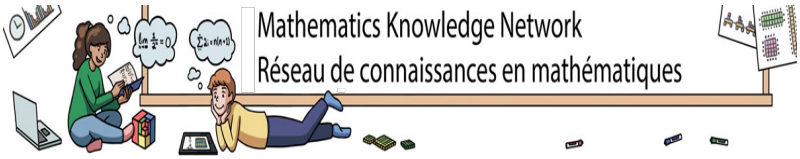

Exploring Geometry and Patterning with Coding

Exploring Geometry and Patterning with Coding was developed with the intention of aiding the students' development of conceptual and fundamental skills for mathematics. It was created for a Grade 9 class for students with diverse challenges. However, for first time coders, the Geometry and Spatial Sense, and Patterning and Algebra material covered in this project could be done any time from Grade 6 to Grade 9, depending on both the programming and math skill level of the class.

> *"Each student worked well independently and immediately it was observed that they each were working to their strengths…Every single student raised their hand to "show off" the work that they had proudly completed…Students were engaged for the majority of the time in both classes that were spent on this activity."*
> *(teacher comment, April 2018)*

Description of Activity*Exploring Geometry and Patterning with Coding* is comprised of two sets of worksheets combined with online Scratch programs. The students will need access to a computer and will need to create their own Scratch accounts for the purpose of saving their work. Each session can be discussed as a whole class in the beginning and then completed in small groups.

Session 1 focuses on a general introduction to Scratch as well as exploring how to draw shapes in Scratch. The worksheet guides students to start drawing basic shapes and then extends to increasingly complex shapes. Throughout the worksheet students are asked to hypothesize about what a certain given code will do before copying it into Scratch to see what really happens. Students will also modify an original code to create a new shape while exploring angles by rotating shapes. This session culminates with students using Blocks to combine shapes in order to draw more complex images like a house.

Session 2 focuses on patterning and has a similar structure to session 1 by giving students basic codes or ideas and then guiding them to extend their learning. The students build on their knowledge of Blocks to create multi-line patterns. The students are then asked to consider what shapes and patterns they can see in the world around them. The next guided activity for the students is to build a pyramid in Scratch using the patterning ideas they have just learned. The last part of the session asked the students to think about area and perimeter of the pyramid they made on Scratch to concretely bring together the coding and math concepts they used throughout the session.

Learning Objectives

- Primary
  - Applying geometry and patterning concepts
  - Using shapes, angles, and patterns to construct new designs
  - Making connections between math and coding
  - Developing and demonstrating mathematical processes

- Secondary

Task created by Ashley Lovnicki for MATH 3P41 at Brock University in collaboration with John Di Pasquale from the Niagara Catholic DSB under the Math Knowledge Network. Coordinated by Laura Cronshaw (Niagara Catholic DSB) and Chantal Buteau (Brock U). Summarized by Kirstin Dreise. August 2018.

- Learning some basics of coding
- Recognizing the usefulness of coding
- Recognizing math in everyday life
- Finding fun and creativity in math

Math Topic & Curriculum

This task aims to guide students in "developing and demonstrating key mathematical processes and describing how math can be applied in everyday situations" (MoE, 2006), with the direct mathematical topics being Geometry and Spatial Sense, and Patterning and Algebra. This activity was designed with reference to the following expectations from the Grade 6 Ontario Ministry of Education Curriculum documents regarding Geometry and Spatial Sense as well as regarding Patterning and Algebra:

> *By the end of Grade 6, student will: sort and classify quadrilaterals by geometric properties related to symmetry, angles, and sides, through investigation using a variety of tools; measure and construct angles up to 180°; construct polygons using a variety of tools, given angle and side measurements; identify, perform, and describe, through investigation using a variety of tools rotations of 180º and clockwise and counter clockwise rotations of 90°, with the centre of rotation inside or outside the shape.* (MoE, 2005)
>
> *By the end of Grade 6, student will: identify geometric patterns, through investigation using concrete materials or drawings; determine a term, given its term number, by extending growing and shrinking patterns.* (MoE, 2005)

The topics included in these expectations are addressed through the various guided and exploratory activities throughout the two sessions. Students will develop an understanding not only of shapes and patterns, but also how to manipulate and conduct their own research to answer questions.

Technology & Project type

For *Exploring Geometry and Patterning with Coding,* the main technology used is scratch.mit.edu which students can access on any computer or laptop. Scratch is a free online programming tool designed to be friendly to all ages and levels of coding. For this activity it is helpful to create a Scratch Teach account with can be used to create and monitor student accounts and progress. The type of activity chosen for this task is an "understand, modify, create" style. Students are introduced to the mathematical concept, asked to modify or build on a baseline code, and then encouraged to take what they learned during the session and create their own model or game. The goal of this style is to allow students to use their creativity and interest in order to build understanding of a guided topic.

Implementation

The intended classroom arrangement for this task is to have students sit together in groups of 3 to 4 at a table, each working on a laptop. The use of laptops allows students to work on their own individual project while arranging themselves in a way that they can scaffold one another's learning by having the opportunity to see other's methods, share information, and compare codes when there is a bug. Common challenges include: using 60^{o} to turn when drawing an equilateral triangle, finding the correct rotation angle when drawing multiple shapes around a point, combining and modifying codes to draw the house, and placing stamps in the correct place to make a pattern align properly when using Blocks. Students should be allowed to explore the code, find bugs, and attempt to solve the problems on their own. It is helpful to remind students that mistakes are great learning opportunities and can allow a coder to gain deeper understanding and even discover new features. Bugs happen to everyone, even expert programmers!

While *Exploring Geometry and Patterning with Coding* was designed for use in Scratch, it can be modified to use different media such as Dash, or another coding program which the class is familiar with. Additionally, as the learning objectives and curriculum expectations include topics that are covered in many grade levels the worksheets can easily be modified to become simpler or more difficult for use in many classroom settings.

Although the task was designed to fill two 60 minute sessions it could also be implemented over multiple shorter time periods. Breaking the worksheets into multiple days could help students gain deeper understanding as they would continually return to the ideas and possibly start to use computational thinking on a daily basis.

Mathematics Engagement

At the beginning of the activity implementation students may not be aware that the task given to them is in fact a mathematics assignment – this is intended and if possible the students should not be explicitly told that it is. However, while the students are completing the activity their mathematical engagement becomes clear. In Session 1, students have the chance to draw, rotate, and explore various polygons. Through this exploration, students are interacting with angles and polygons, in addition to exploring the rotations of shapes. During Session 2, students create geometric patterns that they are able to extend to create more involved patterns through which they are engaging in the identification of patterns through concrete examples in addition to using a variety of exploration tools (MoE, 2005). Students may only realize this through group discussion and reflection when the activity is complete.

This project aims to connect mathematics education to computational thinking allowing for more differentiated learning and student agency. While the worksheets guide students through examples, there truly are wide walls since students are able to approach the problem in a variety of different ways to achieve the same result of dynamically modelling any basic shape or pattern, many of which have been studied previously in the students' education. Furthermore, this activity allows students to be the agents of their own learning as Scratch gives them the opportunity to deeply explore any part of the assignment which intrigue them. They are even able to look at the worksheet and code their own program or game using the principles taught.

Resources for this task:

Session One (pdf) *Session Two (pdf)* *PowerPoint (pdf)*	*Programming files:* *Session 2: Activities 1-3: https://scratch.mit.edu/projects/237259422/* *Session 2: Activities 1-3 Complete: https://scratch.mit.edu/projects/238953395/* *Session 2: Activity 4: https://scratch.mit.edu/projects/237260207/* *Session 2: Activity 4 Complete: https://scratch.mit.edu/projects/238952871/* *Minecraft Blocks: https://scratch.mit.edu/projects/237273357/*

I would love to hear from you! If you try *Exploring Geometry and Patterning with Coding* in your classroom or for more information about this task contact ***Ashley Lovnicki*** – *ashleylovnicki@gmail.com*

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