Brock University
Mathematics Knowledge Network
Réseau de connaissances en mathématiques

Classroom Implementation Report (Grade 6/7): Surface Area Exploration with *Scratch*!

Introduction:
This is a report on the implementation of a newly created *Scratch* activity in a Grade 6/7 classroom by two pre-service teachers in collaboration with two in-service teachers. This report includes information about the activity, its implementation, and some reflections. In addition, it includes the student worksheet and the necessary links to *Scratch* files.

Learning Objectives:
The main learning objective of this activity is to further students' understanding of surface area and nets of a cube/prism through coding. It also aims at developing coding skills and having students become familiar with *Scratch*.

- Primary Objective: Code net and surface area of a cube
- Secondary Objective: Code not and surface area of a rectangle and triangular prism

In addition, this activity addresses the following curriculum expectations:

- Coding expectations: Gr6-C3.1, C3.2 and Gr7-C3.1, C3.2
- Mathematics expectations:
  - E2.4 determine the areas of trapezoids, rhombuses, kites, and composite polygons by decomposing them into shapes with known areas
  - E2.5 create and use nets to demonstrate the relationship between the faces of prisms and pyramids and their surface areas

Activity Instructions:

- Briefly review the number of faces on a cube and what a net is (ask students to answer)
- Have students open the 'starter code' *Scratch* link found in the Student Guideline (the Student Guideline is under Resources)
- Run the 'starter code' once so that the class can see that it only outputs 3 of the 6 faces of the net
- Explain each line of code to the students
- Have students code the next three faces of the net (it might be necessary to draw the complete net on a whiteboard, highlighting the next three faces that they must code by using a different colour)
  - Let the students know that there will be more than one way to do it! Codes are allowed/encouraged to look different, but have the same output
  - During this time, walk around and observe students, giving suggestions (not answers) if any students are stuck on how to proceed

  - For students that complete this quickly, challenge them to think about how they can make their code more efficient by introducing the idea of a function (or a block in *Scratch*) to them
- Ask students to share how they were able to code the next 3 faces to complete the code for the net of a cube (either to project their code onto a screen for everyone to see, or if students are not comfortable with sharing, you can summarize interesting things you noticed while walking around)
- Challenge students to create a program that will make a little robot sprite calculate the surface area of a cube (given any side length) and say it out loud to the user
- Briefly go over the solution for this little robot program as it is a short solution
- Extension: challenge the students in their own time to modify the code for the net and surface area calculation for a rectangular prism and triangular prism
- Let students know that the full solution with comments and without comments is available in the Student Guideline, if needed. (Extension solutions included)
- Ask students what they learned/enjoyed for today's lesson (about math/coding) or if they have any final questions

Discussion Points and Recommended Questions for the Class:

1) What three parts of the code are always repeating?
   - Answer: Needing to 1) move x steps, 2) turn x direction, and 3) think for 1 second
2) What is the formula for surface area of a cube?
   - Answer: Surface area= (Area of a square) * (6 faces)
3) How can you modify the code to make it more efficient? Hint: there is one section of the "backpack" with all the *Scratch* coding blocks that we haven't used yet…which one is it?
   - Answer: the pink one called 'My Blocks'
4) Introduce idea of a function (called a block in *Scratch*)

Classroom Implementation:

- The above activity is appropriate for students who are at the **beginner to intermediate level** for math-coding proficiency
  - This activity can be implemented within 75 minutes* (if you would like to have a more in-depth discussion then we recommend 75+ minutes)
- For classes that have students who are at the **intermediate to advanced level**, we recommend modifying the activity in this way:
  - Provide the program for drawing the net of a cube and calculating surface area as the starter code
  - After explaining the starter code, have students try and modify the program to work for a rectangular prism
  - Challenge students to create a program for drawing the net of a triangular prism and calculating surface area for a triangular prism
  - This activity can be implemented within 120 minutes*

- This activity requires the use of angles (90, 180, 270 degrees), we encourage students to use trial and error to figure out the values of the angle since it is not an expectation for them to have knowledge about angles.

**Note: these are only recommended times, adjust accordingly*

Computational Thinking Affordances in this Activity:

- *Agency*- During the part of the lesson where the students are given time to code the next three faces, mention to them that there will be more than one way to do the coding. This will give the opportunity for agency because it does not limit them to only coding the solution in the solution file but allows them to ask "what-if" and try it out. For example, some students might be able to complete this activity using the "go to" block.
- *Audience- Scratch* enables us to share codes with others. Code is shared with the students and makes it easy for them to remix and reuse. They could reuse the code to add the next three faces to complete the net. Students could also share their code with peers to see all the different ways you could code a solution to the same activity.
- *Automation*- This activity creates a computational model of the net of a cube. There are parts of the code that, when modified, will change the output of the program. This allows for the students to experience surprise and insight as they are able to learn the importance of each part of the code and see how it contributes to the drawing of the net. For example, the students might play around with the angle for the turn block and find that you must turn 180 degrees if you want the sprite to go left to draw the net. This is a surprising and insightful moment for the students.

Notes for Teachers:

- Have a preparatory math lesson before coding implementation.
- Ensure students are familiar with *Scratch.* Allow opportunity for students to explore the programming language.
- The *Use, Modify, Create*[1] method is a good approach to go about an activity like this.
- Encourage trial and error method, testing and debugging, peer collaboration and discussion.

Brief Reflection on Classroom Implementation

Overall, the implementation went well. It seems as if the students were engaged, learned something new and enjoyed the activity. The activity went as planned. Something interesting that happened was with Student A. Student A was trying to code the next three faces and ran into an error. To debug, Student A separated the code that was not working from the rest, so that instead of running the programming from the beginning each time, it would only run the part that they wanted to see, the part that was not working(i.e., they found the Scratch

[1] Waite, J., & Grover, S. (2020). Worked examples & other scaffolding strategies. In S. Grover (Eds.), *Computer Science in K-12: An A-to-Z handbook on teaching programming* (240-249). California, CA: Edfinity.

equivalent to commenting out chunks of code to debug).Overall, we did not have any surprises and was able to proceed with our planned activity summary without modification.

Two Major Takeaways

1. **The idea of 'Low-floor, High Ceiling' connected to our experience with this activity as we worked to ensure that our math and coding activity was accessible to all students.** We wanted to make sure that this task was possible and stimulating for students with little coding knowledge. However, it was important for this activity to also be extended to higher and challenging levels for the students who were more advanced in coding. This is why we had students who were able to create the net, try and create a code to calculate surface area. In addition to this, we had an extension task where students could try and code the net for prisms (rectangular and triangular) if they wanted more of a challenge.

2. **If one isn't sure whether the idea would work, it is completely okay to code, test and debug.** By letting the students know that running into errors and debugging is part of the coding process, we found that many students who went into the activity not very comfortable/confident with coding, gained more comfort/confidence by the end of the lesson. Students were more willing to try out their ideas knowing that errors are okay.

Resources:

- Student Guideline (see next page)
- Programming Files
  - Starter code for students: https://scratch.mit.edu/projects/663545648
  - Solution with comments: https://scratch.mit.edu/projects/664911814
  - Solution without comments: https://scratch.mit.edu/projects/670659320

Here is the revised 2020 Ontario Grade 1-8 Curriculum for reference.

The MKN is funded by the Ontario Ministry of Education. The MKN is a KNAER Project hosted by the Fields Institute for Research in Mathematical Sciences. The views expressed in this document belong to the authors and do not necessarily reflect the opinions of the Ministry of Education nor the Ontario government.

Activity created by Ginia Tam and Daniela Brieiro for MATH 3P41 at Brock University in collaboration with two teachers from the Niagara Catholic DSB under the Math Knowledge Network. Coordinated by Laura Cronshaw and Jeffery Martin (Niagara Catholic DSB) and Dr. Chantal Buteau and Dr. Laura Broley (Brock University). Adapted by Chantal Lof. June 2022

Brock University

Mathematics Knowledge Network
Réseau de connaissances en mathématiques

Coding + Math Classroom Implementation

(Surface Area Exploration with *Scratch*!)

Lesson Schedule (75 mins)

1.Introduction/Learning Objectives or Goals **(5 mins)**
Goals:

- Further students' understanding of creating a net and calculating surface area of a cube through coding
- Develop coding skills and have students become familiar with *Scratch*
- Coding expectations: Gr6-C3.1, C3.2 and Gr7-C3.1, C3.2

2. Open *Scratch* link: https://scratch.mit.edu/projects/663545648
Follow along on your own device through the explanation of how to code the first few squares for the net of a cube **(10 mins)**

3. Now, you will have time to try and work on finishing the net (Peer discussion and collaboration is encouraged) **(25 mins)**

4. When everyone is done, we will discuss as a class and share what everyone came up with/finish coding net. Briefly introduce idea of a function to simplify the code in *Scratch* **(15 mins)**

5. Now we will discuss surface area of a cube. Try coding a program that calculates surface area of a cube! **(15 mins)**

6. Wrap-up and Final Remarks. Link to *Scratch* with full solution codes and additional 3D shape codes (rectangular & triangular prisms) **(5 mins)**
(With Comments) https://scratch.mit.edu/projects/664911814
(Without Comments) https://scratch.mit.edu/projects/670659320

Hopefully you learned something new and had fun today!

Activity created by Ginia Tam and Daniela Brieiro for MATH 3P41 at Brock University in collaboration with two teachers from the Niagara Catholic DSB under the Math Knowledge Network. Coordinated by Laura Cronshaw and Jeffery Martin (Niagara Catholic DSB) and Dr. Chantal Buteau and Dr. Laura Broley (Brock University). Adapted by Chantal Lof. June 2022