata.org](http://ourworldindata.org). After clicking the link, make sure the Map setting is chosen (look at the bottom right-hand corner), then click the Play button (bottom left-hand corner). As the years scroll from 1543 to 2019, the colours of the countries change to reflect changing (increasing) life expectancies. Initially, only the United Kingdom changes as there is no data for the rest of the world in the 1500s. Gradually, all countries are represented.

## ENVISION (MINDS ON):

1. Read students the following vignette (taken directly from the learning experience *Paying for It* from *Math That Matters 2*, Stocker, D. 2017). Teachers may read the following vignette while showing it on the Smartboard.

It is interview day. You have applied for a new 60-hour a week job and the description of the duties you will be performing looks a little daunting. The interviewer, Sylvia, goes over the list. "Event planning, managing financials, cooking, landscaping, carpentry, nursing, childcare, teaching, cleaning, laundry, chauffeuring and other duties as assigned." 'Other duties as assigned' is always the kicker. Things are going smoothly until the end of the interview when she asks you if you have any questions.

"I notice that you didn't list the salary for this position in the posting," you say, eyebrow raised. Blank stare from Sylvia.

"You know," you continue undaunted, "how much I'll be paid?"

"Oh, were you unaware?" she says with a shock. "This isn't a paid position. We do not pay people who stay at home and manage all the duties of the household. If you end up as the successful applicant, you would be working for free" (Stocker, 2017, p. 222-3)

Allow some time for students to voice their reactions to this story.

Explain that in (almost) all countries, men do less housework and childcare than women.

Obviously, there are households in which the division of such labour is equal, and others where men do the majority of this work, but on the whole, women do more domestic work. Men do more of the paid work outside of the home and are paid better for it (consider using the information found [here](#) to show how a forward-thinking country like Canada still has much work to do in both these regards, despite the positive changes made in recent decades).

2. Segue to a discussion on life expectancy. Review (or teach, if you have not already addressed this quality of life indicator with your students) what it is, and use the visualization linked [here](#) (the map setting is best) to show students how life expectancy has changed over the past few hundred years. Some students may notice, that in the 1600s, when Britain is the only country in colour (because it's the only country for which life expectancy data exists in the early 1600s), it backslides from orange (40 to 45 years) back to red (30 to 40 years) in the 1620s. This may be a good prompt for inquiry. Ensure that students understand that the trend for people to live longer lives in all countries is bound to continue into the future.

3. Pose the following **key question** that will guide the inquiry:

“Helen Clark, from the United Nations Development Programme, suggests that an aging global population will have more impact on women” than on men. Explain. (Stocker, 2017, p. 223)

Discuss briefly, recording ideas/predictions/theories where appropriate.

### **ACTION (SOWING):**

4. Provide students with access to the [Minutes of Paid and Unpaid Work per Day, by Gender](#) data table. Give them a few minutes to study it and develop responses to the prompt (What do you notice? What do you wonder?). Facilitate a short discussion.

Lead the students to the notion that, for comparison purposes, the data can be presented such that women's minutes can be shown as a percentage of men's minutes. If the men's figure is seen to be the whole, or 100%, what percentage is represented by the corresponding women's figure? Review how percentages are determined and show students an example by using the figures for men's and women's unpaid work minutes in Canada ( $223.7/148.1 \times 100 = 151.05$ ; Canadian women do 151% of the unpaid work done by Canadian men, on average). Have students manually calculate Canadian women's daily paid work minutes as a percentage of

men's (but stop them from doing the work for the whole table; that is what the Scratch code in the next step is for).

5. Provide students with laptops (a ratio of 1 laptop to 2 students: allowing for sharing, collaboration and discussion) and direct students to go to the Scratch code on [Time Spent in Paid and Unpaid Work, by Gender](#).

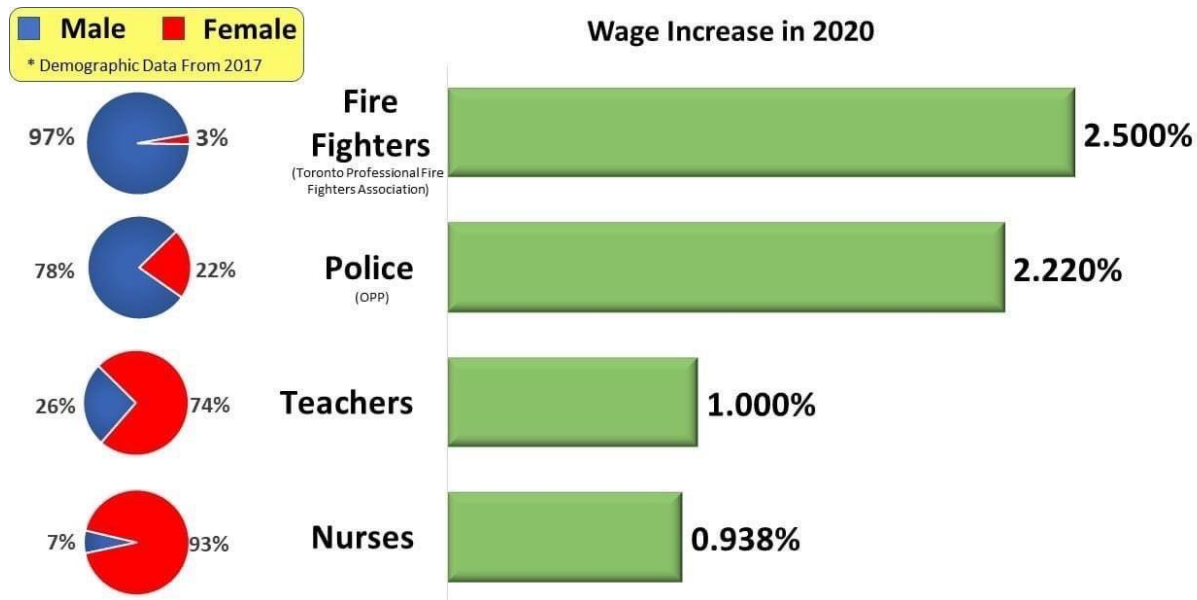
The link will take them to the project page (the one with the instructions on how to use the code). Model what happens when you run the code. Click the green flag to start, then the space bar. When prompted to enter the name of a country, input "Canada." The figures that appear in the second and third columns will reveal the percentages the students developed in the previous step (i.e., women in Canada do 151% of the unpaid work, but only 79% of the paid work, of their male counterparts). Have them run the code for the remaining five countries as well as for the OECD average.

6. Facilitate a short discussion about the social justice issues, mathematics, and coding concepts involved in the experience. Some ideas that should surface include:

- In all countries studied, and indeed in the whole world, as indicated by the OECD average data <https://www.oecd.org/canada/bydate/>, women do more unpaid work and less paid work than men.
- Some countries approach equity (e.g., Sweden) and others are grossly inequitable in this regard (i.e., Turkey, India, and Japan). Societal and cultural constructions of gender roles are at play here.
- There clearly is a strong tendency to value men's and women's work differently. One might wonder what, in addition to comparisons of numbers of minutes worked (paid and unpaid), might be required to provide a clearer picture of this inequity. It may come up that types of work and the amounts that men and women are paid are key pieces of information. The image below might help spark conversation on these topics.



Figure 2: (Thorburn, 2020)



## ABOLISH BILL 124 IN ONTARIO FOR GENDER WAGE RAISE EQUITY!

Mathematically speaking, there are two main things to discuss: the nature and construction of percentages, and the use of variables (although this item is probably best saved for the analysis of the code).

- Guide the students to an understanding of how the code works. By clicking the “See Inside” button, students will be able to see the block coding scripts that makes the Scratch app work. Walk them through the steps in the code. Special attention should be given to the use of broadcast blocks, variables, and lists.

7. Provide students with access to the [Maternity Leave vs. Paternity Leave](#) (p. 26) data tables. Give them a few minutes to study it and develop responses to the prompt (What do you notice? What do you wonder?). Facilitate a short discussion.

8. Give students in pairs, the task of remixing the Scratch code they used previously to represent the 2016 maternity/paternity data. Again, consider the men’s numbers as a whole (100%) against which the women’s figures will be compared. This will invariably involve a great deal of trial, error, and debugging. A sample of a finished Maternity Leave vs Paternity Leave code is linked [here](#).





9. Facilitate a short discussion about the social justice issues, mathematics, and coding concepts involved in the experience. Some ideas that should surface include:

- Maternity leave is a wonderful thing, and we are lucky to live in a country that has it. However, the fact that most countries offer more maternity leave than paternity leave relegates many women to the position of doing more unpaid than paid work. Part of a movement toward true gender equality should include the capacity for mothers and fathers to have equal amounts of parental leave so that both can participate equally in paid work situations.
- Japan is an anomaly in that it offers far more leave time to fathers than to mothers (and yet Japanese men do much more paid work and much less unpaid work than Japanese women). It might be interesting to research the history of this situation.
- The figures for maternity leave as a percentage of paid paternity leave come back as “Infinite” for Canada. This is because Canada offered 0 weeks of paid paternity leave in 2016 (i.e., no non-transferable time is guaranteed for fathers’ leaves). Division by zero is undefined, hence the “Infinite” result.
- Many of the percentages are quite high. For instance, the result for the United Kingdom is 2600%. Care should be taken to explain that 2600% is equal to 26 times (not 2600 times). In this case, 2 weeks are guaranteed (non-transferable) for the father’s leave, while the mother gets 52 weeks.  $2 \times 26 = 52$ , but if the 2 weeks are considered the whole, or 100%, then 26 times that is 2600%.
- Although students are asked to remix one code to calculate percentages for a new set of data, they may go about it in different ways. Most will probably make small changes like the ones represented in the code provided above (i.e., taking out India, adding the UK, creating new variables and lists for the new sets of data) while leaving much of the original in place (i.e., the use of the broadcast blocks, the percentage calculation, the use of the variables, and the assignment of results to lists). It is possible, however, that some will do something completely different. All logical and/or functioning efforts should be honoured.



### CONSOLIDATION (NURTURING):

10. Return to the key question from the **MINDS ON** section. It should come to light that families will have to devote more time and energy to the care of older relatives as life expectancies increase. Because most societies are structured so that women do more unpaid work (much of it related to caring for family members) and less paid work than men, it can be assumed that much of the oncoming unpaid work involved in caring for elderly relatives will fall on female shoulders. This reality threatens to exacerbate an already inequitable situation. At this point, discussion and subsequent inquiry could focus on finding solutions to this situation.

### DISCERN (MONITORING):

Many students live in households that, for a variety of reasons, conform to the unfortunate norm of inequities of paid and unpaid work between men and women. In some cases, cultural values are at play. It is important for everyone involved in this learning experience to remain respectful of all cultures' principles and of each family's right to make decisions for its own benefit while highlighting this very real social justice issue.

As students work on the coding tasks, the teacher will have ample opportunity to circulate among them. This is a good opportunity to monitor students and provide guidance if needed. Coding can come with a steep learning curve. Teachers should be prepared to offer scaffolds for students in time to prevent their disconnection from the task.

If students have difficulty understanding the code provided in step 5, it might be a good idea to try the following unplugged version. Describe the desired outcome and collectively devise a set of steps that will lead to it. These can be noted on a whiteboard or chalkboard as a list of ordered ideas (for example, first I input a country's name, then I want that input to trigger a computation of specific data related to that country, then I want the result of said computation to be sent to a list for display for the user). Once these steps are refined, they can be compared to the code and students can see the chunks of code that make each step occur.

### EXTENSIONS:

Provide each student with a copy of [Pay for Unpaid Work](#) (p.28). Have them complete a column for each parent/guardian/caregiver at home (by logging in the number of minutes per day



devoted to each work category). Upon returning to school, have the students enter their data into the unpaid work calculator found [here](#). The results will provide further discussion.

## CURRICULUM CONNECTIONS:

### GEOGRAPHY (GRADE 8):

- B2.1 Formulate questions to guide investigations into issues related to global development and quality of life from a geographic perspective.
- B2.4 Interpret and analyse data and information relevant to their investigations, using various tools and spatial technologies.
- B2.5 Evaluate evidence and draw conclusions about issues related to global development and quality of life.
- B3.1 Identify and describe the significance of several indicators that are commonly used to measure quality of life on a global scale.
- B3.2 Compare findings with respect to selected quality of life indicators in some developing and more developed countries.

### MATHEMATICS:

- Grade 7 - B1.7 Convert between fractions, decimal numbers, and percentages, in various contexts.
- Grade 8 – B1.4 Use fractions, decimal numbers, and percentages, including percentages of more than 100% or less than 1% interchangeably and flexibly to solve a variety of problems.
- Grade 7 – C2.2 Evaluate algebraic expressions that involve whole numbers and decimal numbers.
- Grade 7 – C3.2 Read and alter existing code, including code that involves events influenced by a defined count and/or sub-program and other control structures, and describe how changes to the code affect the outcomes and the efficiency of the code.
- Grade 8 – C3.2 Read and alter existing code involving the analysis of data to inform and communicate decisions and describe how changes to the code affect the outcomes and the efficiency of the code.

## FAITH CONNECTIONS:

This learning experience corresponds strongly with the Catholic Social Teaching theme of The Dignity of Work and the Rights of Workers. One of the tenets of this theme is that decent and fair wages are required to maintain the dignity of the worker and the work. When we pay people differently for doing the same work or require more unpaid work from some and less from others, we violate this theme.

## ONTARIO CATHOLIC SCHOOL GRADUATE EXPECTATIONS:

- A Collaborative Contributor who works effectively as an interdependent team member.
- A Collaborative Contributor who respects the rights, responsibilities, and contributions of self and others.
- A Responsible Citizen who witnesses Catholic social teaching by promoting equality, democracy, and solidarity for a just, peaceful, and compassionate society.

## NOTES:

This learning experience has been adapted from parts of a learning experience called *Paying for It in Math That Matters 2* (see References section).

## RESOURCES NEEDED:

- Three worksheets ([Minutes of Paid and Unpaid Work per Day](#), [Maternity Leave vs Paternity Leave](#), [Pay for Unpaid Work](#) (p. 25-28).
- Access to laptops.
- Links included in the learning experience.

## REFERENCES:

Life expectancy. (n.d.). Retrieved July 04, 2020, from <https://ourworldindata.org/grapher/life-expectancy?tab=map>

Stocker, D. (2017). *Math that matters 2: A teacher resource linking math and social justice*. Toronto: Canadian Centre for Policy Alternatives.



### Minutes of Paid and Unpaid Work per Day, by Gender

The data shown below was collected by the Organization for Economic Co-operation and Development (OECD). Take a few moments to study the data. What do you notice? What do you wonder?

Country	Minutes per day of unpaid work - Men	Minutes per day of unpaid work – Women	Minutes per day of paid work - Men	Minutes per day of paid work - Women
Canada	148.1	223.7	340.5	268.3
Japan	40.8	224.3	451.8	271.5
Turkey	67.6	305.0	358.3	133.9
Sweden	171.0	220.2	313.0	275.2
Finland	157.5	235.8	248.6	209.9
OECD Average	135.8	262.4	317.4	217.7
India	51.8	351.9	390.6	184.7



## Maternity Leave vs. Paternity Leave

Maternity leave is the amount of time that a mother can take off work for the birth of a child while still having her job protected. The table below shows how the length of maternity leave, in weeks, has changed in several countries since 1990. The final column gives each country's average satisfaction with life rating (out of 10).

	1990	2000	2010	2015	2016	Life Satisfaction
Canada	17	17	17	17	17	7.4
Japan	14	14	14	14	14	5.9
Turkey	12	12	16	16	16	5.5
Sweden	0	11.3	15.6	15.6	19.9	7.3
Finland	17.5	17.5	17.5	17.5	17.5	7.6
OECD Average	14.5	15.8	18.5	19.1	19.1	6.5
United Kingdom	40	40	52	52	52	6.8

The paid leave for fathers for the same countries is shown below:

	1990	2000	2010	2015	2016
Canada	0	0	0	0	0
Japan	0	0	52	52	52
Turkey	0	0	0	0	1
Sweden	1.4	5.8	10	10	14.3
Finland	0	3	7	9	9
OECD Average	0.2	3.4	8.7	9.1	8.2
United Kingdom	0	0	2	2	2

### Pay for Unpaid Work

Log the number of minutes your parent(s)/guardian(s)/caregiver(s) does work that is unpaid. Fill in the following chart and add additional columns if required.

Category of Work	Person 1	Person 2	Person 3
Housework and cleaning			
Meal planning, grocery shopping, cooking			
Yard work			
Laundry			
Planning activities for the family			
Budgeting, finances			
Playing with children			
Helping children with schoolwork			
Taking care of children's health and hygiene			
Shuttling children to different events			

**“Fifty-one percent of a nation can establish a totalitarian regime, suppress minorities, and still remain democratic”**

*Erik von Kuehnett-Leddihn (Stocker, 2008, p. 173)*

#### LEARNING EXPERIENCE OVERVIEW AND LINK TO UNITED NATIONS THEME:

Most Canadians accept our electoral system, single member plurality, more commonly known as First Past the Post, without question. However, it is the source of significant inequity in our society. One only needs to study the results of any provincial or federal election to see how unfair our system can be. In 2018, Ontarians went to the polls. 40.5% voted for the Progressive Conservatives (PCs), who ended up winning a majority (76 of 124 seats).

(<https://globalnews.ca/news/4257183/ontario-election-results-2018/>)

This is an example of the common scenario in which a party's share of seats is disproportionate to its share of the vote. It causes the majority of voters (in this case, the 59.5% who did not vote for the winning party) to feel underrepresented in government because the parties for which they voted have no real power.

Because our system rewards only one candidate per riding, (i.e., the candidate with the highest number of votes wins the seat in the House) the parties of the unsuccessful candidates get a small amount of money per vote. People often vote for the person most likely to defeat the candidate/party they like the least instead of for the candidate/party they like the most. This reality coupled with strategic candidate nominations, leads to reduced representation for women and minorities in provincial and federal governments.

Proportional Representation (PR) is an option of the First Past the Post system. Although there are many different versions of PR, they all revolve around the central principle that each party's allotment of Members of Parliament /Members of Provincial Parliament) is proportional to its share of the vote. In the example noted above, the PCs, by virtue of getting more votes than any other party, would still form the government, but they would only get 40.5% of the 124 seats in the House. Not only does PR result in minority governments more often, but it often leads to increased representation for women and minorities.

In this learning experience, students analyze various sets of election results to see how vote percentages are disproportionate to numbers of seats won in the First Past the Post. They then use proportional reasoning to determine what these governments would look like under a system of Proportional Representation. Throughout this work, they build representations of the data in Scratch to form opinions on levels of fairness and inclusivity in each system. As such, this learning experience addresses United Nations Sustainable Development Goals #10 – Reducing Inequalities, and #16 – Peace, Justice, and Strong Institutions. Within these goals, this learning experience directly addresses the following targets:

- 10.2 By 2030, empower and promote the social, economic, and political inclusion of all, irrespective of age, sex, disability, race, ethnicity, origin, religion or economic or other status.
- 10.3 Ensure equal opportunity and reduce inequalities of outcome, including by eliminating discriminatory laws, policies and practices and promoting appropriate legislation, policies, and action in this regard.
- 16.7 Ensure responsive, inclusive, participatory, and representative decision-making at all levels.
- 16.10 Ensure public access to information and protect fundamental freedoms, in accordance with national legislation and international agreements.

### CODING CONSIDERATIONS:

When teachers guide students to learn to code, they often employ the **Use-Modify-Create** continuum. Students who have little coding experience are best suited to the **Use** stage of the continuum. In the **Use** stage, students run a pre-created code, witness the results, then analyze the code to learn how the ordering of commands creates the results.

As students develop a stronger understanding of coding, the **Modify** stage becomes appropriate. In the **Modify** stage, students make changes to existing codes (or, in some cases, they add on to existing codes) to create results that differ from (or add to) those of the original. This stage introduces the computational thinking skill of debugging. Invariably, first attempts at creating a desired result with code do not work out as hoped, thus necessitating a period of tinkering during which the code inches closer to perfection. This process can be frustrating for students with a narrow coding skill set, so plenty of time in the **Use** stage is advised before moving on to **Modify**.

In the **Create** stage, students envision a desired result and then build the code from scratch. They harness the skills and concepts learned in the previous two stages.



Graph creation in Scratch can be a very involved process. Many blocks must be organized into long chains of code to receive the data, categorize it, and turn it into a graph. A small percentage of students who have significant experience and skill with coding might be able to jump straight to the **Create** stage of the **Use-Modify-Create** continuum. Most, however, will benefit from starting at earlier stages. A code is provided for students to *Use* (it is found in the Action section of this learning experience). Students should run it several times with data from a variety of elections. As they do, they should study the code to learn how the various chunks fulfil different purposes. When students try to input federal election data, they will encounter their first problem because the provided code is made for an Ontario election and there is no room for the Bloc Quebecois. This will force students into the **Modify** stage as they make changes and additions to accommodate a new party. More modifications will be required as the tasks become more complex.

### LEARNING GOALS:

At the end of this learning experience, students will know, understand, and/or be able to:

- How two electoral systems (First Past the Post and Proportional Representation) work.
- Connect ideas related to the fairness of electoral systems to Catholic Social Teaching.
- Discriminate between proportionate and disproportionate situations and link this understanding to social justice issues.
- Apply knowledge of the Cartesian Grid, variables, and loops effectively in code modification and/or creation.
- Develop (either through modification or creation) Scratch codes to represent election results from First Past the Post and Proportional Representation systems.

### LOOK-FORS:

- Student ability to read, understand, modify and/or create code to represent the mathematics underlying two electoral systems (First Past the Post and Proportional Representation).
- Student ability to use mathematics and ideas related to fairness to defend on electoral system over the other.

## INSTRUCTIONAL COMPONENT:

- **PRIOR KNOWLEDGE:** A basic understanding of the Canadian political landscape would be beneficial to this learning experience. If students are new to the topic of Canadian politics, make sure to take the time for discussion of issues and systems as required.
- **TERMINOLOGY:** election, First Past the Post, Proportional Representation, Parliament, House of Commons, political party, federal, provincial.
- **RESOURCES:** The [Student Exploration Guide](#) (p. 40) and the First Past the Post Scratch codes (p.34) are required. Access to technology capable of running Scratch is also needed.

## ENVISION (MINDS ON):

1. Present the following vignette to the students. It is presented as rather generic but can be modified to reflect the make-up and interests of specific classes. Having students vote and subsequently feel a sense of loss because of the “winner takes all” approach, may prompt them to become emotionally invested in the learning to come:

Imagine that your class of 30 students has won a \$10 000 grant. The money must be used for a single improvement initiative (i.e., you must spend all the money on one thing; you cannot spend half on one initiative and half on another). Each student in your class gets to vote for one of three initiatives:

1. Upgrades to the school’s sports equipment
2. Enhanced technology for the classroom
3. Innovative art supplies to allow for a more engaging visual arts program

11 students vote for the sports equipment, 10 students vote for the technology, and 9 students vote for the art supplies. Sports equipment it is, then, right?

But wait! 19 students, well over half the class, wanted something different. This is not fair! Is it?

2. Discuss student reactions and feelings toward the vignette. When appropriate, segue to the topic of electoral systems by reading the first page of the [Student Exploration Guide](#) together. Take time to clarify any political details that are unfamiliar to the students. To help with understanding, present the image below, or a similar source of actual election results. Ask students to study it. Invite them to share any observations they find particularly important. If

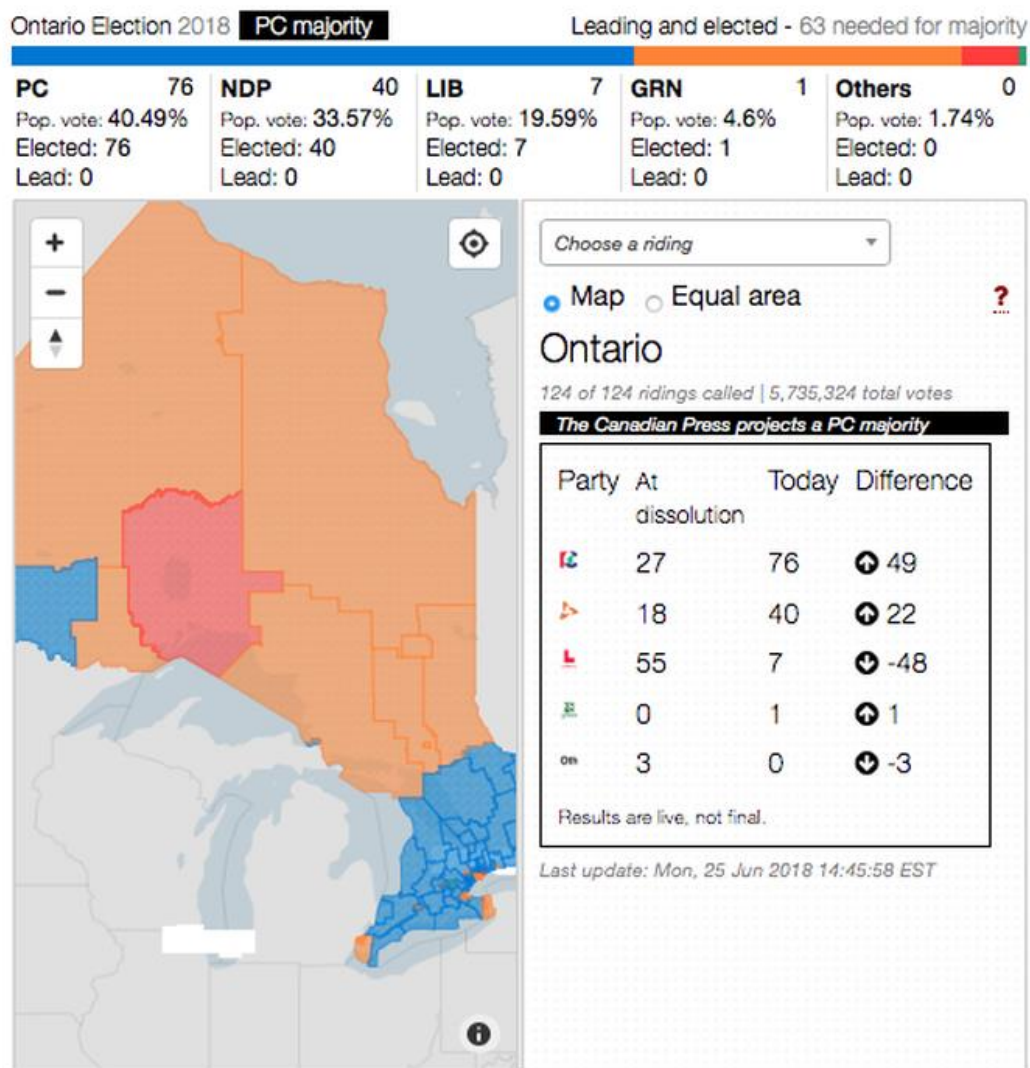




no such comments are forthcoming, ask them to look for things in the image that seem to lack a mathematical sense of fit.

Ensure that the students' attention is drawn to the fact that winning 40.5% of the popular vote allowed the Progressive Conservatives to form a majority government. Clarify political details as needed, then invite students to express their thoughts and opinions on this situation. During this discussion, define proportionality and ensure that students see that the number of seats won in this instance is not proportional to the corresponding vote percentage. Explain that the tension between the number of seats won and the share of the popular vote attained by parties in Canada's electoral system are central to this math learning experience on proportionality.

Figure 3: Ontario Election 2018 (The Canadian Press, 2018)



## ACTION (SOWING):

3. Have students work in pairs on the second page of the [Student Exploration Guide](#), First Past the Post – Unplugged (p.41). This task provides them with simple election results for a fictional Canadian province. Students are to take the numbers of seats won by the three parties across the six ridings and translate them into vote percentages, numbers of seats, and seat percentages for both the First Past the Post system as well as Proportional Representation (PR). They are then prompted to decide which of the two systems they prefer and to justify their choice.

As students work, circulate, and offer support and feedback as needed. As students finish their work, facilitate a whole class discussion. Make sure the disproportionate nature of the First Past the Post results is clear. Highlight the difference between these results and the proportionate ones achieved under PR.

4. Present one of the two Scratch codes linked below:

[Option 1: First Past the Post #1](#) This one uses more of the stage, so the graphs are larger, but this means that the student must work in all four quadrants. If students are familiar with the four quadrants of the Cartesian Grid, with the negative integers involved, then this is a good option.

[Option 2: First Past the Post #2 – 1<sup>st</sup> Quadrant Only](#) This version creates the same graphs but only uses the first quadrant. While the graphs end up being smaller, there is reduced cognitive load on students who are unfamiliar and/or uncomfortable with negative integers and/or the other three quadrants.

Provide students with the results of the most recent Ontario provincial election (page 3 of the [Student Exploration Guide](#), p. 42) and have them run the code several times. Take the time to walk through the code so that students understand the functions of each of the chunks.

Explain to the students that the code, as it has been delivered to them, does not convey the disproportionate nature of the results because only one type of data, vote percentage, is represented. To see proportionality, or its opposite, one must compare vote percentage with number of seats won, or percentage of seats. Assign students the task of remixing the code so that two bars grow on the x-axis for each party: the existing one for vote percentage, and a new one for number of seats, or seat percentage, if they prefer. Together with the students, generate a list of things that can be left alone and things that need to be changed to complete this task. The code that creates the graph's axes and increments can remain untouched, although they might want to adjust the label on the y-axis to accommodate the new data; this



can be accomplished by editing the appropriate backdrop. The commands for the input and graphing of vote percentage data can be left alone, although they may want to make slight adjustments to the widths and placement of the bars to accommodate the new bars. The chunks of code that receive input and graph bars can be duplicated and edited to accommodate the new data to be added to the graph.

Once students have completed their remixes, lead a whole class discussion. The following ideas should come up:

- The First Past the Post system disproportionately favours the party with the highest vote percentage. In this case, the PC party's 40.5% share of the vote translated into over 60% of the seats. Every other party's share of the seats is less than its vote percentage (the NDP almost broke even; its 40 seats amounts to 32.25% of the total, which is just shy of its 33.6% vote percentage).
- To be proportional, vote percentage and seat percentage need to be the same. Under PR, the PCs would lose some seats and every other party would gain seats.
- The new codes are expansive, but there is a high degree of repetition as the task requires the same set of steps to be taken for many pieces of data. While the result may look unwieldy, it is not as complex as it appears at first glance.

5. Now that students have a visual representation of the disproportionality inherent in the First Past the Post system, it is time for them to create a complementary representation of PR. They can do this in at least two ways. They can create a new remix of the provided Scratch code, this time using the numbers of seats the parties would have won under PR instead of First Past the Post. The other option is to add to the codes they developed in step 4. They can change their double bar graphs, showing vote percentage and number of seats in First Past the Post, into triple bar graphs by adding the numbers of seats under PR for each party. As student pairs work on this task, circulate throughout the space and provide support and feedback as required. Once everyone has finished, take time to discuss the proportionality evidenced on the new graphs as well as the coding manipulations that were required to achieve them.

6. Direct students' attention to the election data from the 2019 federal election (last page of the [Student Exploration Guide](#), p. 44). Have students comment on the proportionality (or lack thereof) in this data as compared with Ontario 2018 (fourth page of the [Student Exploration Guide](#), p. 43). Then, have students develop Scratch codes to represent these new results under the existing First Past the Post system and an alternate PR system.



## CONSOLIDATION (NURTURING):

7. The following questions can be used to help students consolidate their understanding of proportionality in the context of the Canadian electoral system:

- Do the results of the most recent federal election exhibit more or less proportionality than the results of the 2018 Ontario election? How do you know? How is this difference in proportionality shown on the graphs produced in Scratch?
- What impacts would a move toward Proportional Representation have on Canadian society? Explain your reasoning.
- In what instances could Proportional Representation be seen as fairer than First Past the Post? In what instances could First Past the Post be seen as fairer than Proportional Representation?
- Which system do you prefer? Defend your choice with evidence (some of which must be math-based).

## DISCERN (MONITORING):

This learning experience is best to be introduced within the context of an actual election campaign when the students may be slightly more aware and knowledgeable than usual about candidates, parties, issues, etc. However, elections do not happen every year. Using this learning experience during a non-election year would require considerable front-loading of knowledge to ensure student interest and success.

It may seem counterintuitive to expose students who cannot vote to the content of an election, a topic not often noted for its “WOW!” factor. Intermediate students, however, have a keen sense of fairness and often become quite concerned with and engaged in contexts that are unfair. This learning experience supplies this motivation.

As students work on the coding tasks, the teacher will have ample opportunity to circulate among them. This is a good opportunity to monitor students and provide guidance if needed. Coding can come with a steep learning curve. Teachers should be prepared to offer scaffolds for students in time to prevent their disconnection from the task.



## EXTENSIONS:

The First Past the Post electoral system is often criticized as being unfair because the winning party's percentage of seats won is usually higher than its share of the popular vote. For example, in Ontario in 2018, the Progressive Conservatives won 61.3% of the seats despite earning 40.5% of all votes cast. This leads many to uphold Proportional Representation as the fair option. However, what if you were one of the successful PC candidates who was not allowed to assume the seat you won because it had to go to another party to make the seat numbers match the popular vote? Would you think that was fair? After all, you did outperform all the other candidates in your riding.

Neither system is perfect. Ask students to research other electoral options such as Mixed-Member Proportional Representation. There are several different forms of this system, but they all attempt to blend First Past the Post and Proportional Representation in some way. Have students learn about one manifestation of this system and code its results in Scratch to analyze it for proportionality.

Students could also investigate the relationship between parties' total numbers of votes and total numbers of seats won. In Ontario in 2018, the PCs received 2 324 742 votes and won 76 seats. That is 30 588.71 votes per seat. On the other end of the spectrum, 264 094 Ontarians voted for the Green party, but all those votes resulted in only one seat. Students could investigate and discover the disproportionate relationship between votes earned and seats won, adjusting to reflect a proportional system.

## CURRICULUM CONNECTIONS:

### MATHEMATICS:

- Grade 7 – B2.10 Identify proportional and non-proportional situations and apply proportional reasoning to solve problems.
- Grade 8 – B2.8 Compare proportional situations and determine unknown values in proportional situations and apply proportional reasoning to solve problems in various contexts.
- Grade 7 – C3.1 Solve problems and create computational representations of mathematical situations by writing and executing efficient code, including code that involves events influenced by a defined count and/or sub-program and other control structures.



- Grade 7 – C3.2 Read and alter existing code, including code that involves events influenced by a defined count and/or sub-program and other control structures, and describe how changes to the code affect the outcomes and the efficiency of the code.
- Grade 8 – C3.1 Solve problems and create computational representations of mathematical situations by writing and executing code, including code that involves the analysis of data to inform and communicate decisions.
- Grade 8 – C3.2 Read and alter existing code involving the analysis of data to inform and communicate decisions and describe how changes to the code affect the outcomes and the efficiency of the code.
- Grade 7 – D1.3 Select from among a variety of graphs, including circle graphs, the type of graph best suited to represent various sets of data; display the data in the graphs with proper sources, titles, and labels, and appropriate scales; and justify their choice of graphs.
- Grade 8 – D1.3 Select from among a variety of graphs, including scatter plots, the type of graph best suited to represent various sets of data; display the data in the graphs with proper sources, titles, and labels, and appropriate scales; and justify their choice of graphs.

#### **FAITH CONNECTIONS:**

This learning experience corresponds strongly with the Catholic Social Teaching theme of Call to Family, Community, Participation. According to this theme, Catholics “believe people have a right and a duty to participate in society, seeking together the common good and well-being of all, especially the poor and vulnerable.” Participation in elections is part of this duty. However, the First Past the Post system often discourages people from voting as they see their votes turn into nothing as the winner in each riding gets 100% of the prize with usually less than 50% of the vote. Under Proportional Representation, each vote would count because it would push a party’s vote percentage higher, thereby proportionally raising the party’s level of representation in government. If people see that their votes have actual impact on the formation of government, they may be more likely to participate in elections.

#### **ONTARIO CATHOLIC SCHOOL GRADUATE EXPECTATIONS:**

- A Reflective, Creative, and Holistic Thinker who makes decisions in light of gospel values with an informed moral conscious.
- A Responsible Citizen who witnesses Catholic social teaching by promoting equality, democracy, and solidarity for a just, peaceful, and compassionate society.



## NOTES:

This learning experience has been adapted from a learning experience called *The Winner Takes It All...?* from *Math That Matters* (see References section).

## RESOURCES NEEDED:

- Access to laptops.
- Links included in the learning experience.
- The [Student Exploration Guide](#).

## REFERENCES:

Bogart, N., & Tahirali, J. (2019, October 24). How Canada's electoral map changed after the vote. Retrieved October 20, 2020, from <https://election.ctvnews.ca/how-canada-s-electoral-map-changed-after-the-vote-1.4652484>

Ontario election results 2018: A map of the results. (2018, June 08). Retrieved from <https://www.theglobeandmail.com/canada/article-ontario-election-results-2018-a-map-of-the-live-results/>

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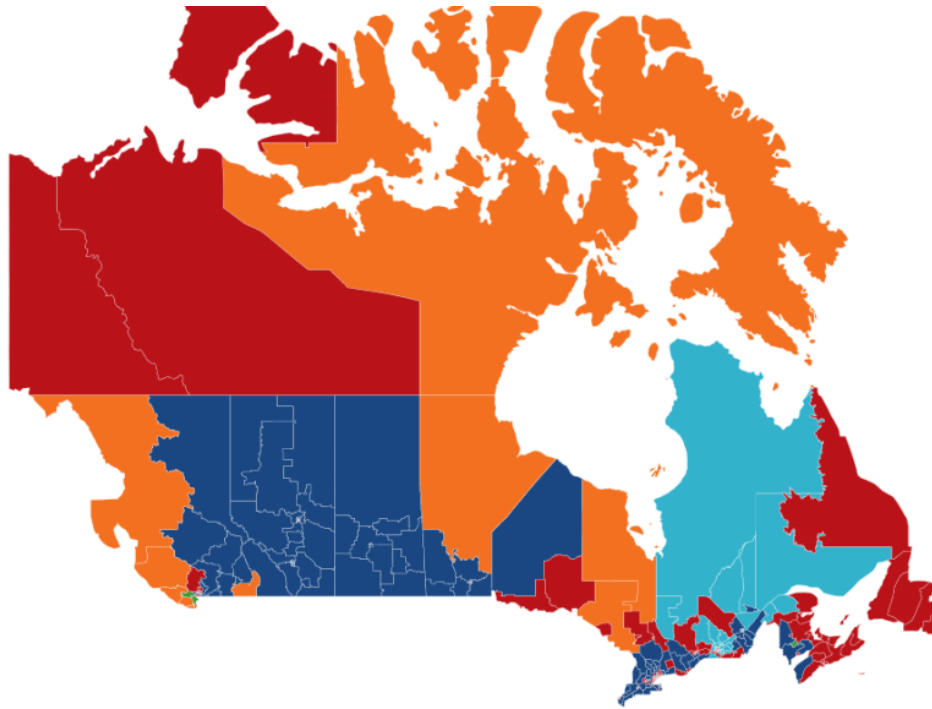
Stocker, D. (2007). *Math That Matters: A teacher resource linking math and social justice*. Ottawa, ON: Canadian Centre for Policy Alternatives.





## First Past the Post – Student Exploration Guide

Figure 4: (Bogart & Tahirali, 2019)



Canada has a "First Past the Post" system of voting. In each of Canada's 338 federal ridings, candidates face off. The winner gets a seat in Parliament as the representative of that riding; the other parties get \$1.75 per vote. In every riding, one person gets 100% of the prize with only a fraction of the votes. Sometimes the winner has less than 40% of the votes, but because he/she has more than anyone else, he/she wins.

If you vote for someone who does not win, your vote does not "get" you anything. You have supported one of the losers, and there is no consolation prize. For this reason, more Canadians report being unhappy with the "First Past the Post" system than are in favour of it.

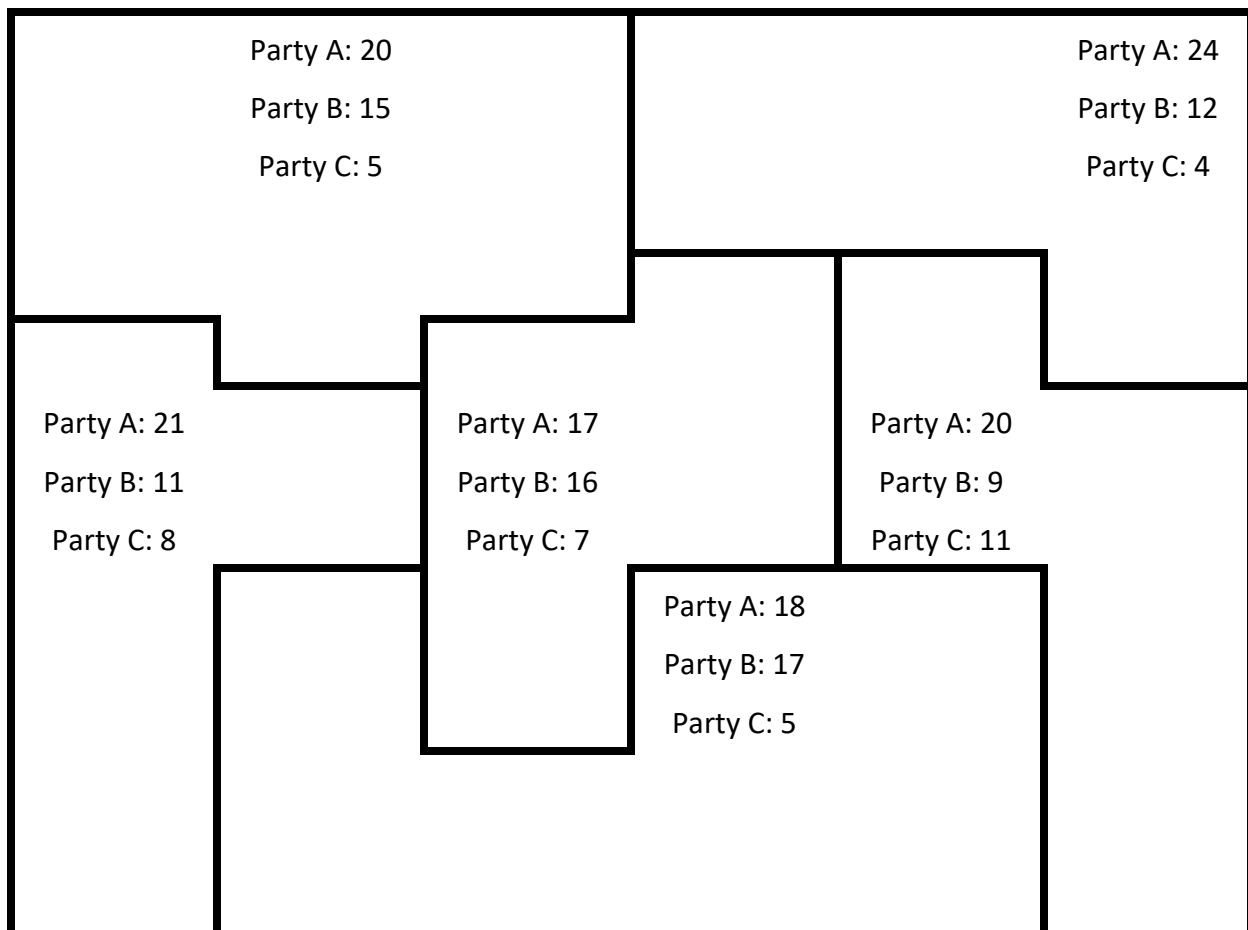
Another way to vote is called **Proportional Representation (PR)**. To put it simply, under this form of voting, if a party gets 41% of the votes, it gets 41% of the seats in the House of Commons. In other words, you will not have situations in which a vote for a non-winning candidate achieves nothing for the voter.

One of the side effects of a system that is not based on "all-or-nothing" selection is that it tends to result in increased representation of women and minorities in government.

In "First Past the Post" voting, why do political parties tend to be conservative (traditional; adverse to change, [https://en.wikipedia.org/wiki/Conservatism\\_in\\_Canada](https://en.wikipedia.org/wiki/Conservatism_in_Canada)) and have more men running as candidates?

### First Past the Post - Unplugged

The diagram below depicts an imaginary province that has six ridings. There are three political parties in this province (Party A, Party B, and Party C). The results of a recent election are as follows:



Analyze the results shown above for each of the electoral systems described below.

### First Past the Post:

- People vote for candidates in their own ridings.
- In each riding, the candidate with the most votes wins the seat. The successful candidate does not need more than 50% of the votes, just more than any other candidate.
- Provincially, the party with the most winning candidates forms the government. If it has more than half the seats, it is a majority government. If not, it is a minority government.
- Often, the number of seats a party gets is not proportional to its share of the popular vote.

Party	% of Vote	# of Seats	% of Seats
A			
B			
C			

### Proportional Representation:

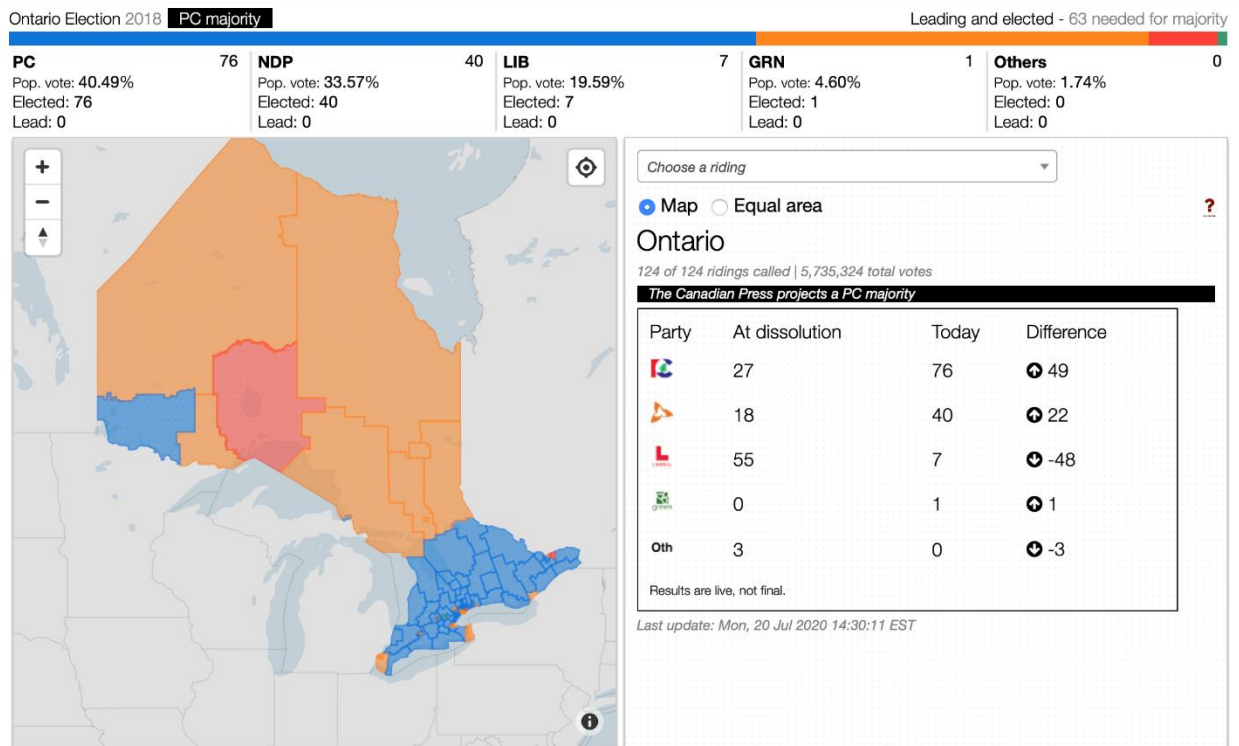
- Voters in all ridings cast their votes.
- The percent of the vote earned by each party is calculated.
- This percentage is then used to determine the number of seats awarded to each party.
- The number of seats a party gets is proportional to its share of the popular vote.

Party	% of Vote	# of Seats	% of Seats
A			
B			
C			

Which system do you prefer? Explain your choice.

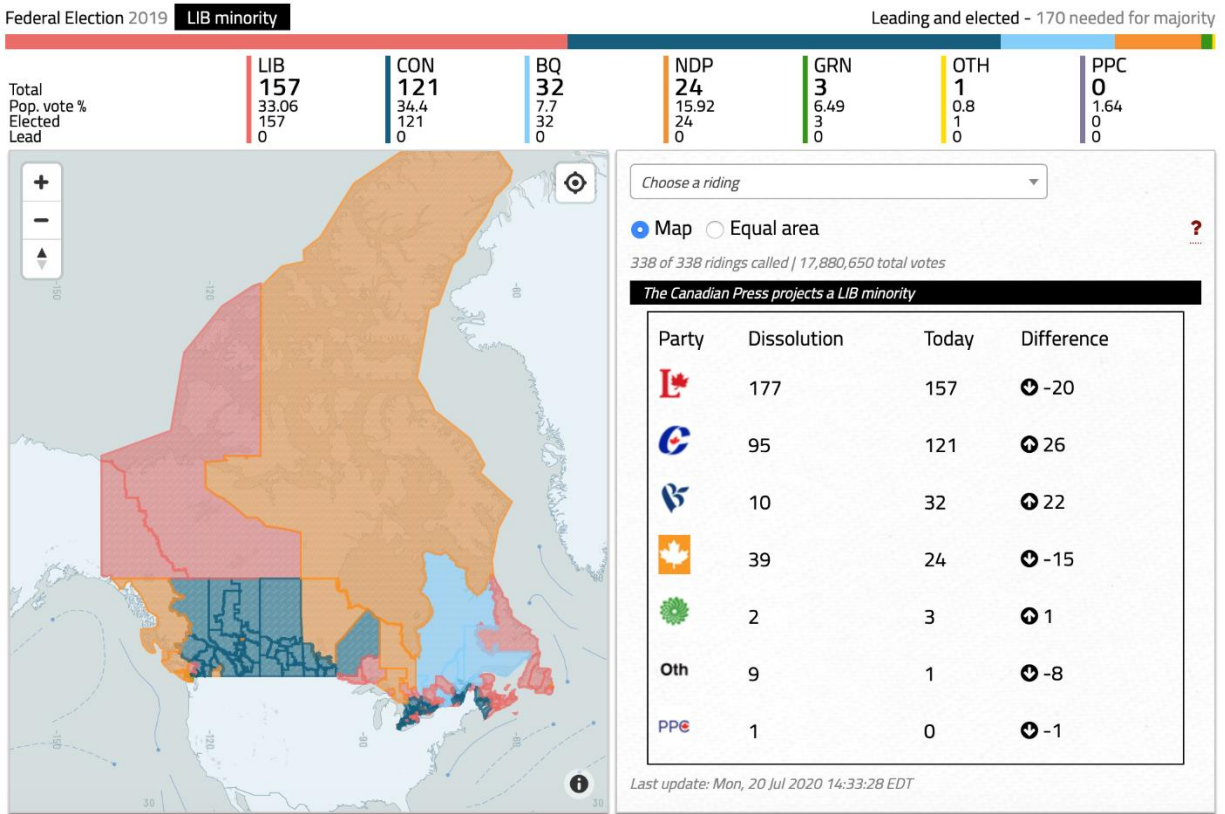
## Ontario 2018 Election Results

Figure 5: Ontario Election 2018 (The Canadian Press, 2018)



## Canada 2019 Election Results

Figure 6: Canada Election 2019 (The Canadian Press, 2019)



## MISSING AND MURDERED INDIGENOUS WOMEN AND GIRLS IN CANADA

**“...there’s another pipeline that’s arguably more lethal than those that carry oil and gas but gets far less attention from the media or politicians: the pipeline from Canada’s foster-care system to murdered, missing and exploited Indigenous women and girls.”**

Palmater, 2017

### LEARNING EXPERIENCE OVERVIEW AND LINK TO UNITED NATIONS THEME:

In this lesson, students examine the issue of Missing and Murdered Indigenous Women and Girls in Canada. They look at the disproportionate nature of violence against Indigenous females, as compared with other groups in Canada, consider some social realities that prompt this higher than normal level of violence, and use code to represent the impact that preventative measures can have on the safety of Indigenous females. As such, this lesson addresses United Nations Sustainable Development Goals #10 – Reducing Inequalities, and #16 – Promote Just, Peaceful, and Inclusive Societies. Within these goals, this lesson directly addresses the following targets:

**10.2** By 2030, empower and promote the social, economic, and political inclusion of all, irrespective of age, sex, disability, race, ethnicity, origin, religion or economic or other status

**10.3** Ensure equal opportunity and reduce inequalities of outcome, including by eliminating discriminatory laws, policies and practices and promoting appropriate legislation, policies, and action in this regard

**16.1** Significantly reduce all forms of violence and related death rates everywhere

**16.2** End abuse, exploitation, trafficking, and all forms of violence against and torture of children

**16.3** Promote the rule of law at the national and international levels and ensure equal access to justice for all

As this lesson focuses specifically on gender-based violence, this lesson also addresses aspects of UNSDG #5 – Gender Equality.



## CODING CONSIDERATIONS:

When teachers guide students to learn to code, they often employ the **Use-Modify-Create** continuum. Students who have little coding experience are best suited to the **Use** stage of the continuum. In the **Use** stage, students run a pre-created code, witness the results, then analyze the code to learn how the ordering of commands creates the results.

As students develop a stronger understanding of coding, the **Modify** stage becomes appropriate. In the **Modify** stage, students make changes to existing codes (or, in some cases, they add on to existing codes) to create results that differ from (or add onto) those of the original. This stage introduces the computational thinking skill of debugging. Invariably, first attempts at creating a desired result with code do not work out as hoped, thus necessitating a period of tinkering during which the code inches closer to perfection. This process can be frustrating for students with a narrow coding skill set, so plenty of time in the **Use** stage is advised before moving on to **Modify**.

In the **Create** stage, students envision a desired result and then build the code from scratch. They harness the skills and concepts learned in the previous two stages.

This lesson can be adapted to accommodate any of the three stages. For each of the coding tasks (in steps 5, 7, and 8 of the lesson), sample Scratch codes are provided. These can be delivered to students who are learning within the **Use** stage. Alternately, the teacher may remix any of the provided codes, perhaps by changing or removing aspects so that the results change, and have the students **Modify** these so that the desired result is attained. For students who are very well versed in Scratch coding, these sample codes can be ignored. In this event, students would be directed to **Create** an original code to meet a desired result.

## LEARNING GOALS:

At the end of this lesson, students will know, understand, and/or be able to:

- That Indigenous females have been and continue to be disproportionately affected by violence.
- Connect the issue of MMIWG to the bigger picture of Canadian history as well as to Catholic Social Teaching.
- Create percentages.
- Discriminate between proportionate and disproportionate situations and link this understanding to social justice issues.





- Use loops and variables effectively in code.
- Develop, either through modification or creation, Scratch codes to represent various ideas related to MMIWG

### LOOK-FORS:

- Student ability to read, understand, modify and/or create code to represent the mathematics underlying a social justice issue.
- An emotional response (on the part of the students) to the issue of Missing and Murdered Indigenous Girls and Women that translates into advocacy to work toward a solution.

### INSTRUCTIONAL COMPONENT:

- **PRIOR KNOWLEDGE:** Most of the knowledge required to participate in this lesson is contained within the steps of the lesson. However, a basic understanding of Canada's history, particularly the ways in which the Indigenous peoples have been disadvantaged, will help students contextualize the lesson.
- **TERMINOLOGY:** Indigenous, First Nations, Inuit, Métis, Aboriginal, homicide, variable, in care.
- **RESOURCES:** Any supplementary resources that can help illuminate the ways in which Indigenous people in Canada have been disadvantaged since contact with Europeans would be of benefit.

### ENVISION (MINDS ON):

1. Project the YouTube video of the REDress Project linked [here](#). The artist/narrator uses the term "Murdered and Missing Indigenous Women and Girls." Ask students what, if anything, they know about the term. Ensure that students have a general understanding of this crisis (i.e., Indigenous females are disproportionately affected by violence, and many of these events have gone uninvestigated and unresolved). View the images from the [REDress Project](#) website. Examine how the artist has represented the issue of Missing and Murdered Indigenous Women and Girls and discuss the impact the exhibition has. For additional information, visit this link <http://walkingwithoursisters.ca/>.



## ACTION (SOWING):

2. Begin a discussion about the experience of Indigenous people in Canada since explorers from Europe arrived hundreds of years ago. Steer the conversation such that well-known abuses against Indigenous people come to light. This discussion might encompass such ideas as the banning of Indigenous culture and religion, the fact that Indigenous people could not vote until 1960, the abuses they endured in the residential school system, and various laws that have limited Indigenous rights (for example, the Indian Act).

3. Present the following facts to the students:

1 017 Indigenous women were killed in Canada between 1980 and 2012.

At least 164 more went missing during that time.

Ask students to comment on these figures. There will very likely be a range of reactions. Some might be horrified while others might not grasp the gravity of these facts (i.e., they may not realize how disproportionate these figures are; this is part of the inquiry to follow).

4. Provide students with the following series of prompts. Debrief and discuss as necessary:

- a. The 2016 Census set Canada's population at 35 151 728. The same census reveals that 4.9% of the population is Aboriginal. This is the term used in the 2016 Census; it is meant to encompass people of First Nations, Metis, and Inuit descent. How many people is that?
- b. There were 20 313 homicides in Canada between 1980 and 2012. 32% of these were female victims. Of this large group of female homicide victims, 1 017 were Indigenous females. What percentage of female homicide victims during this time were Indigenous?
- c. 4.9% of Canadian women are Indigenous. How does this compare with the percentage of murdered Canadian women who are Indigenous? What explanations can be given for this comparison?



- d. In 2017, the number of missing Canadian females was 1 455. What percentage of them were Indigenous? How does this figure compare with the overall percentage of Indigenous females in Canada? What explanations can be given for this comparison?

Take the time to explicitly show the disproportionate nature of these statistics. To determine the percentage required for 4d, students will use two pieces of information: the 1 455 missing Canadian females noted above, and the 164 missing Indigenous females referenced in stage 3 of the lesson. The former statistic, however, is from 2017 while the latter encompassed a time ending in 2012. It is reasonable to assume that the 2017 statistic for Indigenous women is higher. Discuss how this would affect the percentage. The percentages of Indigenous women affected by violence are higher than the percentage of Canadian women who are Indigenous.

5. The next step is to determine reasons for this phenomenon. To this end, present the following information:

The Canadian Community Wellbeing Index (CCWI) studies four aspects, education, labour force activity, income, and housing, of Canadian communities, First Nations, Inuit, and non-Indigenous. The data gleaned from this study is used to rank Canadian communities in terms of wellbeing. According to the latest CCWI data, Indigenous communities comprise 96 of the 100 bottom Canadian communities and 1 of the top 100 Canadian communities.

This information can be represented graphically on Scratch. The code linked [here](#) is an example of how this can be accomplished. If the students have limited experience with coding, this code may be presented to them. If this path is chosen, the following points might be appropriate for discussion:

- The coloration of the bars clearly shows an inequity that exists among Canadian communities. Indigenous communities are over-represented in the bottom 100 and under-represented in the top 100. This indicates that many Indigenous communities have deficits in the four areas covered by the CCWI (education, labour force activity, income, and housing). This paints a picture of poor living conditions, lack of government services, and desperation in many Indigenous communities. These are conditions that often lead to increases in violence. It should come to light that measures to alleviate these conditions could lessen incidents of violence, thereby



helping to reduce violence against women in these most disadvantaged communities.

- The creation of the bars is dictated by the block coding scripts within the Scratch code. These can be analyzed block by block to build student understanding of how computational thinking skills and concepts can be harnessed within a coding environment to generate a desired result on the screen. In this case, a focus on loops and the use of the Cartesian Plane would be appropriate.

If students have some experience with Scratch, the teacher may choose to delete the code that creates the second bar, the one that depicts the bottom 100 communities. When presented with a code that only creates the first bar, the one that depicts the top 100 communities, students can be challenged to duplicate the existing code, and make changes so that an accurate second bar results.

Students with significant coding experience and skill can be challenged to represent the CCWI data in this environment as they see fit. This affords students a level of creativity that is often lacking in mathematics class. If this path is taken, many different representations of the data may result. This is one of the key benefits of using coding to create mathematical representations. In order to honour the validity of multiple means of representing this data, time should be taken to analyze many student codes.

6. The deficits in the four areas covered by the CCWI contribute to a high incidence of child removal from Indigenous homes. The Maclean's article linked [here](#) describes how First Nations, Métis, and Inuit children are removed from their homes and placed in care at shockingly high rates. It also describes how Indigenous children in care are particularly vulnerable to sexual violence. In short, the article presents a strong argument for a link between children in care and Missing and Murdered Indigenous Women and Children. Please note that it would not be appropriate to share this whole article with intermediate students (some of the content is too graphic); it is made available for the teacher's reference. Rather, consider presenting some or all the following facts to enable students to see this the causal relationship between Indigenous children in care and MMIWG:

- "Although Indigenous children make up only seven per cent of the population in Canada, they represent 48 per cent of all children in foster care."
- "...there are three times more Indigenous children in care today than there were during the height of residential schools."
- "Child welfare is a pipeline to prison for Indigenous peoples generally, but for Indigenous women and girls specifically, child welfare is also a pipeline to child exploitation, sex trafficking and murdered and missing Indigenous women and girls."



- “Indigenous girls in foster care have become targets for sexual predators who use the foster care system for easy access, and a recent report from British Columbia found that Indigenous girls are four times more likely to be victims of sexual violence while in foster care.”
- “Dr. Cindy Blackstock, who heads the First Nations Child and Family Caring Society won a human rights claim against Canada at the Canadian Human Rights Tribunal (CHRT) which found the federal government discriminates against First Nations children in care through underfunding, simply because they are Indigenous.” (Palmater, 2017)

By now, students should be open to the idea that preventative measures, especially ones that address both the conditions that lead to increases in violence in disadvantaged communities and the factors that promote the removal of Indigenous children from their families, could help lower rates violence against Indigenous women. If the communities that have deficits in education, labour force activity, income, and housing are the same ones in which women face increased levels of violence, then it would follow that taking steps to strengthen communities in these four areas, as well as others, would contribute to an overall lessening of violence. Obviously, measures such as these cost money. While some might argue that these costs are prohibitive, others claim that preventative costs are much less than the costs incurred when prevention is in place, i.e., costs related to after-the-fact policing, court, health care, and social assistance.

Claims about the cost savings of prevention vary. According to Northwest Alberta Child and Family Services, every dollar spent on preventative measures saves seven dollars of intervention or,  $y = 7x$ , when  $x$  represents prevention dollars and  $y$  represents intervention dollars saved. The Melissa Institute for Violence Prevention and Treatment estimates greater savings at a rate of \$28 of intervention saved for every dollar spent on prevention, or,  $y = 28x$ , when  $x$  represents prevention dollars and  $y$  represents intervention dollars saved. Have students represent these equations in Scratch as tables of values and as graphed lines. The code found [here](#) is an example of how this might be achieved. If the students have significant experience and proficiency with coding in the Scratch environment, they may not need to see the sample code. In this case, the sample can be saved for comparative purposes during a whole class discussion on various approaches to this task. If the students are somewhat new to coding, they may require a partially constructed code from which to start. In this case, a remix of the sample code that features only the steps to represent the first equation will give students the scaffolding required to work on the second relationship.

7. Present the following situation to the students:

Imagine a Canada in which the federal government fully respected Indigenous treaty rights and recompensed Indigenous peoples fairly for the use of their land. Indigenous communities could use this money to counteract the many factors that contribute to violence against Indigenous females. One idea might be to create cultural centres that empower Indigenous peoples to celebrate and preserve their cultures while delivering social services to counteract conditions that lead to violence and the removal of children. There is a lot to consider when developing a centre of this sort. There are many start-up costs (e.g., establishing a Board of Directors, getting the necessary insurance, furnishing the building) as well as ongoing yearly costs (e.g., rent, food, maintenance, paying staff).

Use Scratch to create representations of the following:

- a. Assume that the start-up costs for a cultural centre are \$60 000 and the yearly costs are \$40 000. How could you represent the total costs year by year in Scratch, as a graph, a table of values, both, or something entirely different?
- b. How might you adapt your Scratch code so that the user can input different values for start-up and yearly costs and still see the total costs year by year?
- c. Imagine that the government, in return for the use of Indigenous land, pays an Indigenous community a large sum (i.e., into the millions of dollars). And imagine that the community decides to use that money to fund the existence of the cultural centre for a long period of time. How might you add to your existing code to allow the user to input a large sum, e.g. \$1 500 000 or \$3 500 000, and see how many years it will fund the centre for based on previously input start-up and yearly cost values?

For a sample of what students might develop, click [here](#).

### CONSOLIDATION (NURTURING):

8. Discuss students' feelings and opinions considering their new learning about Missing and Murdered Indigenous Women and Girls in Canada. Focus on how the math, made visible through the act of coding, helps convey the gravity of the issue.



## DISCERN (MONITORING):

Violence against Indigenous women is a sensitive subject. Some students who have limited background knowledge on the topic and no experience with domestic violence themselves, which we wish was the case for all students, may not understand why the victims of such violence do not advocate more strongly for themselves. Other students who have witnessed and lived through and are perhaps are still living through such situations may use a variety of defence mechanisms during this lesson. Teachers must be ready to respond to the wide range of student responses to this subject with compassion and understanding.

As students work on the coding tasks, the teacher will have ample opportunity to circulate among them. This is a good opportunity to monitor students for frustration. Coding can come with a steep learning curve. Teachers should be prepared to offer scaffolds for students in time to prevent their disconnection from the task.

There are three coding tasks in this lesson. The first two offer significant potential scaffolding in the form of pre-made Scratch codes. The last, in step 6 of the lesson, asks students to **Create** a code without a scaffold. However, a scaffold is provided in the form of the sample that students might develop (see above). Teachers should be prepared to deliver it to students to avoid insurmountable levels of frustration.

## EXTENSIONS:

Revisit the [REDress Project](#) website. Consider an arts-based response, perhaps within the Scratch coding environment, to what has been learned in the above lesson. Refer to the Cultural Appropriation section (page 12-13) of [EOCCC's Culture Inspires Art](#).

## CURRICULUM CONNECTIONS:

### HISTORY (GRADE 7):

- A1.2 Analyse some of the main challenges facing various individuals, groups, and/or communities, including First Nations, Métis, and Inuit individuals and/or communities, in Canada between 1713 and 1800 and ways in which people responded to those challenges, and assess similarities and differences between some of these challenges and responses and those of people in present-day Canada.

- A1.3 Analyse the displacement experienced by various groups and communities, including First Nations, Métis, and Inuit communities who were living in or who came to Canada between 1713 and 1800, and compare it with present-day examples of displacement.
- A2.7 Communicate the results of their inquiries using appropriate vocabulary and formats appropriate for specific audiences.
- B1.2 Analyse some of the challenges facing various individuals, groups, and/or communities, including First Nations, Métis, and Inuit individuals and/or communities, in Canada between 1800 and 1850 and ways in which people responded to those challenges, and assess similarities and differences between some of these challenges, and ways in which people responded to those challenges.
- B1.3 Analyse the displacement experienced by various groups and communities, including Indigenous communities, who were living in or who came to Canada between 1800 and 1850, and compare it with present-day examples of displacement, and how some of these groups dealt with their displacement.

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#### HISTORY (GRADE 8):

- A1.2 Assess the impact that limitations with respect to legal status, rights, and privileges had on First Nations, Métis, and Inuit individuals and/or communities in Canada between 1850 and 1890.
- A2.7 Communicate the results of their inquiries using appropriate vocabulary and formats appropriate for specific audiences.
- A3.2 Describe key political and legal developments that affected First Nations, Métis, and Inuit people during this period, including treaties, government policies, and the Indian Act and other legislation, and explain some of their short- and long-term consequences.
- A3.3 Identify some key factors that contributed to the establishment of the Residential School System and explain the impact of this system on Indigenous individuals and communities.
- B1.1 Analyze key similarities and differences in the experiences of various groups and communities, including First Nations, Métis, and Inuit communities, in present-day Canada and the same groups/communities in Canada between 1890 and 1914.
- B1.2 Analyze some ways in which challenges affected First Nations, Métis, and Inuit individuals, families, and communities during this period, with specific reference to treaties, the Indian Act, the reserve system, and the Residential School System and how some of these challenges continue to affect Indigenous peoples today.





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## MATHEMATICS:

- Grade 7 - B1.7 Convert between fractions, decimal numbers, and percents, in various contexts.
- Grade 8 – B1.4 Use fractions, decimal numbers, and percents, including percents of more than 100% or less than 1% interchangeably and flexibly to solve a variety of problems.
- Grade 7 – B2.10 Identify proportional and non-proportional situations and apply proportional reasoning to solve problems.
- Grade 8 – B2.8 Compare proportional situations and determine unknown values in proportional situations and apply proportional reasoning to solve problems in various contexts.
- Grade 7 – C2.2 Evaluate algebraic expressions that involve whole numbers and decimal numbers.
- Grade 7 – C3.1 Solve problems and create computational representations of mathematical situations by writing and executing efficient code, including code that involves events influenced by a defined count and/or sub-program and other control structures.
- Grade 7 – C3.2 Read and alter existing code, including code that involves events influenced by a defined count and/or sub-program and other control structures, and describe how changes to the code affect the outcomes and the efficiency of the code.
- Grade 8 – C3.1 Solve problems and create computational representations of mathematical situations by writing and executing code, including code that involves the analysis of data in order to inform and communicate decisions.
- Grade 8 – C3.2 Read and alter existing code involving the analysis of data in order to inform and communicate decisions and describe how changes to the code affect the outcomes and the efficiency of the code.
- Grade 7 – D1.3 Select from among a variety of graphs, including circle graphs, the type of graph best suited to represent various sets of data; display the data in the graphs with proper sources, titles, and labels, and appropriate scales; and justify their choice of graphs.
- Grade 8 – D1.3 Select from among a variety of graphs, including scatter plots, the type of graph best suited to represent various sets of data; display the data in the graphs with proper sources, titles, and labels, and appropriate scales; and justify their choice of graphs.



## FAITH CONNECTIONS:

This lesson corresponds strongly with the Catholic Social Teaching theme of Life and Dignity of the Human Person. According to this theme, all human life is sacred. It is, therefore, our collective responsibility to work toward a state in which all people can live the full extent their lives without sudden and premature end. The issue of Missing and Murdered Indigenous Women and Girls is one of many examples of how humanity has contravened this responsibility. As with any problem, the first step toward a solution is acknowledging its existence and tracing its origins. This lesson helps accomplish this first step. It is hoped that increased awareness will create an emotional reaction that will be the impetus for positive change.

## ONTARIO CATHOLIC SCHOOL GRADUATE EXPECTATIONS:

- A Reflective, Creative, and Holistic Thinker who adopts a holistic approach to life by integrating learning from various subject areas and experience.
- A Responsible Citizen who witnesses Catholic social teaching by promoting equality, democracy, and solidarity for a just, peaceful, and compassionate society.

## NOTES:

This learning experience has been adapted from parts of a learning experience called *Missing in Math That Matters 2* (see References section).

## RESOURCES NEEDED:

- Access to laptops.
- Links included in the learning experience.

## REFERENCES:

This resource helps educate us around traumatized students and how to support a careful approach to this learning experience: <https://ofifc.org/wp-content/uploads/2020/03/Trauma-Informed-Schools-Report-2016.pdf>.

A Ted Talk about the lack of love in our society that contributes to the reality of MMIWG (Thunder Bay) “We Are More than Murdered and Missing”

<https://www.youtube.com/watch?v=fyILSRQ5kx8>

Palmater, P. (2017, April 12). From foster care to missing or murdered: Canada's other tragic pipeline. *Maclean's*. Retrieved October 20, 2020, from

<https://www.macleans.ca/news/canada/from-foster-care-to-missing-or-murdered-canadas-other-tragic-pipeline/>

*Reclaiming power and place: The final report of the National Inquiry into Missing and Murdered Indigenous Women and Girls* (Vol. 1a). (2019). Gatineau, ON: National Inquiry into Missing and Murdered Indigenous Women and Girls. Retrieved July 24, 2020, from [https://www.mmiwg-ffada.ca/wp-content/uploads/2019/06/Final\\_Report\\_Vol\\_1a.pdf](https://www.mmiwg-ffada.ca/wp-content/uploads/2019/06/Final_Report_Vol_1a.pdf)

Stocker, D. (2007). *Math that matters: A teacher resource linking math and social justice*. Toronto: Canadian Centre for Policy Alternatives.

## WEALTH DISTRIBUTION

**"The promise was that when the glass was full, it would overflow, benefiting the poor. What happens instead is that when the glass is full, it magically gets bigger, but nothing ever comes out for the poor."**

*Pope Francis, 2013*

### LEARNING EXPERIENCE OVERVIEW AND LINK TO UNITED NATIONS THEME:

Most intermediate students are aware that wealth is not distributed equitably and that, in all nations, the rich have much more than the poor. However, they, and most adults, may not be aware of the actual extent of this inequity. [In the United States, the richest 1% of the population owns 40% of the country's wealth. The bottom 80% share a meagre 7%](#) (Politizane, 2012). Canadian students may feel that things are much better in their own country, but they would be mistaken. [In 2012, the richest 20% of Canada's population owned 70% of the country's wealth while the poorest 20% shared less than 1%](#) (Broadbent Institute, 2014).

In this learning experience, students analyze the wealth distributions of three fictional countries. They then compare their findings and representations to the realities of financial inequity in the United States and Canada. As such, this learning experience addresses United Nations Sustainable Development Goal #10 – Reducing Inequalities. Within this goal, this learning experience directly addresses the following targets:

- 10.1 By 2030, progressively achieve and sustain income growth of the bottom 40 per cent of the population at a rate higher than the national average.
- 10.2 By 2030, empower and promote the social, economic and political inclusion of all, irrespective of age, sex, disability, race, ethnicity, origin, religion or economic or other status.
- 10.4 Adopt policies, especially fiscal, wage and social protection policies, and progressively achieve greater equality.
- 10.5 Improve the regulation and monitoring of global financial markets and institutions and strengthen the implementation of such regulations.

### CODING CONSIDERATIONS:

When teachers guide students to learn to code, they often employ the **Use-Modify-Create** continuum. Students who have little coding experience are best suited to the **Use** stage of the



continuum. In the **Use** stage, students run a pre-created code, witness the results, and then analyze the code to learn how the ordering of commands creates the results.

As students develop a stronger understanding of coding, the **Modify** stage becomes appropriate. In the **Modify** stage, students make changes to existing codes (or, in some cases, they add on to existing codes) to create results that differ from (or add onto) those of the original. This stage introduces the computational thinking skill of debugging. Invariably, first attempts at creating a desired result with code do not work out as hoped, thus necessitating a period of tinkering during which the code inches closer to perfection. This process can be frustrating for students with a narrow coding skill set, so plenty of time in the **Use** stage is advised before moving on to **Modify**.

In the **Create** stage, students envision a desired result and then build the code from scratch. They harness the skills and concepts learned in the previous two stages.

In this learning experience, students are asked to use Scratch to generate box and whisker plots of the wealth distribution patterns for three fictional countries. This is a very challenging task. For this reason, it is not advised to assign students to the **Create** stage of the **Use-Modify-Create** continuum. Most Ontario students do not have the coding background to complete a task of this magnitude. That being said, a small number of students have significant coding experience and might choose to build their own codes for this purpose. They should be given the opportunity to do so. For the majority, however, the code provided within the ACTION section of the learning experience is a good starting point. It prompts the students for data input, creates the number line, and then generates a box and whisker plot based on the data. Students should **Use** this code several times to create plots for all three countries. The limitation of the code, however, is that it only generates one plot at a time; students cannot have all three on the stage for comparison. The task is: Can students **Modify** the existing code so that all three plots exist together? Accomplishing this task is less about building something new and more about duplicating and then repurposing existing chunks of code.

## LEARNING GOALS:

At the end of this learning experience, students will know, understand, and/or be able to:

- That wealth distribution in the United States and Canada is highly inequitable.
- Connect ideas related to wealth distribution to Catholic Social Teaching.
- How box and whisker plots can be used to represent sets of social justice data.
- How to determine measures of central tendency and choose the best ones for specific data sets.
- Apply knowledge of the Cartesian Grid effectively in code modification and/or creation.



- Develop (either through modification or creation) Scratch codes to represent multiple countries' wealth distributions in box and whisker plots simultaneously.

### LOOK-FORS:

- Student ability to read, understand, modify and/or create code to represent the mathematics underlying a social justice issue.
- Student advocacy for more equitable distribution of wealth.

### INSTRUCTIONAL COMPONENT:

- **PRIOR KNOWLEDGE:** Students will be well served if they come to this learning experience with knowledge about measures of central tendency and box and whisker plots. They can participate without any specific knowledge about wealth distribution as this will be provided within the learning experience.
- **TERMINOLOGY:** wealth distribution, mean, median, quartile, box and whisker plot (or boxplot).
- **RESOURCES:** The [Student Exploration Guide](#) (p. 64), the two videos ([here](#) and [here](#)), and the [Wealth Distribution Scratch Code](#) are required. Access to technology capable of running Scratch is also needed.

### ENVISION (MINDS ON):

1. Show students the first 21 seconds of the video *Wealth Inequality in America* linked [here](#). Stop the video before any of the graphs appear. This may require the teacher to ask the question, "How do you think the wealth in this country [the United States] is divided?", because the graphs float in as the narrator asks it. It is better for students to use their knowledge of the United States to make their own predictions about American wealth distribution without seeing the graphs. Facilitate a discussion about student predictions and reasoning.

### ACTION (SOWING):

2. Tell the students that they will return to the video later, but that they are going to do a mathematical analysis of wealth distribution first. Direct them to Item 1 on the Student Exploration Guide, choosing one of three fictional countries based on the wealth distributions



shown in table and graph form. Facilitate a discussion about country choices and student reasons.

3. Have students calculate the mean and median of each country's wealth as directed in Item 2 on the Student Exploration Guide. Discuss the merits and limitations of each of these measures of central tendency to represent "typical" wealth per capita.

4. Present the Scratch code linked [here](#). Run it a few times to show how it takes five pieces of data, the lowest value, lower or first quartile, median, third or upper quartile, and highest value, and generates a box and whisker plot. If students are unfamiliar with this mode of data representation, significant time should be taken to explain how it works and how it gives a fast and accurate view of wealth distribution, i.e., the range of the data, the middle 50% of a data set, the outliers.

Explain that the Scratch code, in its current form, is limited in that it can only show one box and whisker plot at a time. This makes it difficult to compare the three countries. Assign to them the task of remixing the code so that it can ultimately show all three plots on the stage at one time.

Take the time to walk through the code with the students. It is quite complex, but students do not need to understand every single block to succeed at this task. Some chunks of code can be left alone, e.g., the blocks that generate the number line. Others need to be duplicated and repurposed, e.g., the chunks that receive the data and draw the plots. Students should be made aware that the Cartesian Grid underlies the whole code and is pivotal to locating the plots on the stage.

Once students have completed their remixes, lead a whole class discussion. The following ideas should come up:

- The shapes of the box and whisker plots reveal extent to which a country's wealth distribution is equitable. Country A's plot has a low range and the middle 50% is exactly in the middle; this is the most equitable distribution. Country C is the least equitable with a wide range, but very few people at the upper end. The middle 50% is to the far left.
- There are many different coding paths to success. Many of these should be highlighted so that all students can learn to approach problems in different ways. There are bound to be common points of difficulty in this coding task. Allow time for students to discuss these as well as the solutions they employed.

5. View the rest of the video. Take care to ensure that students are aware that the inequities of wealth distribution in the United States are greater than most people think.



Discuss any points that students wish to raise. Some may wish to bring the discussion into the Canadian context. This is presented below as an extension activity, but it can be included in the main Action section of the learning experience if desired.

6. Have students work on Item 3 on the [Student Exploration Guide](#) (in which students create a fourth fictitious country with a different wealth distribution. As they add this new data set to their Scratch code, circulate and offer guidance as needed. Take time to allow students to share their work with others as is deemed fit.

### CONSOLIDATION (NURTURING):

7. Discuss students' feelings and opinions in light of their new learning about inequities in wealth distribution. Focus on how the math, made visible through the act of coding, helps convey the gravity of the issue.

### DISCERN (MONITORING):

Because all levels of affluence are represented in Ontario's diverse classroom, discussions about money can make some students uncomfortable. Regardless, of whether their families are well off or struggling financially, some students will shy away from conversations that threaten to publicize their pecuniary status. It is important to keep all discussion impersonal and general. It is also important to monitor students' during this learning experience for symptoms of stress.

As students work on the coding tasks, the teacher will have ample opportunity to circulate among them. This is a good opportunity to monitor students and provide guidance if needed. Coding can come with a steep learning curve. Teachers should be prepared to offer scaffolds for students in time to prevent their disconnection from the task.

### EXTENSIONS:

Many Canadians pride themselves on being different, often meaning better than our neighbours to the south. Some students may fit this description and feel that inequity of wealth distribution is not as big of a problem here. Begin a discussion about this and ask students to make and justify opinions about wealth distribution in Canada. Next, view [this video](#), which is a Canadian version of the video viewed earlier in the learning experience. Conclude with a



discussion in which students can modify or adhere to their previous ideas about the Canadian situation.

## CURRICULUM CONNECTIONS:

### MATHEMATICS:

- Grade 7 – C3.1 Solve problems and create computational representations of mathematical situations by writing and executing efficient code, including code that involves events influenced by a defined count and/or sub-program and other control structures.
- Grade 7 – C3.2 Read and alter existing code, including code that involves events influenced by a defined count and/or sub-program and other control structures, and describe how changes to the code affect the outcomes and the efficiency of the code.
- Grade 8 – C3.1 Solve problems and create computational representations of mathematical situations by writing and executing code, including code that involves the analysis of data to inform and communicate decisions.
- Grade 8 – C3.2 Read and alter existing code involving the analysis of data to inform and communicate decisions and describe how changes to the code affect the outcomes and the efficiency of the code.
- Grade 7 – D1.3 Select from among a variety of graphs, including circle graphs, the type of graph best suited to represent various sets of data; display the data in the graphs with proper sources, titles, and labels, and appropriate scales; and justify their choice of graphs.
- Grade 8 – D1.3 Select from among a variety of graphs, including scatter plots, the type of graph best suited to represent various sets of data; display the data in the graphs with proper sources, titles, and labels, and appropriate scales; and justify their choice of graphs.

## FAITH CONNECTIONS:

This learning experience corresponds strongly with the Catholic Social Teaching theme of Preferential Option for the Poor and Vulnerable. According to this theme, we all have a duty to take care of those whose needs are greatest. As students work through this learning experience, they see that American and Canadian wealth distribution patterns run counter to this teaching. On one hand, we know that we need to take care of the poor and vulnerable. On the other, we live in a society in which a large number of poor people are forced to share a

miniscule portion of the country's wealth. There is a disconnect here. However, learning about this disconnect is the first step toward addressing the problem. Students, now armed with knowledge, are well-positioned to undertake actions that might bring about a small measure of positive change.

#### ONTARIO CATHOLIC SCHOOL GRADUATE EXPECTATIONS:

- A Reflective, Creative, and Holistic Thinker who makes decisions in light of gospel values with an informed moral conscious.
- A Responsible Citizen who acts morally and legally as a person informed by Catholic traditions.

#### NOTES:

This learning experience has been adapted from a learning experience called *Wealth of Nations* from *mathalicious.com* (see References section).

#### RESOURCES NEEDED:

- Access to laptops.
- Links included in the learning experience.

#### REFERENCES:

Broadbent Institute. (2014, December 16). Wealth distribution in Canada. [Video File]. Retrieved from <https://www.youtube.com/watch?v=zBkBiv5ZD7s&feature=youtu.be>

Politizane. (2012, November 20). Wealth distribution in America. [Video File]. Retrieved from <https://www.youtube.com/watch?v=QPKKQnijnsM>

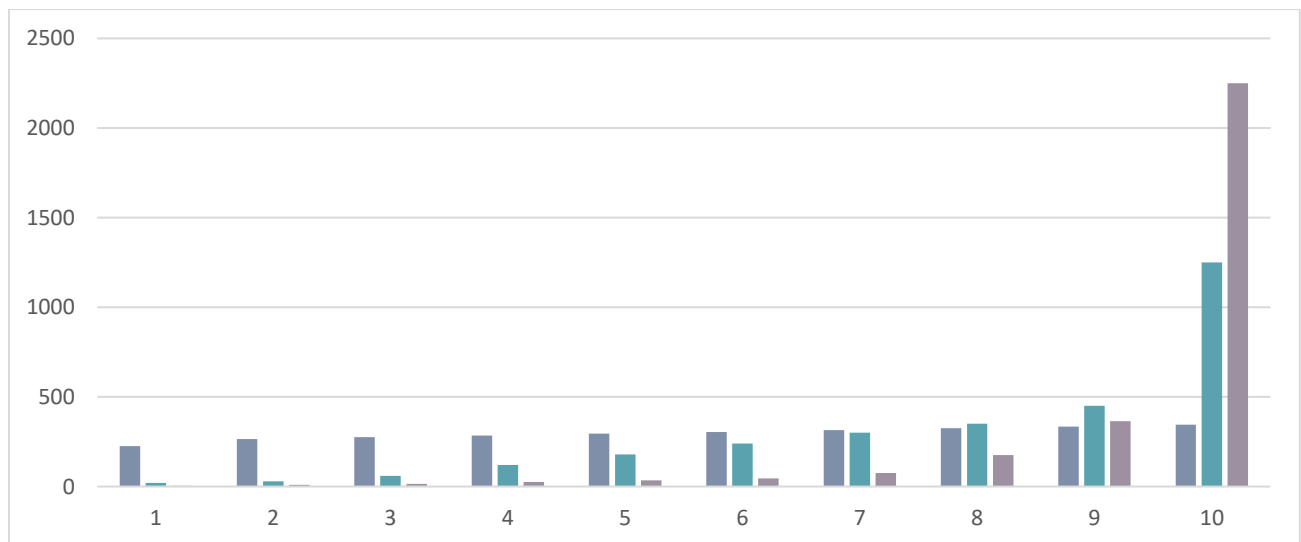
Wealth of Nations: A Learning experience by Mathalicious. (n.d.). Retrieved July 16, 2020, from <https://www.mathalicious.com/learning-experiences/wealth-of-nations>



## Wealth Distribution – Student Exploration Guide

1. There are three fictional countries named A, B, and C. Each country has exactly ten people. The wealth of each country's citizens is shown in order from least to greatest on the table and graph below. If you had to claim citizenship in one country, which would you choose and why?

	1	2	3	4	5	6	7	8	9	10
Country A	\$255	\$265	\$275	\$285	\$295	\$305	\$315	\$325	\$335	\$345
Country B	\$20	\$30	\$60	\$120	\$180	\$240	\$300	\$350	\$450	\$1250
Country C	\$5	\$10	\$15	\$25	\$35	\$45	\$75	\$175	\$375	\$2250



2. Calculate the mean and median of each country's wealth. For each country, which do you think better represents how much wealth the "typical" person has? Explain your thinking.

	Country A	Country B	Country C
Mean			
Median			

3. In the video you watched about wealth inequity in the United States, most people thought that wealth in the US was distributed as it is in Country B. As it turns out, Country C is closer to the actual situation.

Imagine you could create your own country. Based on a wealth total of \$3 000 (the same as countries A, B, and C), what would your ideal wealth distribution look like and why?

Total: \$3 000	1	2	3	4	5	6	7	8	9	10

Add your country to your Scratch code so its box and whisker plot shows up with the other three.

## EVERY DROP COUNTS: WATER CONSUMPTION

**“I urgently appeal, then, for a new dialogue about how we are shaping the future of our planet. We need a conversation which includes everyone since the environmental challenge we are undergoing, and its human roots, concern and affect us all.”**

*Pope Francis*

### LEARNING EXPERIENCE OVERVIEW AND LINK TO UNITED NATIONS THEME:

In this learning experience, students will analyze personal water consumption and reflect on the disproportionate use and/or misuse of water in Canada compared to other countries. Students will create an interactive water usage calculator to think about how much water they use. Throughout this inquiry, students will compare water consumption in Canada with that of a family in a country of their choice. Further, they will examine the various states of water on the earth’s surface and their distribution and use scientific and technological vocabulary in their work. As such, this learning experience addresses United Nations Sustainable Development Goals #6 Clean Water and Sanitation and #12 Responsible Consumption and Production.

Within these goals, this learning experience directly addresses the following targets:

- 6.1 By 2030, achieve universal and equitable access to safe and affordable drinking water for all.
- 6.4 By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity.
- 12.2 By 2030, achieve the sustainable management and efficient use of natural resources.

### CODING CONSIDERATIONS:

When teachers guide students to learn to code, they often employ the ***Use-Modify-Create*** continuum. Students who have little coding experience are best suited to the ***Use*** stage of the continuum. In the ***Use*** stage, students run a pre-created code, witness the results, and then analyze the code to learn how the ordering of commands creates the results.



As students develop a stronger understanding of coding, the **Modify** stage becomes appropriate. In the **Modify** stage, students make changes to existing codes (or, in some cases, they add on to existing codes) to create results that differ from those of the original. This stage introduces the computational thinking skill of debugging. Invariably, first attempts at creating a desired result with code do not work out as hoped, thus necessitating a period of tinkering during which the code inches closer to perfection. This process can be frustrating for students with a narrow coding skill set, so plenty of time in the **Use** stage is advised before moving on to **Modify**.

In the **Create** stage, students envision a desired result and then build the code from scratch. They harness the skills and concepts learned in the previous two stages.

With your students in mind, feel free to adapt this learning experience to accommodate any of the three stages. For the coding tasks in this learning experience, a few sample Scratch programs are provided. These can be delivered to students who are learning within the **Use** stage. Alternately, the teacher may remix (make a copy of) any of the provided programs, and have the students **Modify** these so that the desired result is attained. For students who are very well versed in Scratch coding, these sample codes can be ignored. In this situation, students would be directed to **Create** an original code to meet expectations of the task.

## LEARNING GOALS:

At the end of this learning experience, students will know, understand, and/or be able to:

- Track personal daily water consumption.
- Reflect on the challenges of access to clean water sources faced by others in our global community.
- Develop and nurture habits that will conserve water.
- Connect ideas related to access to clean water to Catholic Social Teaching.
- Use variables effectively in code.
- Calculate percentage change/difference using a variety of code blocks.
- Develop (either through modification/remix or unique independent creation) Scratch codes to calculate daily water use using benchmark equivalencies (e.g. one toilet flush=11 litres of water).



### LOOK-FORS:

- Student ability to read, understand, modify and/or create code to represent the science and mathematics underlying a social justice issue.
- An emotional and faith-informed response (on the part of the students) to the critical nature of responsible water consumption and conservation.

### INSTRUCTIONAL COMPONENT:

- **PRIOR KNOWLEDGE:** Most of the knowledge required to participate in this learning experience is contained within the steps of the learning experience. However, a basic understanding of water consumption, particularly the ways in which humans use and misuse water daily, will help students contextualize the learning experience.
- **TERMINOLOGY:** conservation, perspective, inequity, responsibility.
- **RESOURCES:** Choose resources to support student prior knowledge about water access, consumption, and the sustainable nature of water. Some examples: [The Global Water Crisis](#) video, UNESCO [Multiple Perspectives Approach to Learning About Water](#), [Statistics Canada Reports](#), read short stories and experiences shared in the [UNDP Sustainable Goals Site](#).

### ENVISION (MINDS ON):

1. Launch the learning experience by presenting the following facts to the students:
  - Water is fundamental to our way of life and also to the ecosystems upon which our lives depend.
  - Easy access to water has created a disregard for how much of it we actually use in our daily lives.
  - Recent recognition of the scarcity of water in some parts of the world has caused us to look for ways to be more efficient in our water use, and to find technological solutions to help us use it more efficiently.
  - Canadians currently use an average of 329 litres of water per person, per day — second only to the United States in the developed world, and more than twice as much as Europeans.



- The UNDP has declared that it is a universal right for each person to have access to a minimum of 20 litres of clean water each day.

2. Facilitate a whole group discussion on the importance of water to daily life. Use the following questions to guide the discussion:

- What is your personal responsibility when it comes to water?
- How might we think globally by acting locally?
- How does water consumption in different regions of Canada compare to water consumption in other developed countries and in developing countries?
- What choices are families with restricted water availability forced to make?
- What are possible health implications for families with restricted water availability?

3. Students will begin to think about the ease of access to water in the school and at home. Every day, we simply turn on the tap or go to the water fountain for water. As we know, people in other countries do not have the same liberty.

4. To demonstrate the challenges our global neighbours face in terms of accessing water. Have each small group of students fill a 5L bucket of water. This should be done outside for safety reasons.

5. Have students estimate the following:

- The mass of the water and how far they think they may be able to carry this 5L bucket without spilling any water. Students will share and discuss their estimates with the class.

6. Continue the discussion by sharing the following:

- In some parts of the world, people walk 2.5 km or more to obtain water for daily use. Use Google Earth or another map application to demonstrate a chosen distance within your school community (e.g. walking around a city block, or from the school to a specific landmark), to help students to conceptualize the distance. If time and safety considerations allow, have students carry the bucket of water for shorter, timed distances. Debrief by asking whether they could imagine carrying the bucket 5 km, a typical return trip with a full bucket of water.



## ACTION (SOWING):

7. Students will create a [digital tool using Scratch](#) to assist in monitoring daily water usage. The hope is that when students track daily water consumption, and keep in mind the challenges faced by others in our global community, they will soon begin to develop habits that will conserve water.

8. Provide students with the following information as they begin the design thinking process to develop their program:

When using water at home and school, assume the following information:

- One toilet flush=11 litres.
- One shower=9 litres/minute.
- Washing hands=2 litres each time.
- Brushing teeth (2 minutes) with the tap on=16 litres.
- Drinking water (8 average sized glasses) =2 litres.
- Washing dishes by hand=23 litres.
- One use of a dishwasher=20-40 litres.
- Washing machine (1 Load) =40-80 litres.
- Defrosting food under a running tap=25-25 litres.
- Washing your car with a hose=200-500 litres.

9. If the students are somewhat new to coding, they may require a partially constructed code from which to start. Provide these students with a remix of the sample code found [here](#). Students who require further scaffolding may find [this sample code](#) useful. Students with coding experience should be challenged to create a unique program using the information provided, along with further research if they so choose.

10. At this point, students will naturally begin to discuss ways in which they can conserve or limit their water use at both home and school. Ask students how might their water use change if access to fresh, clean water was not as simple? Revisit the water bucket experience and ask students if they would be willing to walk for a great distance with a 5 litre bucket of water. How many buckets would they need to sustain their water use each day?



11. Students are encouraged to create a tool in Scratch that will track the percentage change in water use over time. By recording their consumption each week and consciously changing their habits, they will use this tool to mathematically see the impact of small changes. Students will need to have a record of their weekly water usage using a table or tool of their choice. For example, they may record weeks 1-4, and use weeks 1 and 4 data to input. Sample code for the Percentage Change calculator can be found [here](#).

### CONSOLIDATION (NURTURING):

12. Discuss reactions and opinions of the new learning about water usage and conservation. Focus on how the math, made visible through the act of coding, helps convey the gravity of the global crisis in terms of access to clean water and the role our daily conservation of water can play.

### DISCERN (MONITORING):

As students work on the coding tasks, the educator is encouraged to circulate among them. This is a good opportunity to monitor students and provide guidance if needed. Teachers should be prepared to offer scaffolds for students in time to prevent their disconnection from the task. Ensure that students are focusing on the mathematical procedures required to develop efficient and effective code.

### EXTENSIONS:

Visit the [Ryan's Well](#) website. Explore the relationship between access to clean water and appropriate sanitation services.

### CURRICULUM CONNECTIONS:

#### SCIENCE (GRADE 8):

- 1.1 evaluate personal water consumption, compare it with personal water consumption in other countries, and propose a plan of action to reduce personal water consumption to help address water sustainability issues.
- 2.7 use a variety of forms (e.g. oral, written, graphic, multimedia) to communicate with different audiences for a variety of purposes.

## MATHEMATICS:

- Grade 7 – B2.10 identify [proportional](#) and non-proportional situations and apply [proportional reasoning](#) to solve problems.
- Grade 7 – C3.1 Solve problems and create computational representations of mathematical situations by writing and executing efficient code, including code that involves events influenced by a defined count and/or sub-program and other control structures.
- Grade 7 – C3.2 Read and alter existing code, including code that involves events influenced by a defined count and/or sub-program and other control structures, and describe how changes to the code affect the outcomes and the efficiency of the code.
- Grade 8 – B1.4 use [fractions](#), [decimal numbers](#), and [percentages](#), including percentages of more than 100% or less than 1%, interchangeably and flexibly to solve a variety of problems.
- Grade 8 – B2.1 use the properties and [order of operations](#), and the [relationships](#) between operations, to solve problems involving [rational numbers](#), [ratios](#), [rates](#), and percentages, including those requiring multiple steps or multiple operations.
- Grade 8 – C3.1 Solve problems and create computational representations of mathematical situations by writing and executing code, including code that involves the analysis of data to inform and communicate decisions.
- Grade 8 – C3.2 Read and alter existing code involving the analysis of data to inform and communicate decisions and describe how changes to the code affect the outcomes and the efficiency of the code.

## FAITH CONNECTIONS:

This learning experience corresponds strongly with the Catholic Social Teaching theme of Stewardship of Creation. According to this theme, we recognize the Earth as sacred. Creation has its own intrinsic value and as a global community, we have a responsibility to protect and to cherish the Earth's ecological diversity, beauty, and life-sustaining properties. The hope is that this learning experience will create an understanding that together we must protect and respect all components of God's Creation provided to be accessed and enjoyed by future generations.



## ONTARIO CATHOLIC SCHOOL GRADUATE EXPECTATIONS:

- A Reflective, Creative, and Holistic Thinker who adopts a holistic approach to life by integrating learning from various subject areas and experience.
- A Responsible Citizen who witnesses Catholic social teaching by promoting equality, democracy, and solidarity for a just, peaceful, and compassionate society.

## RESOURCES NEEDED:

- Access to laptops/Chromebooks.
- Links included in the learning experience.
- [Self-Assessment](#).

## REFERENCES:

[WE Walk for Water learning experience](#)

[Safe Water](#)

[UN Global Goals-Why it Matters](#)

[Statistics Canada](#)

McDonagh, Sean. *On Care for Our Common Home: The Encyclical of Pope Francis on the Environment, Laudato Si'*, 2016.

## Self-Assessment: Critical Thinking Learning Progression

Dimension	Limited Evidence	Developing	Accelerating	Proficient
Evaluating information and perspectives	<p>I can find information on a topic using my computer or by asking a teacher.</p> <p>I have difficulty knowing which information/website to trust as accurate or useful.</p> <p>There is some information that I disagree with; however, I have difficulty explaining why I feel this way.</p>	<p>I can find and evaluate information easily.</p> <p>I can distinguish between effective and ineffective arguments/opinions.</p> <p>I am beginning to explain why some information does not make sense using proof from other trusted sources.</p>	<p>I am highly skilled at finding and evaluating information.</p> <p>I can explain how I evaluate information.</p> <p>I may not always demonstrate the correct understanding of the information or an argument.</p>	<p>I can analyze a variety of sources and provide effective proof for why I have selected specific data or sources.</p> <p>I have a clear understanding of whether or not an information source is relevant, useful and trustworthy.</p> <p>I only add information that I can confirm is accurate and adds value to what I am trying to say, prove or do.</p>
Making Connections	<p>I understand that when I am learning about a topic, information and ideas connect or relate to one another.</p> <p>I have difficulty making these connections on my own.</p>	<p>I can connect what I already know with what I have learned to expand my understanding of a topic or issue.</p> <p>I am able to make some difficult connections (e.g. across subjects/classes)</p>	<p>I understand that looking at a topic or issue from different perspectives is an important part of learning.</p> <p>I am able to make connections across subject areas.</p>	<p>I am skilled at making connections and seeing relationships and patterns.</p> <p>I can use these connections to understand topics, issues and themes deeply.</p> <p>I understand that the world is full of conflicting information.</p> <p>I am able to decide which information is most accurate, relevant and useful.</p>

<b>Knowledge Construction</b>	I can find information on a topic; however, I have difficulty engaging with the information in a meaningful or deep way.	<p>I can use several strategies to find and create new knowledge and beliefs.</p> <p>I can evaluate information and use it to answer questions in class.</p> <p>I am working on making connections between subject areas/classes.</p>	<p>I am able to think about topics in a new and exciting way.</p> <p>I can explain how my new knowledge/perspective is useful.</p> <p>I make meaningful or deep connections and clearly understand why they are important in my life and in the lives of others.</p>	<p>I can analyze, interpret, synthesize, and evaluate information from a variety of sources.</p> <p>I am skilled at looking at topics from different points of view and create my own opinion about them.</p> <p>I reflect on and evaluate how and what I learn and can improve my own learning outcomes.</p>
<b>Leveraging Technology for Learning</b>	I have difficulty in using technology to help me learn, to collaborate with others and to connect my ideas about various topics/issues.	<p>I can use technology to generate and explore important ideas.</p> <p>I can use technology to connect with others and explore ways to apply new knowledge and perspectives.</p>	I can use a variety of technologies to evaluate, generate and explore both new and unfamiliar concepts, issues and arguments.	<p>I effortlessly use technology to help me think critically about issues and share and develop this thinking with others.</p> <p>I can clearly describe how technology helps me to think critically.</p> <p>I can use technology to think and work effectively.</p>

Adapted from: NPDL Student-Friendly Deep Learning Progression (M. Fullan, 2019)

## THIRSTING FOR EQUALITY; THE INDIGENOUS WATER CRISIS

**“Tainted water and broken systems on Ontario’s First Nations reserves are jeopardizing health, burdening parents and caregivers, and exacerbating problems on reserves. First Nations people have the same human rights to adequate water and sanitation as all Canadians, but in practice cannot access them.”**

*Amanda Klasing, Senior Researcher, Women’s Rights Division, Human Rights Watch*

### LEARNING EXPERIENCE OVERVIEW AND LINK TO UNITED NATIONS THEME:

In this learning experience, students will examine the Indigenous water crisis in Canada and reflect on the disproportionate access to clean water in provinces and territories across the nation. In 2015, Justin Trudeau first made a promise to solve all drinking water advisories on First Nations within five years. When Justin Trudeau became Prime Minister, there were 105 long-term boil water advisories on public systems on reserve. What are some First Nations communities that had long-term boil water advisories in the past but successfully resolved them? What are some particularly challenging and/or long cases of boil water advisories in First Nations communities? What are some potential solutions? Students will create an interactive boil water advisory map which will help them to calculate current boil water advisories in First Nations communities across Canada.

As such, this learning experience addresses United Nations Sustainable Development Goals #3 – Good Health and Well-Being, #6 – Clean Water and Sanitation and #12 – Responsible Consumption and Production.

Within these goals, this learning experience directly addresses the following targets:

- 3.9 By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination.
- 6.1 By 2030, achieve universal and equitable access to safe and affordable drinking water for all.
- 6.4 By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity.
- 12.2 By 2030, achieve the sustainable management and efficient use of natural resources.

## CODING CONSIDERATIONS:

When teachers guide students to learn to code, they often employ the **Use-Modify-Create** continuum. Students who have little coding experience are best suited to the **Use** stage of the continuum. In the **Use** stage, students run a pre-created code, witness the results, then analyze the code to learn how the ordering of commands creates the results.

As students develop a stronger understanding of coding, the **Modify** stage becomes appropriate. In the **Modify** stage, students make changes to existing codes (or, in some cases, they add on to existing codes) to create results that differ from those of the original. This stage introduces the computational thinking skill of debugging. Invariably, first attempts at creating a desired result with code do not work out as hoped, thus necessitating a period of tinkering during which the code inches closer to perfection. This process can be frustrating for students with a narrow coding skill set, so plenty of time in the **Use** stage is advised before moving on to **Modify**.

In the **Create** stage, students envision a desired result and then build the code from scratch. They harness the skills and concepts learned in the previous two stages.

With your students in mind, feel free to adapt this learning experience to accommodate any of the three stages.

For the coding tasks in this learning experience, a few sample Scratch programs are provided. These can be delivered to students who are learning within the **Use** stage. Alternately, the teacher may remix (make a copy of) any of the provided programs, and have the students **Modify** these so that the desired result is attained. For students who are very well versed in Scratch coding, these sample codes can be ignored. In this situation, students would be directed to **Create** an original code to meet expectations of the task.

## LEARNING GOALS:

At the end of this learning experience, students will understand and/or be able to:

- Realize that there is an Indigenous water crisis in Canada.
- Reflect on the disproportionate access to clean water in provinces and territories across Canada.
- Connect ideas related to access to clean, potable water and Catholic Social Teaching.





- Create an interactive boil water advisory map which will help them to calculate current boil water advisories in First Nations communities across Canada.
- Use variables effectively in code.
- Develop (either through modification/remix or unique independent creation) Scratch codes to compare boil water advisories across Canada.

### LOOK-FORS:

- Student ability to read, understand, modify and/or create code to represent the mathematics underlying a social justice issue and develop an accurate interactive map of Canada.
- An emotional and faith-informed response (on the part of the students) To inequities involved in accessing clean, potable water for all, specifically in Canada.

### INSTRUCTIONAL COMPONENT:

- **PRIOR KNOWLEDGE:** Most of the knowledge required to participate in this learning experience is contained within the steps of the learning experience. However, a basic understanding of inequalities and issues faced by Canadian Indigenous communities will help students contextualize the learning experience.
- **TERMINOLOGY:** inequity, potable, environmental racism.
- **RESOURCES:** Choose from some of the following resources to support student's prior knowledge about the indigenous water crisis in Canada:
  - Canada's Waterless Communities: Neskantaga. VICE. (October 2015). Retrieved from: <https://www.youtube.com/watch?v=Gsg6eUhFDDo>
  - Canada: Water Crisis Puts First Nations Families at Risk. Human Rights Watch. (June 2016). Retrieved from: <https://hrw.org/news/2016/06/07/canada-water-crisis-puts-first-nations-families-risk>
  - How Yellow Quill First Nation ended a nine-year boil water advisory. (2015). Retrieved from: <https://esemag.com/water/yellow-quill-first-nation/>



- Issues in Shoal Lake 40 First Nation Extend Far Beyond Water. (2017). Retrieved from: <http://www.watertoday.ca/ts-fn-shoal-lake-issues-extend-beyond-water.asp>

### MINDS ON (ENVISION):

1. As a whole group, watch CBC's Out in the Open episode [Water at Six Nations of the Grand River](#) and carefully read the CBC article ["Why so few people on Six Nations reserve have clean running water, unlike their neighbours."](#)

2. In small groups or partnerships, discuss reactions to the CBC article. Provide students with the following question to help facilitate the discussion:

Dawn Martin-Hill refers to the water issues at Six Nations as "environmental racism," which is a form of systemic or institutionalized racism. Do you agree or disagree that limiting access to potable water is an issue of systemic racism? Share points of discussion with the whole group. You can listen to Dwan Martin-Hill speak about the water issues on her reserve.

<https://www.cbc.ca/radio/outintheopen/neighbours-1.4618733/why-so-few-people-on-six-nations-reserve-have-clean-running-water-unlike-their-neighbours-1.4618968>

### ACTION (SOWING):

3. Students will explore boil water advisory statistics and create a digital tool using Scratch to calculate the total number of boil water advisories in Canada. The hope is that when students are exposed to the sheer number of advisories and keep in mind the access to clean water challenges faced by others in our global community, they will become engaged in action to resolve this issue.

4. Provide students with the following resources featuring statistics and information regarding current boil water advisories in Canada as they begin the design thinking process to develop their program:

- The current number of long-term boil water advisories in First Nations communities: (<https://www.sac-isc.gc.ca/eng/150614143353/1533317130660>).
- The current number of short-term boil water advisories in First Nations communities (<https://www.sac-isc.gc.ca/eng/1562856509704/1562856530304>).



- The number of boil water advisories and do not consume orders in non-First Nations communities (<http://www.watertoday.ca/>).

5. Students will create an interactive map of Canada that will calculate the total number current boil water advisories in each province/territory. If students are somewhat new to coding, they may require a partially constructed code from which to start. Provide these students with a remix of the sample code found [here](#). Students with coding experience should be challenged to create a unique program using the information provided in addition to further research.

6. To bring about change and build community, activism should engage and educate others. Students will research a current First Nation community that is under a boil water advisory and will create a podcast or other digital format designed to share important information about the community in focus.

### CONSOLIDATION (NURTURING):

7. Considering this new learning, discuss reactions and opinions about access to clean water in First Nations communities in Canada. Focus on how the math, made visible through the act of coding, helps convey the gravity of this crisis in terms of access to clean water and the role we can play.

### DISCERN (MONITORING):

As students work on the coding tasks, the educator is encouraged to circulate among them. This is a good opportunity to monitor students for strengths and needs. Given that coding is relatively new for many, it is important to provide guidance if needed. Teachers should be prepared to offer scaffolds for students in time to prevent their disconnection from the task. As the educator circulates throughout the learning environment, the following questions could be posed to activate deeper critical thinking processes: What message is your project attempting to convey about water issues on First Nations reserves? What might be possible solutions to effectively addressing these issues?

### EXTENSIONS:



Contact your [local health unit](#)/Member of Parliament/Member of Provincial Parliament to establish a partnership focused on ways to end boil water advisories for Indigenous communities.

Learn more about Autumn Peltier, by viewing this [video](#). Think about/discuss the following:

- Should Indigenous people have special consideration regarding their interest/perspectives on water in Canada?
- First Nations water concerns are unique because of the relationship between federal and provincial jurisdiction. How does this hinder or improve Indigenous efforts?
- Water issues have been in the forefront for Indigenous people for decades, yet it is just now that we are starting to hear about these issues. How can we all make a difference regarding water?

## CURRICULUM CONNECTIONS:

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### SOCIAL STUDIES (GRADE 7):

- A1.1 describe various ways in which people have responded to challenges and opportunities presented by the physical environment.
- B2.6 communicate the results of their inquiries using appropriate vocabulary.

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### SOCIAL STUDIES (GRADE 8):

- B1.1 analyze some interrelationships among factors that can contribute to quality of life.

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### SCIENCE (GRADE 8):

- 1.1 evaluate personal water consumption, compare it with personal water consumption in other countries, and propose a plan of action to reduce personal water consumption to help address water sustainability issues.
- 2.7 use a variety of forms (e.g. oral, written, graphic, multimedia) to communicate with different audiences for a variety of purposes.

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### MATHEMATICS:

- Grade 7 – C3.1 Solve problems and create computational representations of mathematical situations by writing and executing efficient code, including code that involves events influenced by a defined count and/or sub-program and other control structures.
- Grade 7 – C3.2 Read and alter existing code, including code that involves events influenced by a defined count and/or sub-program and other control structures, and describe how changes to the code affect the outcomes and the efficiency of the code.
- Grade 8 – C3.1 Solve problems and create computational representations of mathematical situations by writing and executing code, including code that involves the analysis of data to inform and communicate decisions.
- Grade 8 – C3.2 Read and alter existing code involving the analysis of data to inform and communicate decisions and describe how changes to the code affect the outcomes and the efficiency of the code.

### FAITH CONNECTIONS:

This learning experience corresponds strongly with two Catholic Social Teaching themes: Stewardship of Creation and Rights and Responsibilities.

According to the first theme, we recognize the Earth as sacred. Creation has its own intrinsic value and as a global community, we have a responsibility to protect and cherish the Earth's ecological diversity, beauty, and life-sustaining properties.

Second, the Catholic tradition teaches us that human dignity can be protected, and a healthy community can be achieved only if human rights are protected and responsibilities are met. Every person has a fundamental right to life and a right to those things that are required for human decency. Corresponding to these rights are duties and responsibilities to one another, to our families and to the larger global community. The hope is that this learning experience will create an understanding that together we must protect and hold all parts of Creation to be accessed and enjoyed by future generations.

### ONTARIO CATHOLIC SCHOOL GRADUATE EXPECTATIONS:

- A Reflective, Creative, and Holistic Thinker who adopts a holistic approach to life by integrating learning from various subject areas and experience.
- A Responsible Citizen who witnesses Catholic social teaching by promoting equality, democracy, and solidarity for a just, peaceful, and compassionate society.



## RESOURCES NEEDED:

- Access to laptops/Chromebooks.
- Links/resources included in the learning experience.

## REFERENCES:

[Government of Canada-Ending Long-Term Drinking Water Advisories](#)

[Government of Ontario: Working With First Nations to Improve Drinking Water](#)

[Nibi-Giinwiindawan We-are-Water: Indigenous Youth and Water Curriculum](#)

[World Water Day: Indigenous Canadian Teen Addresses UN General Assembly](#)

[UN Global Goals-Why it Matters](#)



## Self-Assessment: Critical Thinking Learning Progression

Dimension	Limited Evidence	Developing	Accelerating	Proficient
Evaluating information and perspectives	<p>I can find information on a topic using my computer or by asking a teacher.</p> <p>I have difficulty knowing which information/website to trust as accurate or useful.</p> <p>There is some information that I disagree with; however, I have difficulty explaining why I feel this way.</p>	<p>I can find and evaluate information easily.</p> <p>I can distinguish between effective and ineffective arguments/opinions.</p> <p>I am beginning to explain why some information does not make sense using proof from other trusted sources.</p>	<p>I am highly skilled at finding and evaluating information.</p> <p>I can explain how I evaluate information.</p> <p>I may not always demonstrate the correct understanding of the information or an argument.</p>	<p>I can analyze a variety of sources and provide effective proof for why I have selected specific data or sources.</p> <p>I have a clear understanding of whether or not an information source is relevant, useful and trustworthy.</p> <p>I only add information that I can confirm is accurate and adds value to what I am trying to say, prove or do.</p>
Making Connections	<p>I understand that when I am learning about a topic, information and ideas connect or relate to one another.</p> <p>I have difficulty making these connections on my own.</p>	<p>I can connect what I already know with what I have learned to expand my understanding of a topic or issue.</p> <p>I am able to make some difficult connections (e.g. across subjects/classes)</p>	<p>I understand that looking at a topic or issue from different perspectives is an important part of learning.</p> <p>I am able to make connections across subject areas.</p>	<p>I am skilled at making connections and seeing relationships and patterns.</p> <p>I can use these connections to understand topics, issues and themes deeply.</p> <p>I understand that the world is full of conflicting information.</p> <p>I am able to decide which information is most accurate, relevant and useful.</p>

<b>Knowledge Construction</b>	I can find information on a topic; however, I have difficulty engaging with the information in a meaningful or deep way.	<p>I can several strategies to find and create new knowledge and beliefs.</p> <p>I can evaluate information and use it to answer questions in class.</p> <p>I am working on making connections between subject areas/classes.</p>	<p>I am able to think about topics in a new and exciting way.</p> <p>I can explain by my new knowledge/perspective is useful.</p> <p>I make meaningful or deep connections and clearly understand why they are important in my life and in the lives of others.</p>	<p>I can analyze, interpret, synthesize, and evaluate information from a variety of sources.</p> <p>I am skilled at looking at topics from different points of view and create my own opinion about them.</p> <p>I reflect on and evaluate how and what I learn and can improve my own learning outcomes.</p>
<b>Leveraging Technology for Learning</b>	I have difficulty in using technology to help me learn, to collaborate with others and to connect my ideas about various topics/issues.	<p>I can use technology to generate and explore important ideas.</p> <p>I can use technology to connect with others and explore ways to apply new knowledge and perspectives.</p>	I can use a variety of technologies to evaluate, generate and explore both new and unfamiliar concepts, issues and arguments.	<p>I effortlessly use technology to help me think critically about issues and share and develop this thinking with others.</p> <p>I can clearly describe how technology helps me to think critically.</p> <p>I can use technology to think and work effectively.</p>

Adapted from: NPDL Student-Friendly Deep Learning Progression (M. Fullan, 2019)



## CLEAN WATER FOR ALL: WATER FILTRATION INVESTIGATION

**“Access to safe water is a fundamental human need and, therefore, a basic human right. Contaminated water jeopardizes both the physical and social health of all people. It is an affront to human dignity.”**

Kofi Annan, former United Nations Secretary-General

### LEARNING EXPERIENCE OVERVIEW AND LINK TO UNITED NATIONS THEME:

In this learning experience, students will develop and share a prototype for an effective water filtration system and explore how small changes in our own habits can make an impact on water quality in both our local and global communities. Students will explore the critical components of a working water filtration system. Further, they will define environmental stewardship as the careful and responsible management of our environment.

As such, this learning experience addresses United Nations Sustainable Development Goals #6 – Clean Water and Sanitation and #12 – Responsible Consumption and Production, where students will foster an appreciation for water as a precious resource.

Within these goals, this learning experience directly addresses the following targets:

- 6.1 By 2030, achieve universal and equitable access to safe and affordable drinking water for all.
- 6.4 By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity.
- 12.2 By 2030, achieve the sustainable management and efficient use of natural resources.

### CODING CONSIDERATIONS:

When teachers guide students to learn to code, they often employ the ***Use-Modify-Create*** continuum. Students who have little coding experience are best suited to the ***Use*** stage of the continuum. In the ***Use*** stage, students run a pre-created code, witness the results, then analyze the code to learn how the ordering of commands creates the results.

As students develop a stronger understanding of coding, the **Modify** stage becomes appropriate. In the **Modify** stage, students make changes to existing codes (or, in some cases, they add on to existing codes) to create results that differ from those of the original. This stage introduces the computational thinking skill of debugging. Invariably, first attempts at creating a desired result with code do not work out as hoped, thus necessitating a period of tinkering during which the code inches closer to perfection. This process may be frustrating for some students who may have a narrow coding skill set, so plenty of time in the **Use** stage is advised before moving on to **Modify**.

In the **Create** stage, students envision a desired result and then build the code from scratch. They harness the skills and concepts learned in the previous two stages.

With your students in mind, feel free to adapt this learning experience to accommodate any of the three stages. For the coding tasks in this learning experience, a few sample Scratch programs are provided. These can be delivered to students who are learning within the **Use** stage. Alternately, the teacher may remix (make a copy of) any of the provided programs, and have the students **Modify** these so that the desired result is attained. For students who are very well versed in Scratch coding, these sample codes can be ignored. In this situation, students would be directed to **Create** an original code to meet expectations of the task.

## LEARNING GOALS:

At the end of this learning experience, students will know, understand, and/or be able to:

- Design, build, and test a water system device that filters water using hands-on experimentation followed by the creation of a digital tool.
- Choose effective materials to filter dirty water effectively.
- Create and use percentages to determine how clean water is following filtration using a variety of combinations of materials.
- Use variables effectively and efficiently in code.
- Develop (either through modification or creation) Scratch codes to create a water filtration interactive learning tool.



### LOOK-FORS:

- Student ability to read, understand, modify and/or create code to represent the scientific procedures and the mathematics underlying a social justice issue.
- An emotional and faith-informed response (on the part of the students) to inequities involved in access to water filtration devices.

### INSTRUCTIONAL COMPONENT:

- **PRIOR KNOWLEDGE:** Students should be familiar with the basic processes of the water cycle, in particular, the process of filtration (percolation), the movement of water from the Earth's surface to underground reservoirs.
- **TERMINOLOGY:** Conservation of resources, environmental impact, potable, sustainability, filtration, sediment, coagulation.
- **RESOURCES:** Supplementary resources of choice that will illustrate the critical nature of water filtration to create potable water. If students will be building a prototype of a filtration system, this website highlights the engineering design process: [The Dirty Water Project](#) or [Protect Your Body, Filter Your Water!](#).

### ENVISION (MINDS ON):

1. Launch the learning experience by reviewing prior learning about the water cycle. Use the following information to supplement and/or engage students in thoughtful discussion:

One of the processes of Earth's water cycle is infiltration, or percolation. After water is precipitated much of it soaks into the ground. Water naturally moves through various layers of sand, soil, and rock until it reaches an impermeable layer. This process of filtration is how water is purified and filtered in nature. Without this process, much of the fresh water on Earth would be contaminated and not potable for human consumption. Today, you will experiment with the process of natural purification by building both a tangible prototype and a digital water filtration system.

2. Establish small groups for discussion purposes. Provide each group with a question to focus on. Possible topics for small group discussion could be:



- Locally, where does the water that we use at school and/or home come from?
- Considering the fresh water sources available in close proximity, where would you choose to source your water from and why?
- From which sources of water do you not want to get your water? Why not? (Note: you may wish to link back to the Watershed learning experience plan in this resource and guide students to make connections between watersheds and potential contaminants to water quality.)
- In what ways does human activity impact water quality?
- Digging deeper- In what ways do you personally have an impact on local water quality?
- How can you as an individual, and we as a local community, act as environmentally responsible citizens to support the sustainability of our water resources?

3. Discuss the importance of filters and share samples of common, everyday filters, (e.g., coffee filter, furnace filter, aquarium filter).

4. Share the following focus question: What do each of these items have in common and why are filters such as these necessary? Share that the importance of water filtration is becoming increasingly critical due to continual threats to Earth's water quality such as man-made pollutants. Discuss the term "potable" and the critical issue many face in terms of access to potable water.

5. In small lab partnerships or groupings, begin the investigation process. Resources required: a glass of dirty/pond water, a variety of filtering (natural and otherwise) materials, e.g. cheese cloth, coffee filters, strainer mesh, gravel, sand. Suggested experiment procedure/materials list can be found below. This [video](#) may assist as a visual for the experiment procedure.

6. Students will test each filter and discuss the limitations and strengths of each. Provide students with the following question to launch the design process for the code project: How might you design a filtration system to treat water that is not potable? Tell students that they will be building, and testing water filter models using Scratch code to demonstrate and share their understanding of the aquifer or filtration process.

7. During this investigative process (hands-on building of a filtration system), students will construct hypotheses, track materials tested, and record observations in a chart (sample templates are provided below). When the aquifer model is completed, students will test it



using natural materials to demonstrate natural water treatment process. Students will discover how sand, cotton, charcoal, and gravel can filter particulate matter from a water source.

8. Circulate among the student groupings to monitor understanding and knowledge building.

### **ACTION (SOWING):**

9. Using their prior knowledge along with new understanding gained during the prototype build, students will design, build, and test a water filtration device using Scratch. The purpose of the investigation is to determine which materials or combination of materials are most effective in removing pollutants from water.

10. Students will now independently demonstrate and consolidate their understanding of water filtration systems by creating a working aquifer model in Scratch.

11. Share the following program exemplar: [Water Filtration Experiment](#) with the whole group. Students with coding experience should be challenged to create a unique program using the information they have recorded during the hands-on experiment portion of the learning experience, along with further research if they so choose.

### **CONSOLIDATION (NURTURING):**

12. Students will share their programs with peers and apply any received feedback to improve their models.

13. Students may then reflect on their challenges and successes in code development using the optional learning progression [self-assessment](#).

### **DISCERN (MONITORING):**

As students work on the coding tasks, the educator is encouraged to circulate among them. This is a good opportunity to monitor students and provide guidance if needed. Teachers should be prepared to offer scaffolds for students in time to prevent their disconnection from the task.

## EXTENSIONS:

Contact your local water treatment plant to create a community partnership opportunity where a professional will share their expertise with students. Arrange a virtual or in-person visit if possible.

Examine the Walkerton Water Crisis of 2000 to learn more about the potential for water contamination to occur in local and global communities. How might the crisis have been averted? Review: [Inside Walkerton](#) (CBC).

## CURRICULUM CONNECTIONS:

### SCIENCE (GRADE 8):

- 1.3 assess the impact on local and global water systems of a scientific discovery or technological innovation.
- 2.5 use technological problem-solving skills (see page 16) to design, build, and test a water system device that performs a practical function or meets a need.
- 2.7 use a variety of forms (e.g. oral, written, graphic, multimedia) to communicate with different audiences for a variety of purposes.

### MATHEMATICS:

- Grade 7 – C3.1 Solve problems and create computational representations of mathematical situations by writing and executing efficient code, including code that involves events influenced by a defined count and/or sub-program and other control structures.
- Grade 7 – C3.2 Read and alter existing code, including code that involves events influenced by a defined count and/or sub-program and other control structures, and describe how changes to the code affect the outcomes and the efficiency of the code.
- Grade 8 – C3.1 Solve problems and create computational representations of mathematical situations by writing and executing code, including code that involves the analysis of data to inform and communicate decisions.
- Grade 8 – C3.2 Read and alter existing code involving the analysis of data to inform and communicate decisions and describe how changes to the code affect the outcomes and the efficiency of the code.



## FAITH CONNECTIONS:

This learning experience corresponds strongly with the Catholic Social Teaching theme of Stewardship of Creation. According to this theme, we recognize the Earth as sacred. Creation has its own intrinsic value and as a global community, we have a responsibility to protect and to cherish the Earth's ecological diversity, beauty, and life-sustaining properties. The hope is that this learning experience will create an understanding that together we must protect and hold all parts of Creation to be accessed and enjoyed by future generations.

## ONTARIO CATHOLIC SCHOOL GRADUATE EXPECTATIONS:

- A Reflective, Creative, and Holistic Thinker who adopts a holistic approach to life by integrating learning from various subject areas and experience.
- A Responsible Citizen who witnesses Catholic social teaching by promoting equality, democracy, and solidarity for a just, peaceful, and compassionate society.
- A Collaborative Contributor who works effectively as an interdependent team member and respects the rights, responsibilities and contributions of self and others.

## RESOURCES NEEDED:

- Water filter materials and [procedure](#) document.
- Lab template found below.
- Access to laptops/Chromebooks.
- Links and resources included in the learning experience.

## REFERENCES:

[Safe Water](#)

[Teach Engineering](#)

[UN Global Goals-Why it Matters](#)

[Government of Canada: Water Sources \(Ground Water\)](#)

[National Geographic-Aquifers](#)



## Water Filtration Investigation

(Adapted from Teach Engineering: The Dirty Water Project)

[Source](#)

### Materials:

Each lab group will need:

- Data Collection Document, one per student or share digitally.
- 1-2-liter plastic bottle cut in half horizontally, as shown in Figure 1



(Figure 1. Cut a 2-liter plastic soda bottle in half through the middle.)

- 1- 8 cm square of mesh, such as fine nylon screen or fine cheesecloth
- 1 rubber band
- 1 spoon or another stirring utensil; a chopstick, popsicle stick or small dowel will also work well

To share among all lab groups:

- filter materials, such as a large coffee filter (at least 15 cm in diameter), 6 cotton balls, 6 cups soil, ~6 cups sand, 1 dozen large and small pebbles (total), ~6 cups activated charcoal (such as used for potting plants and in aquariums)
- measuring cups
- 2 large jugs/jars, ~4-liter size for mixing/storing “polluted water”
- “polluted water” can be made by mixing the following items in amounts at the educator’s discretion: water (enough to fill the jugs/jars ~¾ full), green liquid food



coloring, soil, organic matter such as grass clippings and orange rinds, dishwashing detergent, vinegar, baking soda, salt, pepper, pieces of polystyrene foam (foam peanuts), small pieces of newspaper, and your own ideas for other items

## Procedure:

- Prepare the “polluted water” supply and let it sit in a warm, sunny spot for a day or two.
- Be sure to mix the “polluted water” solution thoroughly before preparing the student samples.
- Prepare the 2-liter bottles: cut them in half horizontally. Place a square of mesh over the bottle opening and secure it with the rubber band. If you use cheese cloth, you will need to replace it before Part 2.
- Make copies or provide a digital copy of the Data Collection Document for each student
- Review the water cycle with the class. Pay special attention to where the water can be purified.

## ENGAGE STUDENTS:

### Part 1

- Create small lab groupings.
- Give the following supplies to each group: a pre-cut 2-liter bottle, a  $\frac{1}{2}$ - $\frac{3}{4}$  cup (100-200 ml) sample of the “polluted water” in a beaker or cup, one type of “filter” (one group will not get a filter to test the mesh only), and a spoon.
- Ask each group to draw a picture of the “polluted water.” Ask them to describe in words what it looks and smells like. Remind them to gently stir the solution and record their sight and smell observations on the worksheet. (Remind students to never taste the solution.)
- Ask students to come up with questions they think are important to answer throughout the activity about water filters (i.e., what makes a good filter?). Have them also write down on their documents their predictions for what they think their particular filter material will do.
- Ask students to set up their filters by placing the filter material into the inverted 2-liter bottle top, as shown in Figure 2. Note: Place the filter in the end of the bottle with the neck, so it functions like a funnel. Use the other half of the bottle as a stand. Prompt students to draw sketches of their setups on the worksheet.



(Figure 2: A 2-liter bottle with a coffee filter placed in the bottom.)

- Ask students to gently stir the “polluted water” and then slowly pour it into the filter. Make sure the group with the filter paper is careful to not pour liquid above the top of the filter.
- Direct students to observe what happens during the filtration. Expect some filtrations to take longer than others. Remind students to record on their worksheets their observations and draw pictures of the filtered water.
- After all groups have collected data, share the results as a class by filling in the information on a chart or in a table/spreadsheet. Have students record all team results in the class data section on the worksheets.
- Ask students to work in their lab groups to design the best water filtration system given the filter material options. Have them fill in the worksheet to record and explain their design choices. Permit them to use as many of the filtering materials as they want.
- Collect all supplies and dispose of used items properly. Rinse and save the 2-liter bottles

## Part 2

- Give each lab group a prepared 2-liter bottle,  $\frac{1}{2}$ - $\frac{3}{4}$  cup (100-200 ml) of the “polluted water” in a beaker or cup and a spoon.
- Distribute the filter materials as needed. Note: It helps if teams each send a designated “materials” person to collect their supplies from a central classroom location.
- Ask students to create a prototype of their group’s water filter systems and draw pictures of them on their worksheets.
- For testing, direct students to gently stir the polluted water supply and then slowly pour an amount into the filter. For teams that used filter paper, remind them to be careful not to pour the liquid above the top of the filter.





(Figure 3. A 2-liter bottle with a coffee filter traps contaminants.)

- Remind students to carefully observe and record on their worksheets what happens during the filtration process. Note: Some filtration systems take longer than others to process the “polluted water,” so students should not worry if their filtration system takes longer than other systems. Also have teams draw pictures on their worksheets of the filtered water.
- Direct students to record their results and answer the worksheet discussion questions, comparing answers with team members.
- After all the groups are finished, label and line up the filtered samples. Ask each team to present its filter system to the class. Have students discuss similarities and differences in the filters.
- Conclude with a class vote and discussion about which water is the cleanest and why.

**(Adapted from Teach Engineering: The Dirty Water Project)**

[Source](#)



# Data Collection Worksheet: Part 1

(Adapted from Teach Engineering: The Dirty Water Project)

[Source](#)

Describe the polluted water before treatment:

A drawing of our polluted water	Observations of our polluted water (What I see and smell)

I predict that the \_\_\_\_\_ (filter type) will remove \_\_\_\_\_

\_\_\_\_\_

when we pour the polluted water through it because \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_



Our filter is \_\_\_\_\_

Sketch of our filter system

Describe the filtered water after treatment:

A drawing of our filtered water	Observations of our filtered water (What I see and smell)

## Results

My prediction was \_\_\_\_\_ (correct/incorrect) because \_\_\_\_\_

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## Class Data

Treatment Type	Removed this type of "pollution"
Mesh filter only	
Cotton ball filter	
Coffee Filter paper	
Sand filter	
Soil filter	
Small pebbles filter	
Large pebbles filter	
Charcoal filter	

### Plan for the Best Water Filter

We will use (material) \_\_\_\_\_ in our filter because \_\_\_\_\_

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We will use (material) \_\_\_\_\_ in our filter because \_\_\_\_\_

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We will use (material) \_\_\_\_\_ in our filter because \_\_\_\_\_

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We will use (material) \_\_\_\_\_ in our filter because \_\_\_\_\_

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We will use (material) \_\_\_\_\_ in our filter because \_\_\_\_\_

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## Data Collection Worksheet: Part 2

(Adapted from Teach Engineering: The Dirty Water Project)

[Source](#)

A drawing of our best water filter prototype





Describe the filtered water after treatment:

A drawing of our filtered water	Observations of our filtered water (What I see and smell)

### Reflection Questions

Respond to the following questions in your lab book (online, etc.)

1. Did your filter work as you expected it to? Explain why or why not.
2. Do you think the filtered water is clean enough to drink? Explain why or why not.
3. Do you think the filtered water is clean enough to put into a river? Explain why or why not.
4. List some ideas for ways you might get the “polluted water” cleaner.

## Self-Assessment: Critical Thinking Learning Progression

Dimension	Limited Evidence	Developing	Accelerating	Proficient
Evaluating information and perspectives	<p>I can find information on a topic using my computer or by asking a teacher.</p> <p>I have difficulty knowing which information/website to trust as accurate or useful.</p> <p>There is some information that I disagree with; however, I have difficulty explaining why I feel this way.</p>	<p>I can find and evaluate information easily.</p> <p>I can distinguish between effective and ineffective arguments/opinions.</p> <p>I am beginning to explain why some information does not make sense using proof from other trusted sources.</p>	<p>I am highly skilled at finding and evaluating information.</p> <p>I can explain how I evaluate information.</p> <p>I may not always demonstrate the correct understanding of the information or an argument.</p>	<p>I can analyze a variety of sources and provide effective proof for why I have selected specific data or sources.</p> <p>I have a clear understanding of whether or not an information source is relevant, useful and trustworthy.</p> <p>I only add information that I can confirm is accurate and adds value to what I am trying to say, prove or do.</p>
Making Connections	<p>I understand that when I am learning about a topic, information and ideas connect or relate to one another.</p> <p>I have difficulty making these connections on my own.</p>	<p>I can connect what I already know with what I have learned to expand my understanding of a topic or issue.</p> <p>I am able to make some difficult connections (e.g. across subjects/classes)</p>	<p>I understand that looking at a topic or issue from different perspectives is an important part of learning.</p> <p>I am able to make connections across subject areas.</p>	<p>I am skilled at making connections and seeing relationships and patterns.</p> <p>I can use these connections to understand topics, issues and themes deeply.</p> <p>I understand that the world is full of conflicting information.</p> <p>I am able to decide which information is most accurate, relevant and useful.</p>

<b>Knowledge Construction</b>	I can find information on a topic; however, I have difficulty engaging with the information in a meaningful or deep way.	<p>I can use several strategies to find and create new knowledge and beliefs.</p> <p>I can evaluate information and use it to answer questions in class.</p> <p>I am working on making connections between subject areas/classes.</p>	<p>I am able to think about topics in a new and exciting way.</p> <p>I can explain by my new knowledge/perspective is useful.</p> <p>I make meaningful or deep connections and clearly understand why they are important in my life and in the lives of others.</p>	<p>I can analyze, interpret, synthesize, and evaluate information from a variety of sources.</p> <p>I am skilled at looking at topics from different points of view and create my own opinion about them.</p> <p>I reflect on and evaluate how and what I learn and can improve my own learning outcomes.</p>
<b>Leveraging Technology for Learning</b>	I have difficulty in using technology to help me learn, to collaborate with others and to connect my ideas about various topics/issues.	<p>I can use technology to generate and explore important ideas.</p> <p>I can use technology to connect with others and explore ways to apply new knowledge and perspectives.</p>	I can use a variety of technologies to evaluate, generate and explore both new and unfamiliar concepts, issues and arguments.	<p>I effortlessly use technology to help me think critically about issues and share and develop this thinking with others.</p> <p>I can clearly describe how technology helps me to think critically.</p> <p>I can use technology to think and work effectively.</p>

Adapted from: NPDL Student-Friendly Deep Learning Progression (M. Fullan, 2019)

## WATER SECURITY: EXPLORING WAYS TO PROTECT OUR WATERSHEDS

**“As the world charts a more sustainable future, the crucial interplay among water, food and energy is one of the most formidable challenges we face.”**

*Ban Ki-Moon, Secretary General of the United Nations*

### LEARNING EXPERIENCE OVERVIEW AND LINK TO UNITED NATIONS THEME:

In this introductory learning experience, students will be asked to consider the quality of water in a specific watershed. Students will examine and explore the foundational tools they will need to make connections, make discoveries, and ultimately make a plan to improve their local environment. It is important for students to start thinking critically about issues affecting our water sources so that they can begin to shift their personal habits and change the way they use water and dispose of waste. Students will be investigating the quality of water within a local watershed. They will be looking at the [Conservation Ontario](#) website to access the water quality report for this area. Further, students will analyze human impact on water quality and will share innovative solutions for watershed protection.

This learning experience addresses the United Nations Sustainable Development Goal #6 – Clean Water and Sanitation with a specific focus on the following sub goals:

- 6.3 By 2030, improve water quality by reducing pollution, eliminating dumping, and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally.
- 6.6 By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers, and lakes.

This learning experience also addresses Goal #14 – Life Below Water.

### CODING CONSIDERATIONS:

When teachers guide students to learn to code, they often employ the **Use-Modify-Create** continuum. Students who have little coding experience are best suited to the **Use** stage of the continuum. In the **Use** stage, students run a pre-created code, witness the results, and then analyze the code to learn how the ordering of commands creates the results.



As students develop a stronger understanding of coding, the **Modify** stage becomes appropriate. In the **Modify** stage, students make changes to existing codes (or, in some cases, they add on to existing codes) to create results that differ from those of the original. This stage introduces the computational thinking skill of debugging. Invariably, first attempts at creating a desired result with code do not work out as hoped, thus necessitating a period of tinkering during which the code inches closer to perfection. This process can be frustrating for students with a narrow coding skill set, so plenty of time in the **Use** stage is advised before moving on to **Modify**.

In the **Create** stage, students envision a desired result and then build the code from scratch. They harness the skills and concepts learned in the previous two stages.

With your students in mind, feel free to adapt this learning experience to accommodate any of the three stages. For the coding tasks in this learning experience, a few sample Scratch programs are provided. These can be delivered to students who are learning within the **Use** stage. Alternately, the teacher may remix (make a copy of) any of the provided programs, and have the students **Modify** these so that the desired result is attained. For students who are very well versed in Scratch coding, these sample codes can be ignored. In this situation, students would be directed to **Create** an original code to meet expectations of the task.

## LEARNING GOALS:

At the end of this learning experience, students will know, understand, and/or be able to:

- Identify factors that affect local water quality.
- Describe how watersheds relate to water management and planning.
- Explain how human and natural factors can change the water table.
- Connect ideas related to environmental stewardship and Catholic Social Teaching.
- Use variables effectively and efficiently in code.
- Develop (either through modification or creation) Scratch codes to create an informative piece that may be used to share critical information about water sheds with others.

## LOOK-FORS:

- Student ability to read, understand, modify and/or create code to represent the mathematics and science underlying a social justice issue.
- An emotional and faith-informed response (on the part of the students) to the critical nature and our call as Christians to environmental stewardship.

## INSTRUCTIONAL COMPONENT:

- **PRIOR KNOWLEDGE:** Students will have an understanding of the purpose of a watershed ([Conservation Ontario: Watersheds 101](#)).
- **TERMINOLOGY:** watershed, conservation, stewardship.
- Resources: paper or collaborative digital tool (e.g. Google Document/Slides) to record small group jot notes, digital devices (for 1:1 or in partnerships for greater collaborative discussion).
- **FAITH CONNECTION:** Water is a gift from God that makes life possible and yet millions of people do not have access to safe drinking water, and rivers, seas and oceans continue to be polluted. How might our choices impact water quality for others?

## ENVISION (MINDS ON):

1. What is the difference between ‘want’ and ‘need’?

In small, collaborative groups, students will quickly list items under each category. Take time to view the lists and follow up with a whole group discussion focusing on these questions:

- Which side seems to detail basic human rights (wants) and which one seems to be for privileged society (needs)?
- Is there anything missing from the ‘need’ list? (Encourage the addition of ‘water’ if it is not already there).
- Can we organize the items under ‘need’ from this unordered list into an ordered list? (using numbers instead of bullets).
- What do you already know about water? (Sample answers: We need water to grow our food, the chemical makeup is H<sub>2</sub>O; the world is about 70% water; human bodies are up to 60% water; all cells need water to function properly; water is a basic human right;



you can only survive a number of days without water; soft drink manufacturers are bottling water to sell to us)

- Did you know that water is an integral part of our web of ecosystems, necessary for wildlife and plants?
- Knowing what we already do about water, just how valuable is water to life on Earth?

### ACTION (SOWING):

2. Go to [Scratch](#) and log into your account.
3. Have your students, in partners if you choose, investigate the [Conservation Ontario website](#) to narrow their research focus to one watershed.
4. Visit and share the Scratch starter project: [Watershed Project](#)
5. Students will create a remix or start a new Scratch project, depending on their experience/comfort level with coding.
6. Using their research notes, students will create a Scratch project that includes the following:
  - a. Watershed area name/title.
  - b. The ancestral Indigenous territory on which the watershed resides.
  - c. A link to the Conservation authority responsible for monitoring this area.
  - d. Two or more background images (e.g. watershed map, Conservation Authority logo, water sampling methods).

To extend the learning and code experimentation, you may wish to extend this learning experience by including a data analysis component:

7. As a whole group, have students locate and review the [Watershed Report Card](#) for their chosen watershed.
8. Students will analyze and discuss the results of the report using the following questions as guides:



- Has there been significant progress in your chosen watershed?
- In what ways might we continue to improve the health of the watershed?

9. Using their findings from the report card along with their previous watershed research, students will build upon their existing Scratch project. They may also choose to start a new, separate project, and will design and develop a public service announcement focusing on strategies to educate people about the issues faced by Ontario watersheds.

10. Students will identify and share factors that protect or damage watersheds and the impact this will have on communities.

11. Students are encouraged to develop their unique code; however, for those who require a scaffold, please view/share this sample: [Watershed PSA](#)

### **CONSOLIDATION (NURTURING):**

12. Students will share their projects with peers and apply feedback provided.

13. Students will self-assess using the learning progression provided.

14. Revisit the guiding question, “How might our choices impact our local water sources?”

15. Facilitate a whole group discussion focusing on the importance of stewardship for our water sources.

### **DISCERN (MONITORING):**

As students work on the coding tasks, the educator is encouraged to circulate among them. This is a good opportunity to monitor students and provide guidance if needed. Teachers should be prepared to offer scaffolds for students in time to prevent their disconnection from the task.

### **EXTENSIONS:**

- Students may choose to record personal video of a local waterway to embed into their Scratch code.



- Begin researching how to record water quality and begin a longitudinal study.
- Investigate local conservation authority to establish a school partnership.
- Investigate how to lobby municipal government to support the health of the local watershed.
- Consider entering a submission into the [Water Docs](#) at School Film Festival. Samples can be viewed [here](#).

## CURRICULUM CONNECTIONS:

### GEOGRAPHY (GRADE 7)

- A1. Application: analyze some challenges and opportunities presented by the physical environment and ways in which people have responded to them.

### SCIENCE AND TECHNOLOGY (GRADE 7)

- 1. Assess the impacts of human activities and technologies on the environment and evaluate ways of controlling these impacts.
- 2. Investigate interactions within the environment and identify factors that affect the balance between different components of an ecosystem.

### MATHEMATICS (GRADES 7/8)

- C3.2 read and alter existing code, including code that involves events influenced by a defined count and/or sub-program and other control structures, and describe how changes to the code affect the outcomes and the efficiency of the code.
- D1. Data Literacy: manage, analyze, and use data to make convincing arguments and informed decisions, in various contexts drawn from real life.

## ONTARIO CATHOLIC SCHOOL GRADUATE EXPECTATIONS:

- A Collaborative Contributor who works effectively as an interdependent team member.
- An Effective Communicator who speaks, writes, and listens honestly and sensitively, responding critically in light of gospel values.
- A Reflective, Creative and Holistic Thinker who solves problems and makes responsible decisions with an informed moral conscience for the common good.

## RESOURCES NEEDED:

- Access to laptops/Chromebooks.
- Links included in the learning experience.
- [Self-Assessment](#).

## REFERENCES:

[Canadian Geographic](#)

[Caring for Our Watersheds](#)

[Conservation Ontario](#)

[Edugains Watershed Learning experience](#)

[Government of Ontario: Great Lakes and Watersheds](#)

[State of Ontario Watersheds](#)

[Watershed Check Up](#)

**Note:** This learning experience includes components that are adapted from the Edugains Water Sheds learning experience. [Source](#)



## Self-Assessment: Critical Thinking Learning Progression

Dimension	Limited Evidence	Developing	Accelerating	Proficient
<b>Evaluating information and perspectives</b>	<p>I can find information on a topic using my computer or by asking a teacher.</p> <p>I have difficulty knowing which information/website to trust as accurate or useful.</p> <p>There is some information that I disagree with; however, I have difficulty explaining why I feel this way.</p>	<p>I can find and evaluate information easily.</p> <p>I can distinguish between effective and ineffective arguments/opinions.</p> <p>I am beginning to explain why some information does not make sense using proof from other trusted sources.</p>	<p>I am highly skilled at finding and evaluating information.</p> <p>I can explain how I evaluate information.</p> <p>I may not always demonstrate the correct understanding of the information or an argument.</p>	<p>I can analyze a variety of sources and provide effective proof for why I have selected specific data or sources.</p> <p>I have a clear understanding of whether or not an information source is relevant, useful and trustworthy.</p> <p>I only add information that I can confirm is accurate and adds value to what I am trying to say, prove or do.</p>
<b>Making Connections</b>	<p>I understand that when I am learning about a topic, information and ideas connect or relate to one another.</p> <p>I have difficulty making these connections on my own.</p>	<p>I can connect what I already know with what I have learned to expand my understanding of a topic or issue.</p> <p>I am able to make some difficult connections (e.g. across subjects/classes)</p>	<p>I understand that looking at a topic or issue from different perspectives is an important part of learning.</p> <p>I am able to make connections across subject areas.</p>	<p>I am skilled at making connections and seeing relationships and patterns.</p> <p>I can use these connections to understand topics, issues and themes deeply.</p> <p>I understand that the world is full of conflicting information.</p> <p>I am able to decide which information is most accurate, relevant and useful.</p>

<b>Knowledge Construction</b>	I can find information on a topic; however, I have difficulty engaging with the information in a meaningful or deep way.	<p>I can use several strategies to find and create new knowledge and beliefs.</p> <p>I can evaluate information and use it to answer questions in class.</p> <p>I am working on making connections between subject areas/classes.</p>	<p>I am able to think about topics in a new and exciting way.</p> <p>I can explain by my new knowledge/perspective is useful.</p> <p>I make meaningful or deep connections and clearly understand why they are important in my life and in the lives of others.</p>	<p>I can analyze, interpret, synthesize, and evaluate information from a variety of sources.</p> <p>I am skilled at looking at topics from different points of view and create my own opinion about them.</p> <p>I reflect on and evaluate how and what I learn and can improve my own learning outcomes.</p>
<b>Leveraging Technology for Learning</b>	I have difficulty in using technology to help me learn, to collaborate with others and to connect my ideas about various topics/issues.	<p>I can use technology to generate and explore important ideas.</p> <p>I can use technology to connect with others and explore ways to apply new knowledge and perspectives.</p>	I can use a variety of technologies to evaluate, generate and explore both new and unfamiliar concepts, issues and arguments.	<p>I effortlessly use technology to help me think critically about issues and share and develop this thinking with others.</p> <p>I can clearly describe how technology helps me to think critically.</p> <p>I can use technology to think and work effectively.</p>

Adapted from: NPDL Student-Friendly Deep Learning Progression (M. Fullan, 2019)

## INCOME INEQUALITY

**“Poverty persists in Canada amidst apparent wealth... Inequality in income distribution is increasing to the detriment not only of the impoverished but also the entire society. The [Industries in Canada], ..., generate wealth for corporations but has harmful social consequences... give[ing] rise to apparent wealth for some but...not deliver[ing] sustainable well-being for all members of society. Tax reform is needed to redistribute wealth and deter ecological destruction. The current trajectory of the world economy is socially and ecologically unsustainable. We must reorient the economy to live within the limits of the Earth’s ecological carrying capacity.”**

*John Dillon*

### LEARNING EXPERIENCE OVERVIEW AND LINK TO UNITED NATIONS THEME:

In this learning experience, students will examine the differences in income among various classes of Canadians from the top wealthiest 1% to those below the poverty line. Students will reflect on what it means to be a prophet through the call of Isaiah, as one who speaks out for justice and mercy. Furthermore, students will determine the amount of money earned for a range of hours worked, using an input/output code through Scratch. They will compare the number of hours worked for various demographic groups such as: upper class, upper middle class, middle class, working poor, migrant workers, students, minimum wage earners, seniors, hospitality services, homeworkers, and Indigenous people, in tables, graphs and algebraically. They will explore questions such as;

- How much more money might someone from the upper class make compared to migrant workers?
- On average, how much do seniors and Indigenous people make per week?
- Why are there such differences in income amongst various groups?
- What can be done?
- What should be done?

Finally, students will examine the Church’s teaching on the dignity of work and the rights of workers. As such, this learning experience addresses United Nations Sustainable Development Goals #8 – Promote sustained, inclusive, and sustainable economic growth, full and productive employment, and decent work for all and #10 – Reduce inequality within and among countries.



Within these goals, this learning experience directly addresses the following targets:

- 8.3 Promote development-oriented policies that support productive activities, decent job creation, entrepreneurship, creativity, and innovation, and encourage the formalization and growth of micro-, small- and medium-sized enterprises, including through access to financial services.
- 8.5 By 2030, achieve full and productive employment and decent work for all women and men, including for young people and persons with disabilities, and equal pay for work of equal value.
- 8.7 Take immediate and effective measures to eradicate forced labour, end modern slavery and human trafficking and secure the prohibition and elimination of the worst forms of child labour, including recruitment and use of child soldiers, and by 2025 end child labour in all its forms.
- 8.8 Protect labour rights and promote safe and secure working environments for all workers, including migrant workers, in particular women migrants, and those in precarious employment.
- 10.1 By 2030, progressively achieve and sustain income growth of the bottom 40 per cent of the population at a rate higher than the national average.
- 10.2 By 2030, empower and promote the social, economic, and political inclusion of all, irrespective of age, sex, disability, race, ethnicity, origin, religion or economic or other status.
- 10.3 Ensure equal opportunity and reduce inequalities of outcome, including by eliminating discriminatory laws, policies and practices and promoting appropriate legislation, policies, and action in this regard.
- 10.4 Adopt policies, especially fiscal, wage and social protection policies, and progressively achieve greater equality.
- 10.5 Improve the regulation and monitoring of global financial markets and institutions and strengthen the implementation of such regulations.
- 10.6 Ensure enhanced representation and voice for developing countries in decision-making in global international economic and financial institutions to deliver more effective, credible, accountable and legitimate institutions.

## CODING CONSIDERATIONS:

When teachers guide students to learn to code, they often employ the **Use-Modify-Create** continuum. Students who have little coding experience are best suited to the **Use** stage of the continuum. In the **Use** stage, students run a pre-created code, witness the results, and then analyze the code to learn how the ordering of commands creates the results.

As students develop a stronger understanding of coding, the **Modify** stage becomes appropriate. In the **Modify** stage, students make changes to existing codes (or, in some cases, they add on to existing codes) to create results that differ from those of the original. This stage introduces the computational thinking skill of debugging. Invariably, first attempts at creating a desired result with code do not work out as hoped, thus necessitating a period of tinkering during which the code inches closer to perfection. This process can be frustrating for students with a narrow coding skill set, so plenty of time in the **Use** stage is advised before moving on to **Modify**.

In the **Create** stage, students envision a desired result and then build the code from scratch. They harness the skills and concepts learned in the previous two stages.

With your students in mind, feel free to adapt this learning experience to accommodate any of the three stages. For the coding tasks in this learning experience, a few sample Scratch programs are provided. These can be delivered to students who are learning within the **Use** stage. Alternately, the teacher may remix (make a copy of) any of the provided programs, and have the students **Modify** these so that the desired result is attained. For students who are very well versed in Scratch coding, these sample codes can be ignored. In this situation, students would be directed to **Create** an original code to meet expectations of the task.

## LEARNING GOALS:

At the end of this learning experience, students will know, understand, and/or be able to;

- Describe the role of a prophet.
- Describe the problem of income inequality.
- Record the income for hours worked for various economic classes (upper, middle, lower classes).
- Graph the relationship between income and hours worked.



- Remove and replace pieces of the block code in Scratch and determine, through investigation, their function.
- Modify code to include subtraction and multiplication operations on a variable.
- Use variables effectively in code.
- Connect ideas related to income inequality to Catholic Social Teaching.

### LOOK-FORS:

- Student's ability to read, understand, modify and/or create code to represent the mathematics underlying a social justice issue
- An emotional and faith-informed response on the part of the students to the necessity of income equity in Canada and in the World

### INSTRUCTIONAL COMPONENT:

- **PRIOR KNOWLEDGE:** Most of the knowledge required to participate in this learning experience is contained within the steps of the learning experience. However, a basic understanding of inequalities in income amongst Canadians would be beneficial.  
<https://www.conferenceboard.ca/hcp/hottopics/canInequality.aspx?AspxAutoDetectCookieSupport=1#:~:text=Income%20inequality%20in%20Canada%20has,income%20Canadians%20also%20lost%20share>
- **TERMINOLOGY:** inequity, upper class, middle class, minimum wage, migrant workers, International Monetary Fund (IMF), debt loads, interest rates.
- **RESOURCES:** Access to laptops/Chromebooks and the Internet, links included in the learning experience and handouts.

### ENVISION (MINDS ON):

1. As a whole group, read "[The Call of Isaiah](#)". Facilitate a discussion with your class about the role of a prophet, both biblically and in the present day. Students may be asked to complete some reflection questions in their journal and/or share their ideas with the class.
2. As a whole group, watch CBC's Lang and O'Leary Exchange [Dangers of Income Inequality](#) and carefully read the CBC articles:





- [The wage gap is shrinking: Women earned 87 cents for every dollar earned by men in 2018](#)
- [Income inequality damaging Canadian economy](#)

3. In small groups or partners, discuss reactions to the CBC articles. As a way to help stimulate some discussion, provide students with the following questions:

John Myles of University of Toronto indicates that there are dangers with income inequality, but there are some possible solutions.

- What are these dangers that John Myles shares in the video and those shared in the second article?
- What do you think are some possible solutions?
- What are your thoughts on these problems and solutions?

Be sure to allow for time to encourage students to share their thoughts with the whole group.

### **ACTION (SOWING):**

4. Using the [handout](#) provided, students are asked to record data collected and ask students to explore the relationship between income and hours worked for various income classes. Students are encouraged to obtain the amount earned for a set number of hours worked using a digital input/output tool from [Scratch](#). From this data, students will create a table, and then graph the relationship between income and hours worked for various income classes. The hope is that when students are exposed to the great differences in the number of hours needed to obtain the same income for various classes, they will be encouraged to speak out against this great injustice of wages.

5. Students are asked to inspect the code, remove and/or replace building blocks of the code and to identify the purpose of various pieces of the code. They are asked to take a screen shot, using the snipping tool, of 2-3 elements and describe the purpose of the code and any other details that are required for the code to work properly.

## CONSOLIDATION (NURTURING):

6. Students are asked to answer questions related to the distribution of income and the relationship between incomes and hours worked. Guiding questions are provided in the [handout](#).

7. Students are asked to share one coding element that they found interesting and describe what it does, how it works, and what details or conditions are needed. The following questions may guide discussion:

“Are there order or sequencing requirements?”

There are a variety of ways you might have the class share their knowledge and understanding. Students might be asked to record coding elements on a piece of paper. They could be asked to share a picture of the element and its description. As a class or in large groups, they might be asked to place their findings on a table and asked to find patterns among the submissions the group has provided. Each of these methods should be seen as an opportunity to generate further discussion around their findings.

## DISCERN (MONITORING):

As students work on the coding tasks, you are encouraged to circulate among them. This is a good opportunity to observe students' strengths and needs. Given that coding may be relatively new for many, it is important to make sure to provide guidance if needed. You should encourage students to take the piece of coding that they are investigating out of the program and re-run the program and see what happens. Students should be encouraged to change the modifiable (white) elements of the code. Students are also encouraged to do some research on the code and its function by researching on the Internet. In doing so, students will see which parts of the code require specific instructions, which require variables, which require other pieces of code to function properly. By trial and error, students can see what works and what does not. When they encounter a piece of code that does not seem to work properly, further research may be needed because some pieces of code have very strict requirements.

As time permits, and as students become more familiar with the coding elements, encourage your students to modify the existing code to include a subtraction of some simple expenses

related to generating income (e.g. subtract \$10 from all incomes to accommodate for travel and meal expenses). Have students verify that they have successfully accomplished this task by calculating this net income by hand.

As you circulate throughout the learning environment, pose the following to encourage deeper critical thinking among your students:

- What message do you think this activity conveys about income distribution in Canada?
- What might be possible solutions to effectively addressing these issues?
- How do expenses impact a low wage earner versus a high wage earner?

### EXTENSIONS:

Have students modify the code even further to incorporate other payroll deductions, using reasonable estimates. For example, a very simple calculation such as 25% of income is removed for deductions for Employment Insurance and Canadian Pension Plan.

Encourage your students to engage in a discussion surrounding their new findings.

Students are encouraged to reflect on Jesus' parables of the *"Attitude of a Servant"* and *"The Workers in the Vineyard"* using the [handout](#) provided. Furthermore, they are asked to consider Catholic Social Teaching on the [Dignity of Work and the Rights of Workers](#). Use the [handout](#) as a resource with reflection questions that they will submit or discuss as a class. Think about/discuss the following:

- Describe the distribution of income that you observed in the mathematics and coding activity.
- Should income be so different. Why or why not?
- What contributes to these differences in income?
- What is the poverty line, the level of income below which one is considered poor, and is that level of income enough to live a healthy and sustainable life?
- Why do different demographics such as gender, ethnicity, disability, and age receive certain maximum average incomes?
- Which of the two Gospel views, Attitude of a Servant or Workers in a Vineyard, matches most closely your view of work and why?



- What are your thoughts on the Catholic Social Teaching of [Dignity of Work and Rights of Workers](#)?
- We are all called as prophets to speak for justice and mercy. What can you do to speak out for just wages and rights of workers?
- What are some of your concluding thoughts on the distribution of income in Canada?

## CURRICULUM CONNECTIONS:

### RELIGIOUS STUDIES (GRADE 7):

- LC1.1: Identify how the Church has promoted the Fourth Commandment, Honour your father and mother, by the witness of solidarity with society, promoting issues of social justice and its social teaching.
- LS2.2: Describe the forms of solidarity which can effectively address socio-economic problems (i.e. poor among themselves, between rich and poor, among workers, employers and employees, etc.) and explain through example how these forms of solidarity can promote social change (communal conversion of society) and respect for the common good.
- LS2.3: Describe the ways that the “principle of solidarity” is manifested by the distribution of goods (i.e. food, clean water, shelter, and basic necessities) and the remuneration for work (i.e. just wage, working conditions, etc.) in the local and global communities.

### RELIGIOUS STUDIES (GRADE 8):

- LS1.1: Connect the principle of the ‘Common Good’ to its biblical source.
- LS1.2: Examine the political initiatives presently being promoted at various levels of civil society (city, provincial, federal) and critique how well each promotes the dignity of the human person and the Common Good as it is defined in Sacred Scripture and Catholic social teaching.
- LS2.2: Summarize the key principles of Catholic social justice and link them to the primary Christian values of love, promotion of life, reconciliation, inclusion, compassion, fidelity, liberation, community, and hope.
- LS2.3: Define the Church’s social teaching with respect to personal responsibility (i.e. care of family and their education, conscientious work, etc.) and participation in public

life (i.e. leadership, politics, culture, etc.) and give examples of how each promotes the good of individuals and the common good of society.

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## MATHEMATICS (GRADE 7)

- B2.1 use the properties and order of operations, and the relationships between operations, to solve problems involving whole numbers, decimal numbers, fractions, ratios, rates, and percentages, including those requiring multiple steps or multiple operations.
- B2.4 use objects, diagrams, and equations to represent, describe, and solve situations involving addition and subtraction of integers.
- C1.1 identify and compare a variety of repeating, growing, and shrinking patterns, including patterns found in real-life contexts, and compare linear growing patterns on the basis of their constant rates and initial values.
- C3.1 solve problems and create computational representations of mathematical situations by writing and executing efficient code, including code that involves events influenced by a defined count and/or sub-program and other control structures.
- C3.2 read and alter existing code, including code that involves events influenced by a defined count and/or sub-program and other control structures, and describe how changes to the code affect the outcomes and the efficiency of the code.
- D1.3 select from among a variety of graphs, including scatter plots, the type of graph best suited to represent various sets of data; display the data in the graphs with proper sources, titles, and labels, and appropriate scales; and justify their choice of graph.
- D1.4 create an infographic about a data set, representing the data in appropriate ways, including in tables and scatter plots, and incorporating any other relevant information that helps to tell a story about the data.

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## MATHEMATICS (GRADE 8)

- B2.4 add and subtract integers, using appropriate strategies, in various contexts.
- B2.7 multiply and divide integers, using appropriate strategies, in various contexts.
- C1.1 identify and compare a variety of repeating, growing, and shrinking patterns, including patterns found in real-life contexts, and compare linear growing and shrinking patterns on the basis of their constant rates and initial values.



- C3.1 solve problems and create computational representations of mathematical situations by writing and executing code, including code that involves the analysis of data to inform and communicate decisions.
- C3.2 read and alter existing code involving the analysis of data to inform and communicate decisions and describe how changes to the code affect the outcomes and the efficiency of the code.
- D1.3 select from among a variety of graphs, including scatter plots, the type of graph best suited to represent various sets of data; display the data in the graphs with proper sources, titles, and labels, and appropriate scales; and justify their choice of graph.
- D1.4 create an infographic about a data set, representing the data in appropriate ways, including in tables and scatter plots, and incorporating any other relevant information that helps to tell a story about the data.
- D1.6 analyze different sets of data presented in various ways, including in scatter plots and in misleading graphs, by asking and answering questions about the data, challenging preconceived notions, and drawing conclusions, then make convincing arguments and informed decisions.
- F1.2 create a financial plan to reach a long-term financial goal, accounting for income, expenses, and tax implications.

### FAITH CONNECTIONS:

This learning experience corresponds strongly with the Catholic Social Teaching of “The Dignity of Work and the Rights of Workers”. The Church teaches that the economy must provide opportunities for work and fair wages for every individual who is willing and able to work. According to the United States Catholic Conference of Bishops (USCCB), “Work is more than a way to make a living; it is a form of continuing participation in God’s creation. If the dignity of work is to be protected, then the basic rights of workers must be respected—the right to productive work, to decent and fair wages, to the organization and joining of unions, to private property, and to economic initiative.”

### ONTARIO CATHOLIC SCHOOL GRADUATE EXPECTATIONS:

- A Reflective, Creative, and Holistic Thinker who adopts a holistic approach to life by integrating learning from various subject areas and experience.



- A Responsible Citizen who witnesses Catholic social teaching by promoting equality, democracy, and solidarity for a just, peaceful, and compassionate society.

### RESOURCES NEEDED:

- Access to laptops/Chromebooks and the Internet.
- Links included in the learning experience.
- Handouts.

### REFERENCES:

**John Dillon (KAIROS)** Poverty, Wealth and Ecology in Canada A study for the Alternative Globalization Addressing People and the Earth (AGAPE) program of the World Council of Churches

<https://www.kairoscanada.org/wp-content/uploads/2011/11/SUS-CJ-11-10-PovertyWealthEcology.pdf>

**Lang and O’Leary Exchange (CBC)** Dangers of Income Inequality

<https://www.cbc.ca/player/play/2443084765>

**CBC News.** The wage gap is shrinking: Women earned 87 cents for every dollar earned by men in 2018

<https://www.cbc.ca/news/business/statistics-canada-gender-wage-gap-1.5311454#:~:text=Business-,The%20wage%20gap%20is%20shrinking%3A%20Women%20earned%2087%20cents%20for,every%20dollar%20earned%20by%20men.>

**CBC News.** Income inequality damaging Canadian economy

<https://www.cbc.ca/news/canada/manitoba/income-inequality-damaging-canadian-economy-1.2882793>

## The Call of Isaiah (*Isaiah 6:1—8*) – Reflection Questions and Journal

In the year King Uzziah died, I saw the Lord seated on a high and lofty throne, with the train of his garment filling the temple. Seraphim were stationed above; each of them had six wings: with two they veiled their faces, with two they veiled their feet, and with two they hovered aloft.

They cried one to the other, “Holy, holy, holy is the Lord of hosts! All the earth is filled with his glory!” At the sound of that cry, the frame of the door shook, and the house was filled with smoke.

Then I said, “Woe is me, I am doomed! For I am a man of unclean lips, living among a people of unclean lips; yet my eyes have seen the King, the Lord of hosts!” Then one of the seraphim flew to me, holding an ember that he had taken with tongs from the altar.

He touched my mouth with it and said, “See, now that this has touched your lips, your wickedness is removed, your sin purged.”

Then I heard the voice of the Lord saying, “Whom shall I send? Who will go for us?” “Here I am,” I said; “send me!”

*Source: July 10, 2020 Daily Readings, Word Among US*

### Did you know?

**Isaiah** was the 8<sup>th</sup>-century BCE Israelite prophet after whom the Book of Isaiah is named.

Within the text of the Book of Isaiah, Isaiah himself is referred to as “the prophet”, but the exact relationship between the Book of Isaiah and any such historical Isaiah is complicated. The traditional view is that all 66 chapters of the book of Isaiah were written by one man, Isaiah, possibly in two periods between 740 BC and c. 686 BC, separated by approximately 15 years, and that the book includes dramatic prophetic declarations of Cyrus the Great in the Bible, acting to restore the nation of Israel from Babylonian captivity. Another widely held view is that parts of the first half of the book (chapters 1–39) originated with the historical prophet, interspersed with prose commentaries written in the time of King Josiah a hundred years later, and that the remainder of the book dates from immediately before and immediately after the end of the exile in Babylon, almost two centuries after the time of the historical prophet.

*Source: Wikipedia. Isaiah. <https://en.wikipedia.org/wiki/Isaiah> (Accessed July 12, 2020)*

*Other sources: Biography. Isaiah (Prophet) <https://www.biography.com/religious-figure/isaiah#:~:text=of%20Jesus%20Christ.,Synopsis,of%20the%20Messiah%20Jesus%20Christ.> (Accessed July 12, 2020)*





## Journal

In your journal, answer the following questions:

What is a prophet?

Take a moment and discuss this definition of a prophet. Does it match with your understanding of what a prophet is?

*The biblical idea of a prophet is different than present day people who claim to be prophets. A prophet speaks out for justice and mercy and seeks the common good. They do not foresee the future and are not fortune tellers. Is this your idea of a prophet?*

What do justice, mercy, and the common good mean?

Do we have prophets in our world? Name one and why you think they are a prophet.

God calls his disciples to be prophets in our world. How can you be a prophet in the world? What specifically can you do?

## Inquiry—Wage Equity

Consider ten different working groups in Canada. Some incomes are reported as hourly wages, and some are as yearly salaries. For comparison purposes, use 2000 hours as an approximate number of hours worked in one year. By law, without paying overtime, people can be expected to work 48 hours a week or almost 10 hours a day.

Upper Class—Top 1% of Canadians make over \$381,300/yr.

Upper Middle Class—Top 5% of Canadians make over \$179,800/yr.

Middle Class—Top 10% of Canadians make over \$134,900/yr.

Working Poor—\$28,000/yr.

Migrant Workers—Under \$15 per hour (60 hrs. but paid for 40 hrs. at minimum wage)

Student Minimum Wage--\$13.15/hr.

General Minimum Wage--\$14/hr.

Seniors and Hospitality Services--\$12.20/hr.

At Home Workers (PSWs)--\$15.40/hr.

Average Indigenous Person in Ontario--\$33, 218/yr. compared to \$42,524/yr. for non-Indigenous

### Sources:

[https://www12.statcan.gc.ca/nhs-enm/2011/as-sa/99-014-x/99-014-x2011003\\_2-eng.cfm](https://www12.statcan.gc.ca/nhs-enm/2011/as-sa/99-014-x/99-014-x2011003_2-eng.cfm)

<https://migrantworkersalliance.org/makeitright/equalwages/>

<https://www.ontario.ca/document/your-guide-employment-standards-act-0/minimum-wage>

<https://www.ontario.ca/document/your-guide-employment-standards-act-0/hours-work>

### Instructions:

Using the computer program from [Scratch](#) input the hourly rate for the Upper Class and then input each of the following number of hours of work: 0, 1, 2, 3, 4, 5, 10, 48, 192 and record the amount earned for each number of hours. For annual income (/yr.), you will need to convert to an hourly rate, using an approximate number of hours worked in a year (see above).

Repeat for each working class above and record in the table below.



Graph the data from 0—10 hours, comparing different classes ensuring that you compare the upper, and middle class to some of the lower income or minimum wage jobs.

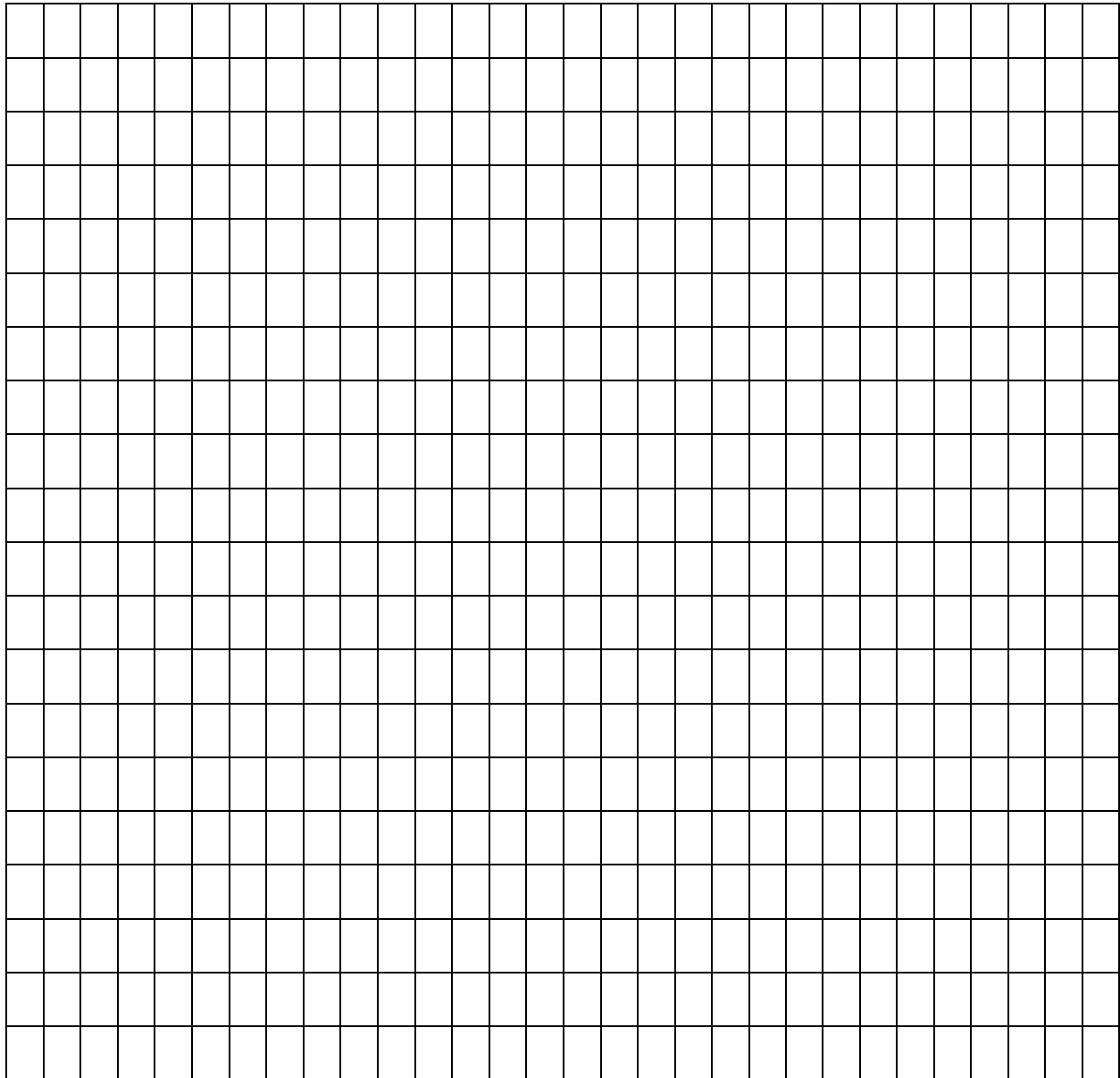
Inspect the code, removing and/or replacing elements of it. Identify the purpose of the coding elements. Take a screen shot (or use the Snipping Tool found on most computers) of 2-3 elements and describe their purpose in the code and any other details that are required for them to work properly.

**Table 1. Relationship between Pay and Number of Hours Worked for Various Household Income Classes**

	Pay (\$)				
Hours Worked (hours)	Upper Class	Upper Middle Class	Middle Class	Working Poor	Migrant Workers
0					
1					
2					
3					
4					
5					
10					
48					
192					

	Pay (\$)				
Hours Worked (hours)	Upper Class	Upper Middle Class	Middle Class	Working Poor	Migrant Workers
0					
1					
2					
3					
4					
5					
10					
48					
192					

**Graph 1. Relationship between Pay and Number of Hours Worked for Various Household Income Classes**



## Guiding Questions

1. How much does a migrant worker make in one month (about 192 hours)?
2. How much does 1% of the richest Canadian make in about a month?
3. How many times larger is the monthly income of the upper class (top 1%) than the migrant worker? What does this value mean?
4. How much do you think you would need to make in a week to ensure a healthy lifestyle?
5. How much do you think a senior would need to make in a week to ensure a healthy lifestyle?
6. How much does an Indigenous person make generally in one week?
7. How much more does a non-Indigenous person make compared to other working groups, on average? What is the percent or proportion? Why do you think there is a difference? What do you think can/should be done about this inequity?
8. What did you notice about the pay of upper classes and lower classes?
9. What was surprising or interesting to you?
10. What are you skeptical of in these values or interpretations?
11. Should there be something done for the vast differences in pay for work? What could be done? Describe.
12. What coding elements did you choose to investigate? What do they do? How do they accomplish them? What details are needed (specific numbers, conditions, etc.) for them to function properly? Is an order needed?
13. Modify the code to include a subtraction of \$5 or \$10, or some value you feel is appropriate for expenses incurred at work or in having to get to work. See if what you modified results in this subtraction correctly. Describe how you modified the code to accommodate these changes.



## Income Inequity Reflection

Read the following two Gospel passages and some excerpts of writings by the Catholic Church about the Dignity of Work and the Rights of Workers.

### Attitude of a Servant—Luke 17:7—10

Who among you would say to your servant who has just come in from plowing or tending sheep in the field, ‘Come here immediately and take your place at table’? Would he not rather say to him, ‘Prepare something for me to eat. Put on your apron and wait on me while I eat and drink. You may eat and drink when I am finished’? Is he grateful to that servant because he did what was commanded? So, should it be with you. When you have done all you have been commanded, say, ‘We are unprofitable servants; we have done what we were obliged to do.’

### The Workers in the Vineyard. Matthew 20:1—16

The kingdom of heaven is like a landowner who went out at dawn to hire laborers for his vineyard. After agreeing with them for the usual daily wage, he sent them into his vineyard. Going out about nine o’clock, he saw others standing idle in the marketplace, and he said to them, ‘You too go into my vineyard, and I will give you what is just.’ So, they went off. And, he went out again around noon, and around three o’clock, and did likewise. Going out about five o’clock, he found others standing around, and said to them, ‘Why do you stand here idle all day?’ They answered, ‘Because no one has hired us.’ He said to them, ‘You too go into my vineyard.’ When it was evening the owner of the vineyard said to his foreman, ‘Summon the laborers and give them their pay, beginning with the last and ending with the first.’ When those who had started about five o’clock came, each received the usual daily wage. So, when the first came, they thought that they would receive more, but each of them also got the usual wage. And on receiving it they grumbled against the landowner, saying, ‘These last ones worked only one hour, and you have made them equal to us, who bore the day’s burden and the heat.’ He said to one of them in reply, ‘My friend, I am not cheating you.\* Did you not agree with me for the usual daily wage? Take what is yours and go. What if I wish to give this last one the same as you? Or, am I not free to do as I wish with my own money? Are you envious because I am generous?’ Thus, the last will be first, and the first will be last.

## **What's the Church's official teaching on the dignity of work and the rights of workers?**

The Church teaches that the economy must provide opportunities for work and fair wages for every individual, who is willing and able to work. According to the United States Catholic Conference of Bishops (USCCB), "Work is more than a way to make a living; it is a form of continuing participation in God's creation. If the dignity of work is to be protected, then the basic rights of workers must be respected--the right to productive work, to decent and fair wages, to the organization and joining of unions, to private property, and to economic initiative."

All too often though, in our society, the poor and vulnerable are left without opportunities for adequate employment. As Catholics, we must fight to create fair opportunities for all, because our faith tells us "the beginning, the subject and the goal of all social institutions is and must be the human person. All people have the right to work, to a chance to develop their qualities and their personalities in the exercise of their professions, to equitable remuneration which will enable them and their families "to lead a worthy life on the material, social, cultural and spiritual level and to assistance in case of need arising from sickness or age." (Blessed Paul VI, A Call to Action, [[OCTOGESIMA ADVENIENS](#)], no. 14)

## **What are some current issues, which are affecting the rights of workers?**

Right now, millions of Americans are vulnerable to losing access to affordable, quality healthcare depending on potential legislation, which may be passed. For example, in Iowa, teachers have recently lost their collective bargaining rights, and all across America, there are a significant number of working poor Americans, who cannot afford their basic needs, even though they are employed to the best of their abilities.

Some saints, who have worked tirelessly to fight for the dignity and rights of workers include:

- St. Benedict of Nursia, who created the Rule of Benedict, which is a guideline for working and living together in community, supporting each other in alignment with God's will.
- Servant of God Dorothy Day, who was a writer and activist that founded the Catholic Worker Movement, which still helps achieve justice for workers around the world.

Local organizations that help support the dignity of workers:

- Catholic Worker House in Davenport



- Dress for Success
- Quad City Interfaith
- Quad City Federation of Labor

## How can we as individual Catholics help support the rights of workers?

We can advocate for legislation, which supports the rights of workers; collective bargaining, unions, and affordable healthcare options for everyone. If we are in a position of employing people, we can take our employees basic needs into consideration and offer fair wages, opportunities for growth and health benefits to the best of our abilities.

Source: Dignity of Work and Rights of Workers. St Paul Catholic Parish Catholic Social Teaching Resource. [https://www.stpaulcatholicparish.org/apps/pages/index.jsp?uREC\\_ID=839534&type=d&pREC\\_ID=1228474](https://www.stpaulcatholicparish.org/apps/pages/index.jsp?uREC_ID=839534&type=d&pREC_ID=1228474)

## Reflection

Write a short reflection, following the prompts below, describing your thoughts on the Dignity of Work and Rights of Workers.

- Describe the distribution of income that you observed in the mathematics and coding activity.
- Should income be so different and why?
- What contributes to these differences in income?
- What is the poverty line, the level of income below which one is considered poor, and is that level of income enough to live?
- Why do different demographics, such as gender, ethnicity, disability, and age achieve certain maximum average income?
- Which of the two Gospel views, Attitude of a Servant or Workers in a Vineyard, matches most closely to your view of work and why?
- What are your thoughts on the Catholic Social Teaching of Dignity of Work and Rights of Workers?
- What are some of your concluding thoughts on the distribution of incomes in Canada?
- What has all this work taught you about inequity in the workforce?

## Self-Assessment: Critical Thinking Learning Progression

Dimension	Limited Evidence	Developing	Accelerating	Proficient
Evaluating information and perspectives	<p>I can find information on a topic using my computer or by asking a teacher.</p> <p>I have difficulty knowing which information/website to trust as accurate or useful.</p> <p>There is some information that I disagree with; however, I have difficulty explaining why I feel this way.</p>	<p>I can find and evaluate information easily.</p> <p>I can distinguish between effective and ineffective arguments/opinions.</p> <p>I am beginning to explain why some information does not make sense using proof from other trusted sources.</p>	<p>I am highly skilled at finding and evaluating information.</p> <p>I can explain how I evaluate information.</p> <p>I may not always demonstrate the correct understanding of the information or an argument.</p>	<p>I can analyze a variety of sources and provide effective proof for why I have selected specific data or sources.</p> <p>I have a clear understanding of whether or not an information source is relevant, useful and trustworthy.</p> <p>I only add information that I can confirm is accurate and adds value to what I am trying to say, prove or do.</p>
Making Connections	<p>I understand that when I am learning about a topic, information and ideas connect or relate to one another.</p> <p>I have difficulty making these connections on my own.</p>	<p>I can connect what I already know with what I have learned to expand my understanding of a topic or issue.</p> <p>I am able to make some difficult connections (e.g. across subjects/classes)</p>	<p>I understand that looking at a topic or issue from different perspectives is an important part of learning.</p> <p>I am able to make connections across subject areas.</p>	<p>I am skilled at making connections and seeing relationships and patterns.</p> <p>I can use these connections to understand topics, issues and themes deeply.</p> <p>I understand that the world is full of conflicting information.</p> <p>I am able to decide which information is most accurate, relevant and useful.</p>

<b>Knowledge Construction</b>	I can find information on a topic; however, I have difficulty engaging with the information in a meaningful or deep way.	<p>I can use several strategies to find and create new knowledge and beliefs.</p> <p>I can evaluate information and use it to answer questions in class.</p> <p>I am working on making connections between subject areas/classes.</p>	<p>I am able to think about topics in a new and exciting way.</p> <p>I can explain by my new knowledge/perspective is useful.</p> <p>I make meaningful or deep connections and clearly understand why they are important in my life and in the lives of others.</p>	<p>I can analyze, interpret, synthesize, and evaluate information from a variety of sources.</p> <p>I am skilled at looking at topics from different points of view and create my own opinion about them.</p> <p>I reflect on and evaluate how and what I learn and can improve my own learning outcomes.</p>
<b>Leveraging Technology for Learning</b>	I have difficulty in using technology to help me learn, to collaborate with others and to connect my ideas about various topics/issues.	<p>I can use technology to generate and explore important ideas.</p> <p>I can use technology to connect with others and explore ways to apply new knowledge and perspectives.</p>	I can use a variety of technologies to evaluate, generate and explore both new and unfamiliar concepts, issues and arguments.	<p>I effortlessly use technology to help me think critically about issues and share and develop this thinking with others.</p> <p>I can clearly describe how technology helps me to think critically.</p> <p>I can use technology to think and work effectively.</p>

Adapted from: NPDL Student-Friendly Deep Learning Progression (M. Fullan, 2019)

## FOOD DESERTS FOR THOUGHT

***“We have food deserts in our cities. We know that the distance you live from a supplier of fresh produce is one of the best predictors of your health. And in the inner city, people don’t have grocery stores. They have to get on a bus and take a long ride to get to a source of fresh produce.”***

*Michael Pollan, American Author, Professor and Lecturer at Harvard University and UC Berkeley*

### LEARNING EXPERIENCE OVERVIEW AND LINK TO UNITED NATIONS THEME:

This learning experience addresses the issue of food security in urban areas and beyond, specifically an individual’s proximity to healthy food options. Around the world, increases in urbanization have led to the removal of accessible healthy food options, such as grocery stores, markets, etc. In this learning experience, students will alter a map of a city to see if there are any regions that may be classified as a ‘food desert’ – locations without adequate healthy food access. This is a worldwide issue that afflicts the developed and developing world. In New York alone, it is [estimated that 750 000 people live in food deserts](#). Students will develop data and make inferences about urban planning that will directly connect to the idea that no one should go without access to healthy food. This idea is addressed by United Nations Sustainable Development Goal #2 – End hunger, achieve food security and improved nutrition and promote sustainable agriculture, specifically:

- 2.1 By 2030, end hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round.

Connections can also be made to UNSDGs #3 – Good Health and Well-Being, #10 – Reduced Inequalities, and #11 – Sustainable Cities and Communities.

### CODING CONSIDERATIONS:

When teachers guide students to learn to code, they often employ the ***Use-Modify-Create*** continuum. Students who have little coding experience are best suited to the ***Use*** stage of the continuum. In the ***Use*** stage, students run a pre-created code, witness the results, and then analyze the code to learn how the ordering of commands creates the results.



As students develop a stronger understanding of coding, the **Modify** stage becomes appropriate. In the **Modify** stage, students make changes to existing codes (or, in some cases, they add on to existing codes) to create results that differ from those of the original. This stage introduces the computational thinking skill of debugging. Invariably, first attempts at creating a desired result with code do not work out as hoped, thus necessitating a period of tinkering during which the code inches closer to perfection. This process can be frustrating for students with a narrow coding skill set, so plenty of time in the **Use** stage is advised before moving on to **Modify**.

In the **Create** stage, students envision a desired result and then build the code from scratch. They harness the skills and concepts learned in the previous two stages.

With your students in mind, feel free to adapt this learning experience to accommodate any of the three stages. For the coding tasks in this learning experience, a few sample Scratch programs are provided. These can be delivered to students who are learning within the **Use** stage. Alternately, the teacher may remix (make a copy of) any of the provided programs, and have the students **Modify** these so that the desired result is attained. For students who are very well versed in Scratch coding, these sample codes can be ignored. In this situation, students would be directed to **Create** an original code to meet expectations of the task.

## LEARNING GOALS:

Throughout this learning experience, students will learn:

- That access to affordable fresh food is an issue that affects millions in both the developed and developing world.
- That the existence of ‘food deserts’ exists as a result of urbanization and removal of accessible healthy food options.
- That acquiring food often involves the use of public transit for those living in city centres.
- That there is a relationship between the radius and circumference of a circle ( $C = \pi r^2$ ).
- That a radius and circle can indicate the service range of a store or other amenity.

## LOOK-FORS

- Students will make estimations of reasonable distances to travel for fresh food, and see how these estimations affect the creation of food deserts on a map of an urban area

- Students will make conversions between meters used in their estimations and pixels in a Scratch Cartesian plane.
- Students will draw conclusions about whether their reasonable distances to food sources have created urban food deserts or not.

### INSTRUCTIONAL COMPONENT:

- **PRIOR KNOWLEDGE** – Students should come into this learning experience with conceptual understanding of circumference and area of a circle and its relationship to a given radius. They will also require an understanding of position and place in a Cartesian grid and will be required to convert numbers through use of a scale.
- **TERMINOLOGY** – food deserts, food security, radius, circumference.
- **RESOURCES** -
  - Class copies - *Food Deserts for Thought* (Appendix A).
  - Digital Access to Scratch Learning experience – [Food Deserts for Thought](#).
  - [Food Deserts – Food Empowerment Project](#).
  - [Michael Pollan Fixes Dinner \(Extended Interview\)](#).

### ENVISION (MINDS-ON):

1. Read aloud the following quote to the class:

“If every U.S. citizen ate just one meal a week (any meal) composed of locally and organically raised meats and produce, we would reduce our country’s oil consumption by over 1.1 million barrels of oil every week.”

Barbara Kingsolver

Explain/read to the class the following, from *Math that Matters 2* by David Stocker:

“Food Security has become a growing issue in the past few years. It has to do with the amount of healthy food in a community and each person’s access to it. When a community does not have easy access to affordable, healthy food it is called a “food desert”.



When some of these neighbourhoods were first designed, average incomes were higher and transportation by car was commonplace. Ensuring that grocery stores were in easy-to-reach locations was not a high priority. But as incomes have stagnated and declined and people have shifted to public transit, more and more people find themselves without food security.

Access can be examined more broadly, too. People's quality of life depends on access to public services like community centers, public libraries, and green spaces for recreation. Health impacts, like obesity, have an impact on the health of our communities (Stocker, 103-4).

2. Pose the following question to your class allowing think time for 15-30 seconds, and then discuss as a larger group.

"What is it about convenience stores and fast-food outlets that would be troubling if people could not access a grocery store in their immediate area?"

The lack of access to healthy food options within a reasonable distance of home would mean that people and families would be relying on less healthy sources of food, likely an overreliance on fast food and convenience stores.

### ACTION (SOWING):

3. Students may now receive their copy of [Food Deserts for Thought](#) and are to work through the written instruction provided with a laptop and in pairs, if possible. They will also now need access to the [Scratch](#) project. Students are asked to select 'See Inside'.

Students will work through Appendix A, working on a range of questions focused on estimating reasonable on-foot travel distances for grocery stores and community buildings. Students will be directed to [Scratch](#) to test their initial estimations.

4. In tables similar to the one below, students will record their estimations for the reasonable distance column of the table. Said differently, what is a reasonable distance to have to travel to get to this service? This [Scratch](#) map is broken into 20 pixel x 20 pixel squares, and the scale is that every 20 pixels of length or width is equivalent to 200 meters. Students will have to be mindful of this scale throughout this task and you must assume that they do not have a car. They're walking, biking, or taking public transit (Adapted from Stocker, 104). How

far is reasonable to walk to get to the grocery store, or the library? Students will need to represent work in meters and pixels.

Table 1: Stocker, 2019, p. 105

Feature	Symbol	Reasonable Distance	Distances		Av. Distance
Your Home	H				
High End Grocery.	HG				
Affordable Grocery.	AG				
Libraries	L				
Community Centers	CC				

This [Scratch](#) program will allow students to assess the food security of a sample neighbourhood, and they will be able to do so using existing code and some of their own calculations. Their first task is to determine the distance between your home and each of the other buildings. This grid map is actually a Cartesian plane, and each building placement is reflective of its position on this plane. Each square has measurements of 20 px x 20 px.

Notice that this block indicates the position of Home, in this case at (-80, -40). All Sprite locations are set up in this way.

5. While selecting the “Home” Sprite, students will scroll to the bottom two blocks, and adjust each to say, “1st High-End grocery store”, if they aren’t already listed. They will then observe and record the distance to each of the listed features. Students will then find the mean average of each of these features and list the average under the “Average Distance” Column.

6. Students will then input their own reasonable distances into [Scratch](#) after they have converted from meters to pixels, essentially dividing each figure by 10. From here, students will observe what happens when inputting different distances based on their estimations.

7. Students are then tasked with finding the area that is within the radius of affordable grocery stores, and the areas that falls out of this catchment. Students will need to apply the formula for area of a circle ( $\pi r^2$ ) and will need to subtract their findings from 360 x 480, the size of the grid in pixels, 172 800.



## CONSOLIDATION (NURTURING):

8. Students are asked to respond to the following reflection/consolidation questions, though it may be more appropriate to have a group discussion for each of these questions.

- a. Although you have found the area inside and outside of the radius of affordable grocery stores in town, how could these answers be larger? Smaller?

Dependent on the availability of public transit, the service range of all these facilities could potentially be expanded. Students may have a range of other reasons to justify larger or smaller answers.

- b. Would you consider this home to be in a food desert or not? Explain.

Answers may vary based on student estimations or “reasonable distance” - more importantly it isn’t whether it is or isn’t in a food desert but more about student’s explanations and supporting ideas. They may say that it is not in a desert as it’s in range of a high-end grocery store, where others may say that this may not be affordable for everyone. Based on this, answers may vary.

- c. Cities often try to assist with mobility around a city through development of mass transit, like above-ground rail or development of subways underground. While both assist in getting people around a city rapidly, subways can be significantly more expensive than a rail line. Why do you think governments still opt to build subways despite a significantly greater cost?

Answers will vary but will likely all connect to ideas around social justice and creating equitable opportunities for everyone. Connections may be made to Catholic Social Teachings, specifically themes of solidarity and care for the poor and vulnerable.

- d. What new questions have come to mind as you have worked your way through this task?

Answers may vary.



## DISCERN (MONITORING):

Throughout this learning experience students may have difficulty from time to time navigating throughout [Scratch](#). If at any point they accidentally adjust the wrong setting or delete the wrong item, they can use the link again to visit the reset project. At any point, you may find it necessary to stop the class to review or walkthrough either a mathematical concept or to model a situation within Scratch using a projector or other means.

## CURRICULUM CONNECTIONS:

### MATHEMATICS

- Grade 7 - C3.2 read and alter existing code, including code that involves events influenced by a defined count and/or sub-program and other control structures, and describe how changes to the code affect the outcomes and the efficiency of the code.
- Grade 8 - C3.2 read and alter existing code involving the analysis of data to inform and communicate decisions and describe how changes to the code affect the outcomes and the efficiency of the code.
- Grade 7 - E2.3 use the relationships between the radius, diameter, and circumference of a circle to explain the formula for finding the circumference and to solve related problems.
- Grade 7 - E2.5 show the relationships between the radius, diameter, and area of a circle, and use these relationships to develop the formula for measuring the area of a circle and to solve related problems.

### SCIENCE

- Grade 8 – Systems in Action Overall Expectation 1 - assess the personal, social, and/or environmental impacts of a system, and evaluate improvements to a system and/or alternative ways of meeting the same needs.

## FAITH CONNECTIONS:

This learning experience has potential for exploration of Catholic Social Teachings, specifically the Principle of Preferential Option for the Poor and Vulnerable. As cities grow and the gap between rich and poor continues to widen, it is imperative that we consider our most vulnerable when engaging in any sort of infrastructure improvement or demographic analysis.



## ONTARIO CATHOLIC SCHOOL GRADUATE EXPECTATIONS:

- A Responsible Citizen who contributes to the common good.
- A Reflective, Creative and Holistic Thinker who examines, evaluates, and applies knowledge of interdependent systems (physical, political, ethical, socio-economic, and ecological) for the development of a just and compassionate society.

## NOTES:

Learning experience reflection is addressed in the consolidation section of the learning experience.

## RESOURCES NEEDED:

- Class copies - [Food Deserts for Thought](#) (Appendix A).
- Digital Access to Scratch Learning experience – [Food Deserts for Thought](#).
- Laptop and projector for class viewing.

## REFERENCES:

[Food Deserts – Food Empowerment Project](#)

[Michael Pollan Fixes Dinner \(Extended Interview\)](#)

Stocker, David. *Maththatmatters 2. a Teacher Resource Linking Math and Social Justice*. Canadian Centre for Policy Alternatives, 2019.



## Appendix A

### Food Deserts for Thought

“We have food deserts in our cities. We know that the distance you live from a supplier of fresh produce is one of the best predictors of your health. And in the inner city, people don’t have grocery stores. They have to get on a bus and take a long ride to get to a source of fresh produce.”

*Michael Pollan, American Author, Professor and Lecturer at Harvard University and UC Berkeley*

“**Food Security** has become a growing issue in the past few years. It has to do with the amount of healthy food in a community and each person’s access to it. When a community does not have easy access to affordable, healthy food it is called a “**food desert**”. *Maththatmatters 2, Stocker, D.*

When some of these neighbourhoods were first designed, average incomes were higher and transportation by car was commonplace. Ensuring that grocery stores were in easy-to-reach locations was not a high priority. But as incomes have stagnated and declined and people have shifted to public transit, more and more people find themselves without food security.

Access can be examined more broadly, too. People’s quality of life depends on access to public services like community centers, public libraries, and green spaces for recreation. Health impacts, like obesity, have an impact on the health of our communities. (Stocker, 103-4)

You will need to access [Scratch](#) for this activity. Once you visit this link select “See Inside” to view and modify the code involved.

1. In the table below fill in the reasonable distance column of the table. Said differently, what is a reasonable distance to have to travel to get to this service? This [Scratch](#) map is broken into 20 pixel x 20 pixel squares, and the scale is that every 20 pixels of length or width is equivalent to 200 meters. 200 meters = 20 pixels. Remember to be mindful of this scale throughout this task - you must assume that you do not have a car. You are walking, biking, or taking public transit (Adapted from Stocker, 104). How far is reasonable to walk to get to the grocery store or the library? List them in the chart below – and be sure to convert from pixels to meters!



Table 2: Stocker, 2019, p. 105

Feature Distance (in meters)					
Feature	Symbol	Reasonable Distance	Distances		Av. Distance
Your Home	H				
High End Groc.	HG				
Affordable Groc.	AG				
Libraries	L				
Comm. Centers	CC				

Feature Distance (in pixels)					
Feature	Symbol	Reasonable Distance	Distances		Av. Distance
Your Home	H				
High End Groc.	HG				
Affordable Groc.	AG				
Libraries	L				
Comm. Centers	CC				

This [Scratch](#) program will allow you to assess the food security of a sample neighbourhood and you will be able to do so using existing code and some of your own calculations. The first thing you need to do is determine the distance between your home and each of these other buildings. To do this, select the “Home” Sprite from the list of Sprites in the bottom right of your screen. In here, there is a series of code that resets the location of home and then travels to different Sprites i.e., all other locations and indicates the number of pixels to travel there.

This grid map is actually a Cartesian plane, and each building placement is reflective of its position on this plane. Each square has measurements of 20 px x 20 px.

Notice that it indicates the position of Home, in this case at (-80, -40). Each of these Sprites (locations) use this block to determine location.

2. While selecting the “Home” Sprite, scroll to the bottom two blocks, and adjust each to say, “1st High-End grocery store”, if they are not already listed. Press “H” to observe the distance to this store. Record this in your chart. Now, repeat for each of the other structures listed in this chart. They can all be selected from your available dropdown options.

3. Find the mean average of each of these features and list this average under the “Average Distance Column”.

4. It is now time to add your reasonable distances and see what happens! By clicking on each Sprite, you can adjust the radius of the building to align with your reasonable distance. Select the number next to “radius” and convert your reasonable distance from meters to pixels. In this example, 20 pixels is equal to 200 meters. Selecting the flag will run this code, and you can determine if this home falls into a “reasonable distance” from the different features. What do you notice/observe after adjusting each feature radius?

5. The circles around each of these features represents their catchment areas, or the area where people can be expected to come from. Let us consider the catchment of affordable grocery stores – to find out the total area served; we must find the area of the circle it supports. Our formula would be:

$$\text{Area} = \pi r^2 \times \text{total number of affordable grocery stores in town}$$

What is the total area supported by libraries in this city? Show your work on a separate page.

6. If you’ve calculated the area of support, it’s important to know what areas aren’t supported – if you know the Scratch grid map is 480 x 360 pixels, can you determine the area not in the radius of support? Again, show your work on a separate page.

7. Reflection Questions:

- a) Although you have found the area inside and outside of the radius of affordable grocery stores in town, how could these answers be larger? Smaller?
- b) Would you consider this home to be in a food desert or not? Explain.
- c) Cities often try to assist with mobility around a city through development of mass transit, like above-ground rail or development of subways underground. While both assist in getting people around a city rapidly, subways can be significantly more expensive than a rail line. Why do you think governments still opt to build subways despite a significantly greater cost?
- d) What new questions have come to mind as you have worked your way through this task?



## HOW'S MY HEALTH?

***"Health care is vital to all of us some of the time, but public health is vital to all of us all of the time."***

*C. Everett Koop – 13<sup>th</sup> Surgeon General of the United States*

### LEARNING EXPERIENCE OVERVIEW AND LINK TO UNITED NATIONS THEME:

Though tremendous gains have been made across the globe over the last several decades, the fact remains that today [less than half of the global population has access to essential health services](#). The ability to self-assess general health and well-being is an important tool in improving this metric, as it provides an indicator to individuals of potential concerns. This learning experience uses the United Nations Sustainable Development Goal #3 – Good Health and Well-Being, as the basis for investigation. Specifically, students will evaluate the health and well-being of a few sample individuals through use of an existing report generator. This tool, programmed in Scratch, will allow students to investigate the following goal at the micro, or individual, level:

- 3.D Strengthen the capacity of all countries, in particular developing countries, for early warning, risk reduction and management of national and global health risks.

Though students are looking at micro-level data sets, they will be asked how a tool like the one they are using could be used at a macro level, for diagnostic purposes, preventative medicines, etc.

### CODING CONSIDERATIONS:

When teachers guide students to learn to code, they often employ the ***Use-Modify-Create*** continuum. Students who have little coding experience are best suited to the ***Use*** stage of the continuum. In the ***Use*** stage, students run a pre-created code, witness the results, and then analyze the code to learn how the ordering of commands creates the results.

As students develop a stronger understanding of coding, the ***Modify*** stage becomes appropriate. In the ***Modify*** stage, students make changes to existing codes (or, in some cases, they add on to existing codes) to create results that differ from those of the original. This stage introduces the computational thinking skill of debugging. Invariably, first attempts at creating a



desired result with code do not work out as hoped, thus necessitating a period of tinkering during which the code inches closer to perfection. This process can be frustrating for students with a narrow coding skill set, so plenty of time in the **Use** stage is advised before moving on to **Modify**.

In the **Create** stage, students envision a desired result and then build the code from scratch. They harness the skills and concepts learned in the previous two stages.

With your students in mind, feel free to adapt this learning experience to accommodate any of the three stages. For the coding tasks in this learning experience, a few sample Scratch programs are provided. These can be delivered to students who are learning within the **Use** stage. Alternately, the teacher may remix (make a copy of) any of the provided programs, and have the students **Modify** these so that the desired result is attained. For students who are very well versed in Scratch coding, these sample codes can be ignored. In this situation, students would be directed to **Create** an original code to meet expectations of the task.

This is a learning experience that provides an introductory jump-off for students and individuals who have little background with coding. Rather than building unique Scratch code, students are able to manipulate an existing tool for the purpose of data collection and can view inside the program to see how it works. In this way the learning experience falls within the **Use** section of the **Use-Modify-Create** continuum of learning to code.

### LEARNING GOALS:

At the conclusion of this learning experience students will know and/or be able to:

- Use existing code to collect health data indicators of heart rate, BMI, and sleep.
- Make connections between their work at a micro-level and implications at the macro/global level.

### LOOK-FORS:

- Throughout this learning experience students will be inputting, collecting, and making inferences based on data.
- Extending thinking to include programming and data collection of other potential indicators of health.





## INSTRUCTIONAL COMPONENT:

- **PRIOR KNOWLEDGE** – though students need not have strong conceptual knowledge of the markers of health, students may bring an understanding of what data sets can be indicative of good overall health (ex. heart rate, average hours of sleep, water consumption, etc.).
- **TERMINOLOGY** – body mass index; heart rate; tachycardia; bradycardia; recommended sleep.
- **RESOURCES** –
  - [Good Health and Well-Being: Why It Matters.](#)
  - [All About Heart Rate \(Pulse\).](#)
  - [Calculate your BMI.](#)
  - Clock.
  - Meters sticks/bathroom scale (optional if students have personal height/weight estimates).

## ENVISION (MINDS-ON):

1. Begin learning experience with a simple question – we know good health is important, but what does good health mean? How do we determine someone is in ‘good health’? As you receive feedback from your students you may anticipate some expected answers. After a brief discussion, pose this follow-up question – what are some barriers to our/your personal good health? Again, students may suggest a variety of variables that can influence the goal of good personal health.

2. Share with the class;

In the development of a list of sustainable development goals, the United Nations agreed with the idea everyone around the world should have access to tools and measures that promote good health and well-being. While there has been significant progress made since creating the goal, since March 2020 the COVID-19 crisis has significantly disrupted the ability to work on this goal worldwide.

Using the [document](#) linked in your task, read about why Good Health and Well-Being matters according to the United Nations, and see how COVID-19 has affected their work around the world.

### ACTION (SOWING):

3. It is best that students work 2:1 with a computer, to access the handout “[How’s My Health](#)” (p. 154) and work through questions 1-3. Students will read that their personal markers of good health are not necessarily the same priorities as others around the world, specifically the two-thirds of the population who do not have access to essential health services. Discussion of questions to follow time on-task.

4. It’s now time to explore “How’s My Health?” in [Scratch](#). The program provides students with the ability to enter different data and determine if it falls within typically “healthy ranges”. Though these measures, such as heart rate, average hours of sleep, etc., can be reasonably reliable indicators of a healthy lifestyle, it is important to explain that individuals may have underlying reasons for different data that are out of their control.

Students are provided with a number of different cases/data sets and will determine where this information fits on these different scales. If they choose, they may enter their own personal data and determine where this falls on each of these scales; however, it is not required if students are uncomfortable sharing. To calculate personal heart rate, if students so choose, a link has been provided to directions that can be followed. It is also available [here](#).

### CONSOLIDATION (NURTURING):

5. The final question posed to students asks them to consider what a tool like this health checker could be used for in settings around the world. Answers may vary and can be discussed as a group. Responses may include:

- Setting up of health check stations provides access to tools and information that may not otherwise be readily available. This may serve as a form of proactive or preventative medicine.
- Build capacity around important indicators of health, thereby increasing awareness at the personal and community level.

- It could be used as a screening service by local health authorities, making health service wait time more efficient and equitable.

### DISCERN (MONITORING):

As students record data they may be moving around the classroom, recording their personal heart rates or measuring their own height/weight data. Students will need to be respectful of the workspaces of others during this time. In other cases, students may not wish to record their BMI for any number of reasons – this has not been made mandatory as a way of alleviating any potential student discomfort.

### EXTENSIONS:

While students are to work through Hours of Sleep, Heart Rate, and BMI variables and compile results, a fourth icon at the bottom right has been started in the event students would like to try to build their own tool. They may have an idea for another indicator of health that is worth inclusion. Students are encouraged to modify code from the other icons or create their own piece of code for the purpose of unique data collection. This would pull students out of the *Use* section of the *Use-Modify-Create* continuum of coding and into the *Modify-Create* sections.

### CURRICULUM CONNECTIONS:

#### MATHEMATICS

- Grade 7 - C3.1 solve problems and create computational representations of mathematical situations by writing and executing efficient code, including code that involves events influenced by a defined count and/or sub-program and other control structures.
- Grade 8 - C3.1 solve problems and create computational representations of mathematical situations by writing and executing code, including code that involves the analysis of data to inform and communicate decisions Healthy Living.
- Grade 7/8 – D2. demonstrate the ability to apply health knowledge and social-emotional learning skills to make reasoned decisions and take appropriate actions relating to their personal health and well-being.
-

## FAITH CONNECTIONS:

When we consider the well-being of others, we are caring for all of God’s Creation. Care of ourselves and others is an act of stewardship and is an act of maximizing our individual and collective gifts from God. This can be explicitly addressed as part of the reflection/consolidation section of the learning experience. Ask your students to consider the following:

The program you have been using to determine health data for select individuals (including your own if you chose to do so), may be personally interesting. A tool and code such as this may have more meaningful application depending on the context. Where could you see use of a more refined version of this tool? Recall the reading from the beginning of class and think beyond your classroom or community – what purpose could it serve to improve the lives of others around the world?

## ONTARIO CATHOLIC SCHOOL GRADUATE EXPECTATIONS:

- A Reflective, Creative and Holistic Thinker who creates, adapts, and evaluates new ideas in light of the common good.
- A Reflective, Creative and Holistic Thinker who thinks reflectively and creatively to evaluate situations and solve problems.

## RESOURCES NEEDED:

- Clock.
- Meter sticks/bathroom scale (optional if students have personal height/weight estimates).
- Laptop Access (2:1 Ratio if possible).
- Class copies of “[How’s My Health](#)” (Appendix A).

## REFERENCES:

[Good Health and Well-Being: Why It Matters](#)

[All About Heart Rate \(Pulse\)](#)

[Calculate your BMI](#)

[Are Canadian Children Getting Enough Sleep?](#)



## Appendix A

### How's My Health?

***"Health care is vital to all of us some of the time, but public health is vital to all of us all of the time."***

*C. Everett Koop – 13<sup>th</sup> Surgeon General of the United States*

Number 3.D of the United Nations' Sustainable Development Goals:

Strengthen the capacity of all countries, in particular developing countries, for early warning, risk reduction and management of national and global health risks.

<https://www.un.org/sustainabledevelopment/health/>

All would agree on the importance of working towards the health and well-being of everyone of all ages around the world, but these indicators or priorities around the world vary greatly. What may be a large health focus here at home may not be a priority elsewhere? Using the link below, read and reflect on the questions that follow:

[Good Health and Well-Being: Why It Matters](#)

1. What was the focus of the United Nations' efforts around the world to improve individual health? What progress had/has been made so far?
2. What has happened to delay progress around the world? How have children under the age of one been especially affected since this delay?
3. While these are worldwide issues, what do the United Nations suggest you can do to help work towards this goal? Provide evidence to support the idea that your personal goals related to good health may vary from other parts of the world based on what you have read.
4. It is now time to investigate some measures that can be used by individuals to address and determine personal health. Use the link below to visit "How's my Health?" – a Scratch program built to allow users to complete a personal check-in to determine where some of their personal data and habits can be used to indicate if they fall into a healthy range. At any point, you can select "See Inside" to view the code behind this project.



## How's My Health? Data Checker

Upon starting the program, use the prompts to navigate around and enter the data of the people listed below. Indicate in the chart if their information falls within a typical or healthy range, or if their information is higher or lower than recommended. Note – while data may indicate that they are in an “unhealthy” range, these are only guidelines – there may be an underlying reason for data to be outside of a “healthy” range! In the chart below, highlight any measures that fall in a potentially ‘unhealthy’ range.

**Case 1 – Mark** – Mark is a 53-year-old man who weighs 70 kg and has a height of 1.78 meters. He sleeps an average of 6 hours a night, and has a heart rate of 75 BPM

**Case 2 – Samantha** – Samantha is a 17-year-old girl who weighs 50 kg and has a height of 1.65 meters. She has a heart rate of 55 BPM, and sleeps for roughly 9 hours a night

**Case 3 – Phil** – Phil is an 83-year-old man who weighs 95 kg and has a height of 1.83 meters. He has a resting heart rate of 85 and sleeps roughly 7 hours a night.

Here are some instructions to collect your own data if you would like to!

- [Calculate your Heart Rate](#)
- [Calculate your BMI](#)
- [Are Canadian Children Getting Enough Sleep?](#)

Name	Height	Weight	BMI	Sleep	Heart Rate

Any time the program stalls or needs resetting, select the stop sign in the top left.



**Extension** (if you are curious or finish early):

You may have noticed that while there are three icons you are using to curate data for different individuals, there is a fourth icon that has not been used. If you look inside this program, you will notice that this one has been left empty for you! By selecting the question mark icon in the bottom right you can add code to this specific 'Sprite'. Consider what else could be used as a measure of good health. Is there a way to turn this icon into a data collector? When finished, feel free to modify or create new code that will address the health measure of your choice. If you are wondering where to begin, drag code over from any of the other Sprites, and modify that as you need!

**Reflection:**

The program you've been using to determine health data for some select number of individuals including your own data, if you chose to do so, may be personally interesting, but a tool and code such as this may have more meaningful application depending on the setting. Where could you see use of a more refined version of this tool? Recall the reading from the beginning of class and think beyond your classroom or community – what purpose could it serve to improve the lives of others around the world?





## SUSTAINABLE SUBWAY STEWARDSHIP

**“You can't understand a city without using its public transportation system.”**

*Erol Ozan*

### LEARNING EXPERIENCE OVERVIEW AND LINK TO UNITED NATIONS THEME:

In “Sustainable Subway Stewardship”, students will develop plans for a mass transit system using a predetermined city layout in Scratch. Throughout the planning, students will consider the importance of equitable accessibility to a mass transit system and reflect on potential decision-making processes that go into urban transit planning. Around the world, as cost of living expenses increase and wealth, standard of living, and earning gaps continue widening, steps to ensure equitable access to transportation has grown in importance. This learning experience is based on the United Nations Sustainable Development Goal #11 – Sustainable Cities and Communities, specifically:

- 11.2 By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons.

Also relevant to this learning experience is UNSDG #9- Industry, Innovation, and Infrastructure.

### CODING CONSIDERATIONS:

When teachers guide students to learn to code, they often employ the **Use-Modify-Create** continuum. Students who have little coding experience are best suited to the **Use** stage of the continuum. In the **Use** stage, students run a pre-created code, witness the results, and then analyze the code to learn how the ordering of commands creates the results.

As students develop a stronger understanding of coding, the **Modify** stage becomes appropriate. In the **Modify** stage, students make changes to existing codes (or, in some cases, they add on to existing codes) to create results that differ from those of the original. This stage introduces the computational thinking skill of debugging. Invariably, first attempts at creating a desired result with code do not work out as hoped, thus necessitating a period of tinkering during which the code inches closer to perfection. This process can be frustrating for students



with a narrow coding skill set, so plenty of time in the **Use** stage is advised before moving on to **Modify**.

In the **Create** stage, students envision a desired result and then build the code from scratch. They harness the skills and concepts learned in the previous two stages.

With your students in mind, feel free to adapt this learning experience to accommodate any of the three stages. For the coding tasks in this learning experience, a few sample Scratch programs are provided. These can be delivered to students who are learning within the **Use** stage. Alternately, the teacher may remix (make a copy of) any of the provided programs, and have the students **Modify** these so that the desired result is attained. For students who are very well versed in Scratch coding, these sample codes can be ignored. In this situation, students would be directed to create an original code to meet expectations of the task.

Throughout the course of this learning experience, students will be provided with an opportunity to observe the results of running a piece of Scratch code. They will then use these observations to adjust this code to meet specific goals. In this way students are working within the first two stages of the **Use-Modify-Create** continuum of learning to code. Students will first be given an opportunity to view the route of an existing subway line (**Use**), and from there will adjust code that represents other transit lines (**Modify**).

### LEARNING GOALS:

At the conclusion of this learning experience, students will know or be able to:

- Modify and extend existing code to meet the goal of developing an appropriate subway route for a city.
- Perform appropriate translations and rotations using code to run a subway line along a student-determined route.

### LOOK-FORS:

- Students will be adding specific movement blocks that involve rotations and translations to preexisting code.
- Students reflecting on the need to balance city transportation needs with other factors (construction expenses, existing structures requiring relocating, etc.).



## INSTRUCTIONAL COMPONENT:

- **PRIOR KNOWLEDGE:** Students should have some conceptual understanding and ability to describe and perform rotations on a cartesian plane, though application will only require the rotation of a shape around a specific point through a piece of code (clockwise or counter-clockwise rotation). Additionally, though not explicitly required, students may benefit from a geographical understanding of different economic sectors (primary, quaternary, secondary, and tertiary sectors). In this level, regions are divided by residential, commercial, and industrial zone types, though students may be encouraged to see the connections to aforementioned sectors.
- **TERMINOLOGY:** urbanization; sustainability; mass transit; residential, commercial, and industrial zones, rotation, pixel.
- **RESOURCES:**
  - [Subway Definition](#).
  - [The Largest Metro Systems in the World](#).
  - [UN SDG's - Mobilizing Sustainable Transport for Development](#).

## ENVISION (MINDS ON):

1. Provide each of your students with a copy of the learning experience handout, [Sustainable Subway Stewardship](#).
2. Begin by way of offering your students the following question:

Think about and record where you and your family/caregivers have travelled, or typically travel outside of your home in a week. Also consider the method of transportation used to get to each destination. In thirty seconds, we will start creating a group list of your thinking.



As students think about this question, create a t-chart with the following headings. These are also present on their [handout](#).

Methods of Transportation	Why you left your home

3. Class Discussion: Ask your students to consider what they notice about these methods of transportation and places they have travelled. Would there be any possible way to group them? Dependent on where students live, transportation may be personal vehicles, shared or mass transportation such as bus, metro, etc., or a combination of the two.

In many large cities around the world, increased urbanization, an increase in the percentage of people living and/or working in urban places, means that more people are trying to get to and from their homes in the same area. Dependent on many factors, people have access to differing transportation options. This is the basis of the United Nations Sustainable Development Goal 11.2:

By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons.

Today, we will be mindful of this goal when engaging in mass transit development for a city and try to create a sustainable transportation service that is equitable for all.

### ACTION (SOWING):

4. In pairs, provide students with laptops and access to the following links. Students will read through some material and an article meant to build an understanding of subway and metro systems around the world.

- Subway Definition <https://www.britannica.com/technology/subway>
- The Largest Metro Systems in the World <https://www.titlemax.com/discovery-center/planes-trains-and-automobiles/largest-metro-systems-in-the-world/>



5. As appropriate, and once students have settled into small group work, pull up the Sustainable Transport document (p.13) on your presentation screen ([Mobilizing Sustainable Transport for Development](#)). Offer the following questions for whole class discussion;

Sustainable Transport aims to have a positive impact in terms of safety, affordability, and accessibility. In which of these ways do you think a subway or metro system has the greatest impact? Why?

6. Once students have neared completion of these questions, direct them to access this [Scratch](#) program.

Once students arrive at this project, direct them to select “See Inside”. In this [Scratch](#) Project, three subway lines have been set up to depart from different locations in the same station (rectangle in red in the top left of the stage). The ‘city’ that they will travel through has the different zones colour-coded (residential – green, commercial - dark blue, industrial – yellow). If students need a point of reference on the map, they need to know that this is actually a Cartesian grid, and the black x- and y-axis meet at 0,0. Each city block, or square on the map, is 20 pixels by 20 pixels. To move forward 1 square, you would enter 20 in the ‘repeat’ block. This current setup allows us to track the total numbers of pixels travelled by each individual line. In this way multiples of 20 are ‘friendly numbers’ and represent a city block each.

7. Students are now challenged to try and create a subway system in this city with the following conditions:

- No city block is more than 100 pixels from a subway line (approx. 5 city blocks).
- No travel through/under water (light blue).
- Attempt made to create as efficient a line as possible.
- Subway lines may or may not run in a loop (they may run a length of track forward and then reverse course and may overlap with other lines).

### CONSOLIDATION (NURTURING):

8. Using the systems that have been created, students are presented with two problems. Two sample residents in this city are described below. Students must describe the route that each would take to get around the city in a given day.

Mark, who lives with his wife and two children in Block A, has been struggling to find work since he was laid off by his previous employer. He has since found a job opportunity in Block B that will pay enough to take care of his family, but he neither can nor wants to commute via a personal mode of transportation like a car. On a daily basis, he will also have to drop off and pick up his daughter from a before- and after-school program, located in the same building where she goes to school (Block C).

Mark's new coworker Michaela works at the same place as Mark (Block B) but lives on the other side of town (Block D). Because of a medical condition, she must travel to a specific clinic every other day for treatment (Block E). On opposite days she likes to travel down to run along the waterfront after work (Block F).

### **DISCERN (MONITORING):**

Students will have completed handout work for submission and review if necessary, but at learning experience conclusion can be asked to write and reflect on the following prompt in exit slip form:

The United Nations theme of developing sustainable transport in a city seeks to improve cities in micro- and macro-level ways. In this case, micro-level improvements benefit individual users, while macro-level improvements benefit the city and region. Give some examples of micro- and macro-level improvements in the space provided and explain these benefits.

### **EXTENSIONS:**

Just because a metro or subway line runs along a given track does not mean that individuals have access to it. Using the graph provided on handout, students will make recommendations about where specific subway stations or access points should be located. Students need to be mindful of the need to balance having enough with too many stations present.

## CURRICULUM CONNECTIONS:

### MATHEMATICS

- Grade 7 - C3.2 read and alter existing code, including code that involves events influenced by a defined count and/or sub-program and other control structures, and describe how changes to the code affect the outcomes and the efficiency of the code.
- Grade 8 - C3.2 read and alter existing code involving the analysis of data to inform and communicate decisions and describe how changes to the code affect the outcomes and the efficiency of the code.
- Grade 7/8 - E1.4 describe and perform translations, reflections, rotations, and dilations on a Cartesian plane, and predict the results of these transformations.

### GEOGRAPHY

- Grade 8 – A2 Inquiry: use the geographic inquiry process to investigate issues related to the interrelationship between human settlement and sustainability from a geographic perspective.
- Grade 8 – B3 Understanding Geographic Context: demonstrate an understanding of significant patterns in and factors affecting economic development and quality of life in different regions of the world.

## FAITH CONNECTIONS:

Throughout this learning experience students explore and discuss themes of equity and accessibility to transportation for everyone. This theme of equity connects to Catholic Social Teaching and should underpin the justification for working toward solutions across these themes.

## ONTARIO CATHOLIC SCHOOL GRADUATE EXPECTATIONS:

- A Reflective, Creative and Holistic Thinker who creates, adapts, and evaluates new ideas in light of the common good.
- A Reflective, Creative, and Holistic Thinker who thinks reflectively and creatively to evaluate situations and solve problems.



- A Self-Directed, Responsible Lifelong Learner who demonstrates flexibility and adaptability.

### RESOURCES NEEDED:

- Class laptop access (2:1 if possible).
- Presentation screen/projector, for any group modelling/sharing of work or resources.
- Class copies of [\*Sustainable Subway Stewardship\*](#) (Appendix A).

### REFERENCES:

Mobilizing Sustainable Transport for Development

<https://sustainabledevelopment.un.org/content/documents/2375Mobilizing%20Sustainable%20Transport.pdf>

The Largest Metro Systems Worldwide

<https://infographicjournal.com/the-largest-metro-systems-worldwide/>

Subway Definition

<https://www.britannica.com/technology/subway>





## Appendix A

### Sustainable Subway Stewardship

**“You can't understand a city without using its public transportation system.”**

*Erol Ozan*

Think about it:

Think about and record where you and your family/caregivers have travelled, or typically travel outside of your home in a week. Also consider the method of transportation used to get to each destination. List them below:

Methods of Transportation	Why you left your home

Reward: Could it end at ‘destinations’? What do you notice about these methods of transportation and destinations you left home for? Specifically, is there any way to meaningfully group these trips or methods of travel?

In many large cities around the world, increased urbanization (an increase in the percentage of people living and/or working in urban places) means that more people are trying to get to and from their homes in the same area. Dependent on many factors, people have access to differing transportation options. This is the basis of the [United Nations Sustainable Development Goal](#)

[11.2:](#)

By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons.

Today we will be mindful of this goal when engaging in mass transit development for a city and try to create a sustainable transportation service that is equitable for all.



Metro Systems are [urban passenger transportation system\(s\) using elevated or underground trains or a combination of both](#). Subways are the underground part of these metro systems. Below is a link profiling some of the largest metro systems in the world. Note that the majority of these systems exist in developed countries: [The Largest Metro Systems in the World](#)

1. What similarities and/or differences can you draw between different metro systems around the world? What reasons can you give to explain these similarities or differences?

2. Use the following link to read about problems related to urbanization (on p.13):

[Mobilizing Sustainable Transport for Development](#)

Based on your reading, describe/define concepts of urban sprawl and urbanization. Conduct some additional research if necessary.

3. Use the above link of the UN's goals around transportation in urban areas. Based on p.13 of this document, what do you think would be the potential value of a subway or metro system in solving issues related to urbanization?

4. Subway systems can be used to combat urban sprawl, reduce traffic, and for many other benefits. Today we will attempt to create a subway/mass transit system for a city in need. To do this you will first need to open this Scratch Program:

<https://scratch.mit.edu/projects/410222936/>

5. Select "See Inside" to view the code behind this Scratch program. In this Scratch Project, three subway lines (the three arrows in the top left) have been set up to depart from different locations in the same station (rectangle in red in the top left of the stage). The 'city' that they will travel through has the different zones colour-coded (residential – green, commercial - dark blue, industrial – yellow).

Residential zones, in green, represent where people live.

Commercial Zones, in blue, represent where people work and shop for goods and services.

Industrial Zones, in yellow, represent where people work and where goods are created/assembled.



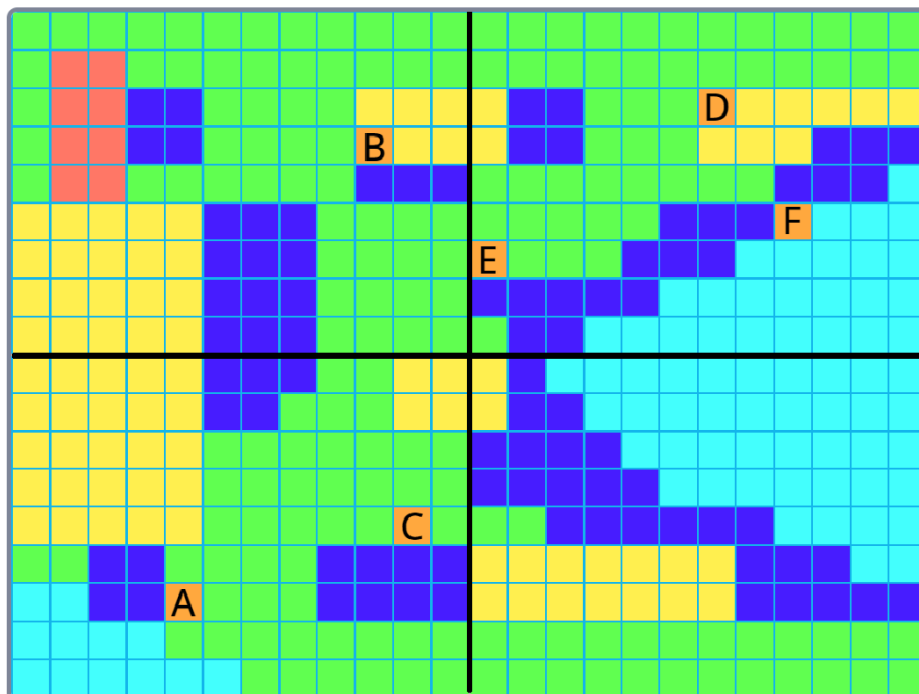
This map is actually a cartesian grid, and the black x- and y-axis meet at 0,0. Each city block, or square on the map, is 20 pixels by 20 pixels. To move forward 1 square, you would enter 20 in the 'repeat' block. This current setup allows us to track the total numbers of pixels travelled by each individual line. In this way multiples of 20 are 'friendly numbers' and represent a city block each. To adjust the direction and travel of each arrow/line, click on the Sprite of the arrow you would like to move and add/modify the end of the code.

For example, the red arrow moves forward 160 pixels, or 8 blocks, and stops. To add to this code, add a "turn" block, and input the degrees you would like to turn. Arrow movement will result from repeated adding of the last four blocks (repeat, move, change, turn). Notice that there are three different lines in the "Change" blocks – one for each colour.

6. Using this set up, you are now asked to create a subway system for this city with the following conditions:

- No city block is more than 100 pixels from a subway line (approx. 5 city blocks).
- No travel through/under water (light blue).
- Attempt to create as efficient a line as possible.
- Subway lines may or may not run in a loop (they may run a length of track forward and then reverse course and may overlap with other lines).

7. Once you have programmed your subway lines into Scratch, copy them onto the grid below:



8. Using the subway routes, you have created, describe the route that each of these city residents must take to get around the city in a given day or week:

Mark, who lives with his wife and two children in Block A, has been struggling to find work since he was laid off by his previous employer. He has since found a job opportunity in Block B that will pay enough to take care of his family, but he neither can nor wants to commute via a personal mode of transportation like a car. On a daily basis, he will also have to drop off and pick up his daughter from a before- and after-school program, located in the same building where she goes to school (Block C).

Mark's new coworker Michaela works at the same place as Mark (Block B) but lives on the other side of town (Block D). Because of a medical condition, she must travel to a specific clinic every other day for treatment (Block E). On opposite days she likes to travel down to run along the waterfront after work (Block F).

### **Reflection:**

The United Nations theme of developing sustainable transport in a city seeks to improve cities in micro- and macro-level ways. In this case, micro-level improvements benefit individual users, while macro-level improvements benefit the city and region. Give some examples of micro- and macro-level improvements in the space provided and explain these benefits.

### **Extension:**

Just because a metro or subway line runs along a given track does not mean that individuals have access to it. Using the graph provided on handout, make recommendations about where specific subway stations or access points should be located. Students need to be mindful of the need to balance having enough and too many stations present.

## WHAT FARE PRICE IS FAIR? – SUSTAINABILITY THROUGH AFFORDABLE PUBLIC TRANSIT

*“A developed country is not a place where the poor have cars. It’s where the rich use public transportation”*

Enrique Peñalosa - Former Mayor of Bogota

### LEARNING EXPERIENCE OVERVIEW AND LINK TO UNITED NATIONS THEME:

This learning experience addresses the issue of public transportation costs and their influence on ridership. In Canada, there is a [growing movement](#) towards fare-free public transit systems. The model has been employed around the world to differing degrees of success, though the measures of success go [beyond](#) dollars generated by transit itself. Despite the potential benefits (like incentivizing transit use, reducing traffic congestion, etc.), there are still arguments that transit fares are required to help offset the costs of maintenance, staffing, and other associated costs. In this learning experience, students will use a formula represented in Scratch to evaluate the influence of adjusting fare prices on a city transit system. Equitable access to transportation is addressed as a human rights issue by the United Nations Sustainable Development Goals #9 and #11, specifically:

- 9.1 Develop quality, reliable, sustainable, and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all.
- 11.2 By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons.

### CODING CONSIDERATIONS:

When teachers guide students to learn to code, they often employ the **Use-Modify-Create** continuum. Students who have little coding experience are best suited to the **Use** stage of the continuum. In the **Use** stage, students run a pre-created code, witness the results, and then analyze the code to learn how the ordering of commands creates the results.



As students develop a stronger understanding of coding, the **Modify** stage becomes appropriate. In the **Modify** stage, students make changes to existing codes (or, in some cases, they add on to existing codes) to create results that differ from those of the original. This stage introduces the computational thinking skill of debugging. Invariably, first attempts at creating a desired result with code do not work out as hoped, thus necessitating a period of tinkering during which the code inches closer to perfection. This process can be frustrating for students with a narrow coding skill set, so plenty of time in the **Use** stage is advised before moving on to **Modify**.

In the **Create** stage, students envision a desired result and then build the code from scratch. They harness the skills and concepts learned in the previous two stages.

With your students in mind, feel free to adapt this learning experience to accommodate any of the three stages. For the coding tasks in this learning experience, a few sample Scratch programs are provided. These can be delivered to students who are learning within the **Use** stage. Alternately, the teacher may remix (make a copy of) any of the provided programs, and have the students **Modify** these so that the desired result is attained. For students who are very well versed in Scratch coding, these sample codes can be ignored. In this situation, students would be directed to **Create** an original code to meet expectations of the task.

### LEARNING GOALS:

At the end of this learning experience, students will have:

- Used data to make inferences about the influence of price on public transit.
- Entered, recorded, and displayed variable data through use of a Scratch input/output machine.
- Connected ideas of sustainable and affordable transportation to Catholic Social Teachings and Inclusion.

### LOOK-FORS:

- Students inputting data in a Scratch Input/Output machine, and logging findings in a t-chart and graphical representation.
- Students using visual representations of data to make informed analyses and recommendations as to the recommended price of public transit.



## INSTRUCTIONAL COMPONENT:

- **PRIOR KNOWLEDGE** – In this learning experience, students will be provided with most of what they need to complete each step. As students will be using an Input/Output machine and equation that involves use of negative numbers and exponents, an understanding of Order of Operations and Input/Output Machines is valuable, though not necessary.
- **TERMINOLOGY** - public/mass transit, zero-fare transit.
- **RESOURCES** - Any of the following resources can be used to complement in-learning experience learning, and to facilitate knowledge-building around mass transit:
  - United Nations SDG #11 Infographic: Sustainable Development Goals Report (2020) Retrieved from [https://sdgs.un.org/sites/default/files/2020-07/The-Sustainable-Development-Goals-Report-2020\\_Page\\_18.png](https://sdgs.un.org/sites/default/files/2020-07/The-Sustainable-Development-Goals-Report-2020_Page_18.png).
  - Should public transit be free? The cost will be bigger than you think. The Globe and Mail (March 2020). Retrieved from <https://www.globeandmail.com/opinion/editorials/article-should-public-transit-be-free-the-cost-will-be-higher-than-you-think/>.
  - Free Public Transit in Canada? Amalgamated Transit Union. (January 2020). Retrieved from <https://www.atucanada.ca/blog/free-public-transit-canada>.
  - Americans spend over 15% of their budgets on transportation costs—these US cities are trying to make it free. CNBC. (March 2020). Retrieved from <https://www.cnbc.com/2020/03/02/free-public-transportation-is-a-reality-in-100-citiesheres-why.html>.

## ENVISION (MINDS-ON):

1. Read aloud the following excerpt from *Maththatmatters 2*, Stocker, page 114;

“Alone we can do so little, together we can do so much.”  
Helen Keller



Imagine a big city where there are subways, buses, streetcars, and other forms of public transit. The more people that you can get traveling together, the less energy and oil you will use. As a result, the amount of air pollution drops. If you fund the system properly and ensure that the cost to ride the vehicles is not overly expensive, you address issues of poverty by encouraging mobility amongst people who cannot afford cars. In the United States, some studies found that 21% of respondents would not make a trip if transit were not available.

Some places around the world have even moved to free transit, where no fares are charged. Funding is covered either by the government, or by the institution running the service, for example, a University campus that offers free transit to its students.

If you oversaw transit within your community, what would it look like? Who would pay for it? How would it take into account the requirements of people who most need it? (Stocker, p. 114)

2. Ask the class the following question and discuss:

What Reasons might a city or community give for zero-fare transit? Can you see any possible downsides?

Students may mention the cost to maintain a service like a subway, missed revenue, etc. This may also be an appropriate point to pull up different case studies or opinions on the matter. Some examples are listed under [References](#).

### ACTION (SOWING):

3. Students are now given a copy of [What Fare Price is Fair?](#) (Appendix A) and need to be prompted to access the [Scratch](#) project for this learning experience. Direct students to select the “See Inside” option to access the different calculation options.

4. Students will work through the problems listed below:

City A has a funding shortfall for their transit system of \$14 000 a day. On a piece of graph paper, draw the line  $y = 14$ . Label your y-axis “Revenue/Shortfall in thousands of dollars”. This is the expense to operate their transit system on a daily basis.





Let us pretend that the equation that represents the income that the city collects from fares is  $y = -x^2 + 9x$ , where  $x$  represents “the number of five cent increases to the current bus fare price”. In Scratch, code can be set up to represent and solve equations when variables are provided. Follow the prompts and input each  $x$  value to fill out this t-table below:

(Solutions are listed in the t-chart below in red.)

$y = -x^2 + 9x$	
When $x$ is...	... $y$ is equal to...
0	0
1	8
2	14
3	18
4	20
5	20
6	18
7	14
8	8
9	0

5. Questions 3-7 in Appendix A [What Fare Price is Fair?](#) move students away from simply collecting and plotting data and asks them to make inferences based on what they have recorded. At any point, you may choose to stop individuals, small groups, or the whole class to unpack what they are seeing and why data looks the way it does.

- Why does increasing the fares initially increase the revenue?

Initially, revenue will increase as the public is paying more per fare.

- Why will overall revenues peak and then begin to fall? What happens in the real world that would cause a decline in overall revenue after a certain number of five cent fare increases?

After a certain number of price increases, people will stop using public transit as a means of travel, in many cases because it is now too expensive.

**Graph** the points from the above t-chart on the same graph paper as you graphed in the first line. Student results should look like this:

- Visually, where do the two lines intersect?  
(2, 14) and (7, 14)
- How many five cent increases are required to break even?  
Two fare increases are needed, meaning people pay 10 cents more per fare.
- How many before revenue peaks?  
Revenue peaks at 4.5 increases.

(Adapted from Stocker, p. 114-115)

### CONSOLIDATION (NURTURING):

6. Students can reflect on the following question when finished, and can use remaining time to explore how Scratch can be used for calculation;

Often, even when maximizing profit potential, mass transit systems fail to make enough money to support themselves. Still, mass/public transit systems grow around the world every day. Why do you think governments continue to make this a goal, and where might this payoff be seen beyond financially?

### DISCERN (MONITORING):

Students may ask if the shape they are creating has a name beyond a curved line. This parabola is meant to show the increasing, cresting, and then decreasing level of revenue based on increasing transit fees. After a certain point, users will be deterred by the high cost of transit

use or may find alternative methods of transportation more economical. Students may also ask questions about how this relatively short piece of code works. To create  $y = -x^2 + 9x$ , a series of sensing and operator blocks were used to identify the answer listed and then apply it to the equation. Specifically, this line was used to simulate  $y = -x^2 + 9x$ : The 'answer' block takes what students enter as the value of 'x'.  $0 - \text{'answer'}$  is meant to provide a negative number that would be multiplied with it is positive, producing a negative number. This would be added to the product of  $9 \times$  the value of  $x$ .

## CURRICULUM CONNECTIONS:

### MATHEMATICS

- Grade Seven - D1.2 collect qualitative data and discrete and continuous quantitative data to answer questions of interest, and organize the sets of data as appropriate, including using percentages.
- Grade Eight - D1.2 collect continuous data to answer questions of interest involving two variables and organize the data sets as appropriate in a table of values.
- Grade Seven - B2.1 use the properties and order of operations, and the relationships between operations, to solve problems involving whole numbers, decimal numbers, fractions, ratios, rates, and percentages, including those requiring multiple steps or multiple operations.
- Grade Eight - B2.1 use the properties and order of operations, and the relationships between operations, to solve problems involving rational numbers, ratios, rates, and percentages, including those requiring multiple steps or multiple operations.

## FAITH CONNECTIONS:

This learning experience lends itself to Catholic Social Teachings in two possible ways. The decisions considered here are part of an effort to organize a part society and infrastructure in a way that supports individual success and growth. By considering and reflecting on the need to adjust fare prices without profits at the forefront of decision-making, students can also be prompted to be mindful of the individual and group call to family, community, and participation, as well as the respect for dignity of work and worker rights.

## ONTARIO CATHOLIC SCHOOL GRADUATE EXPECTATIONS:

- An Effective Communicator who reads, understands, and uses materials effectively.
- An Effective Communicator who listens actively and critically to understand and learn in light of gospel values.

## RESOURCES NEEDED:

- Graph paper for class.
- Digital or hard class copy of [What Fare Price is Fair](#).
- Digital links to any articles or information you would like to share with class, located in *REFERENCES*.
- Whole class device projector (for sharing articles, modelling, group discussion, etc.).

## REFERENCES:

Stocker, David. *Maththatmatters 2. a Teacher Resource Linking Math and Social Justice*. Canadian Centre for Policy Alternatives, 2019.

[Americans spend over 15% of their budgets on transportation costs—these US cities are trying to make it free](#)

[Free Public Transit in Canada? Amalgamated Transit Union](#)

[Should public transit be free? The cost will be bigger than you think](#)

[United Nations SDG #11 Infographic: Sustainable Development Goals Report](#)



## Appendix A

### What Fare Price is Fair?

**“Alone we can do so little, together we can do so much”**

*Helen Keller*

Imagine a big city where there are subways, buses, streetcars, and other forms of public transit. The more people that you can get traveling together, the less energy and oil you will use. As a result, the amount of air pollution drops. If you fund the system properly and ensure that the cost to ride the vehicles is not overly expensive, you address issues of poverty by encouraging mobility amongst people who cannot afford cars. In the United States, some studies found that 21% of respondents would not make a trip if transit were not available.

Some places around the world have even moved to free transit, where no fares are charged. Funding is covered either by the government, or by the institution running the service, for example a University campus that offers free transit to its students.

If you oversaw transit within your community, what would it look like? Who would pay for it? How would it take into account the requirements of people who most need it? (Stocker, p. 114)

Use the link below to access the Scratch page you will need for today. Select, **See Inside** to see how it works!

<https://scratch.mit.edu/projects/413098934/>

You are looking at the financial information of a large city’s transit system. Currently, the maintenance and upkeep of the system has a constant daily expense or shortfall, and transit planners are trying to determine how to best benefit from increasing fare prices.

1. This city has a funding shortfall for their transit system of \$14 000 a day. On a piece of graph paper, draw the line  $y = 14$ . Label your y-axis “Revenue/Shortfall in thousands of dollars”. This is the daily expense to operate their transit system.



2. Let us pretend that the equation that represents the income that the city collects from fares is  $y = -x^2 + 9x$ , where  $x$  represents “the number of five cent increases to the current bus fare price”. In Scratch, code can be set up to represent and solve equations when variables are provided. Follow the prompts and input each  $x$  value to fill out this t-table below:

$Y = -x^2 + 9x$	
When $x$ is...	... $y$ is equal to...
0	
1	
2	
3	
4	
5	
6	
7	
8	
9	

3. Why does increasing the fares initially increase the revenue?

4. Why will overall revenues peak and then begin to fall? What happens in the real world that would cause a decline in overall revenue after a certain number of five cent fare increases?

5. Graph the points from the above t-chart on the same graph paper as you graphed in the first line. What do these two lines look like?

6. Visually, where do the two lines intersect? How many five cent increases are required to break even? How many before revenue peaks? (Adapted from Stocker, p. 114-115)

## Reflection

Often, even when maximizing profit potential, mass transit systems fail to make enough money to support themselves. Still, mass/public transit systems grow around the world every day. Why do you think governments continue to make this a goal, and where might this payoff be seen beyond financially?



