Math Final Unit Plan: Computer Science Unplugged

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Guiding Questions

- What is computer science?
- How are math and computer science related?
- How is math a language that we speak?
- What is the importance of clear instructions in math and day to day life?
- How do binary numbers work?
- How do computers use sorting networks to make decisions?
- How do computers detect error and why is it important?

Unit Purpose

BC's new curriculum ensures that students have consistent exposure to information and communication technology (ICT) enabled learning environments, and states that "students need opportunities to develop the competencies required to use current and emerging technologies effectively in all aspects of their learning and life."(BC Ministry of Education, Curriculum Overview) The purpose of this unit is for students to explore various ideas, skills, and ways of thinking related to computers, coding, and logical thinking through hands-on activities that do not require any digital equipment. The activities are chosen for our youngest students, in kindergarten and grade 1, to begin their exploration and understanding of these critical skills in our modern world. The goal for this unit is to provide students with experience in computational thinking and communication of mathematical ideas in order for them to have a solid base of skills to prepare them for mathematics in later grades. The explorations that students will do throughout the unit in number concepts, patterning, and data and probability are all applicable to the continuing mathematics content in later grades. Additionally, the curricular competencies explored in this unit, specifically using logic and reasoning strategies for problem solving, continue to be a part of the curriculum in some way through to the end of highschool. We have chosen to create this unit plan for both Kindergarten and Grade 1 because these grades are often combined in the school system. The BC Ministry of Education states that "the focus on personalization and the flexible structure of the curriculum support the configuration of combined grade classrooms." (BC Ministry of Education, Curriculum Overview). This unit has lots of opportunities for personalization through the peer mentorship that is inherent in split grade classes.

Source Material & Adjustments

All of the activities included in this unit plan come from the website CS Unplugged. This website is a project of the Computer Science Education Research Group at the University of Canterbury in New Zealand. The mission of CS Unplugged is to "promote Computer Science (and computing in general) to young people as an interesting, engaging, and intellectually stimulating discipline." All of the activities created by CS Unplugged are intended to teach computer science through hands-on experiences that allow children to explore computer science questions and challenges without needing to have any programming skills. We chose to use only activities that are intended for ages 5-7. However, we did alter some of these activities to fit better with the BC Curriculum for kindergarten and grade 1. For example, the Divide and Conquer activity (see Lesson #9) originally had students exploring numbers from 1 to 100. However, for BC Curriculum in K and grade 1 the highest number we would explore is 20. For some of the activities it was necessary to add elements to the lessons, such as an introduction activity or wrap up discussion questions, or to expand significantly on an activity. These additions are most apparent in our expanded Lesson Plans. We also have tried to include more local Ingdigenous content in some of these lessons. For example, see the Rescue Mission (Expanded Lesson #1). Some of the activities also included aspects that felt coercive, such as using rewards in games related to students getting extra time for a fun activity if they won (and therefore students who lose not receiving these rewards). We removed these elements as they do not fit with our philosophies around classroom management and learning.

Unit Curricular Goals
Prior Knowledge
As this is a unit for Kindergarten/Grade 1, very little previous knowledge is required. Basic number concepts to 10 and 20 (respectively) are important for the basis of this unit. Also, students should have some previous exposure to repeating patterns and equalities and inequalities prior to starting this unit.
Big Ideas
Numbers from 10 to 20 represent quantities that can be decomposed into 10s and 1s. (K-1) Repeating elements in patterns can be identified. (K-1) Familiar events can be described as likely or unlikely and compared. (K)

First Peoples' Principles of Learning

Learning is holistic, reflexive, reflective, experiential, and relational (focused on connectedness, on reciprocal relationships, and a sense of place).
Learning involves patience and time.
Learning involves recognizing the consequences of one's actions.

Curricular Competencies	Content
Kindergarten & Grade 1 Reasoning & Analyzing ● Use reasoning to explore and make connections ● Estimate reasonably ● Develop mental math strategies and abilities to make sense of quantities ● Model mathematics in contextualized experiences Understanding & Solving ● Develop, demonstrate, and apply mathematical understanding through play, inquiry, and problem solving ● Visualize to explore mathematical concepts ● Develop and use multiple strategies to engage in problem solving Communicating & Representing ● Communicate mathematical thinking in many ways ● Use mathematical vocabulary and language to contribute to mathematical discussions ● Explain and justify mathematical ideas and decisions Connect & Reflecting ● Reflect on mathematical thinking ● Connect mathematical concepts to each other and to other areas and personal interests	**Kindergarten** ● number concepts to 10 ● repeating patterns with two or three elements ● likelihood of familiar life events ● Equality as a balance and inequality as an imbalance **Grade 1** ● number concepts to 20 ○ comparing and ordering numbers to 20 ● repeating patterns with multiple elements and attributes ● likelihood of familiar life events, using comparative language ● Meaning of equality and inequality

Cross-Curricular Integration

Most of the activities in this unit combine mathematics concepts with other subjects in some way. As many of these activities deal with exploring different kinds of data and how data can be organized, including through algorithms, this unit has a lot of crossover with Science, particularly the curricular competencies. Problem solving, communicating observations and ideas, asking questions, and making simple predictions are all overlaps between the mathematics and science curricular competencies in kindergarten and grade 1 that are covered in this unit. Applied Design, Skills, and Technologies explores both technologies and complex skills and tasks. In kindergarten and grade 1 students learn that "technologies are tools that extend human capabilities" (ADST Big Idea) and ADST is meant to be combined with curricular competencies from other subjects to develop foundational mindsets. Exploration into computer science leads to digital literacy, computational thinking, computers, and communication devices, starting in Grade 6 ADST. This unit also incorporated a variety of different arts, including music, drama, and visual arts. Students have the opportunity to "express feelings, ideas, stories, observations, and experiences through the arts", as well as "reflect on creative processes and make connections to other experiences." (Art Education, K-1 Curricular Competencies) Finally, some of the activities involve physical activity and fitness in Physical & Health Education. There are also some interesting extensions that can be made to the health sections of PHE. When we explore different ways to make decisions in math we can also discussions of how we make decisions about lots of things in our lives (e.g. see Divide and Conquer Activity #9).

We have tried to incorporate local Indigenous knowledge whenever possible. However, it is important to note that teachers should adapt lessons to the indigenous knowledge that is local to the area where they are teaching. For example, we have adapted Rescue Mission Lesson #1 to include W̱SÁNEĆ knowledge and ways of knowing, as this is appropriate to the place where we live and teach. Teachers in other locations should use knowledge and ways of knowing from their local First Nations, Inuit, or Metis peoples for this unit.

Personalization & Family Integration

Knowledge of our particular students inherently directs and informs personalization and adaptations to our lessons and unit plans. However, there are some basic Universal Design Principles that are still incorporated into this unit. For example, children on the autism spectrum may need amendments to the Sorting Networks With Bells (Lesson #5), therefore we have included some suggestions on how to reduce overstimulation for this lesson. See Modifications/Considerations section in the tabular Unit Plan Overview for personalization suggestions for each individual lesson.

Exploration of computing and programming is fairly new in BC Curriculum. Even our young students exploring these concepts may be learning things that their adult family members do not know. Providing opportunities for family communication around this unit, particularly involving the students, can provide some great learning opportunities for everyone. Students will benefit from being the 'mentor' to their families on what they are learning. One option could be to send home resources for some of the activities to provide families with the opportunity to explore the concepts in this unit together.

Assessment Strategies

Formative Assessments	Summative Assessment
-Observations and teacher notes from student participation in activities -Various physical samples of evidence of learning (see individual lessons below) -Simple self-assessments (Core Competencies); including Exit Slips, Fist to Five, or Red/Yellow/Green Light, or other graphic organizer.	-Creation of a portfolio of all the evidence of learning from summative assessments in the unit (could also be organized as a Interactive Student Notebook) -Student Conferences to review the final portfolios, including information from teacher's observational notes and student's self-assessments

Unit Plan Overview

Lesson Sequence	Lesson Description	Materials/Resources	Modifications/ Considerations:	Assessment/Evaluation
Lesson #1 **Rescue Mission** **Objective:** Communicate mathematical thinking in many ways *See expanded lesson plan*	-Introduce the importance of clear instructions -Create a large grid (8x8) on the floor -Students will develop a set of instructions that a "bot" must follow to retrieve an item from the grid -Students will troubleshoot, correct errors, and continue testing until one or multiple solutions are found -Students will play with their own grids and toys to practice developing clear instructions	-Printables: ○ Arrows ○ Grid ○ Job Badges ○ Left and Right cards -Blocks -Clipboards -Handheld whiteboards -Paper & Pens -Whiteboard pens	-Class can work together in a group as the Developer, rather than making that an individual role -This can be done indoors or outside -Left and Right cards can be printed for students who still struggle with directionality	-Students choose two toys (one to be rescued and one to be the hero) and develop their own code, then ask a friend to "test" it -Reflection conversation: What was the most challenging part of being a programmer?

Lesson #2 **How Do Binary Digits Work?** **Objective:** Exploring number concepts to 20 using the binary system *See expanded lesson plan*	-Introduce the binary system using the *binary cards* and explain why it exists -As a class, count up from 0-15 using 4 binary cards -In pairs, students will practice creating different numbers in binary using *binary windows*	Printables ○ Binary cards (one set) ○ Binary windows (one set per pair of students)	-Can use fewer binary cards to keep the numbers smaller -This is a new way of thinking about numbers, it may be confusing for some students -Can work in larger groups, if necessary	- Observational for understanding, making notes afterwards -Whole class understanding by having the students produce specific numbers with their windows
Lesson #3 **ON/OFF ~** Reinforcing sequence in binary number systems **Objective:** Understanding one to one correspondence and number represent quantities that can be decomposed into smaller parts using the binary system.	**-** Review binary counting 0-15 - Reframe binary fluency using alternative on/off pattern - Collaboratively brainstorm alternative items to create the on/off number representative, examples ○ Yes/No ○ Sounds (high, low or short, long) ○ Body stance (ball or starburst) - Divide into groups of 2-4 depending on fluency to create different number with the chosen alternative representation - Set up activity as a game show, where one group demonstrates the alternative on/off sequence, and other groups write out their guess on white board and share ideas with the class.	- Binary cards for review - White board for groups - Staging area - Props optional but fun, make pom poms for body stance representation	-Fluency with binary number used within activity. -Sharing answer optional to groups	- Anecdotal observation notes during activity. ○ Group response ○ Engagement ○ Conversation
Lesson #4 **Alphabet Codes ~** Coding letters using binary representation	- Review how to use binary to count up to15 using the binary cards - Introduce the idea of using numbers to represent letters of the alphabet	- Binary cards (one set) - Binary windows (one per student) - Binary to Alphabet cheat sheet	- Can use fewer binary cards to keep numbers smaller - Provide a binary to alphabet cheat sheet	Observational notes ○ Checking for understanding

Objective: Connect mathematical thinking to other areas Use patterns and reasoning to make connections between binary numbers and the alphabet	- Demonstrate the need for more than 15 different numbers and add a "bit" to ensure there is a binary number for every letter -Walk the students through spelling a basic word using the binary code(eg:hi, dad, cat) - Practice spelling more complicated words as a class using the binary cards on the board (eg. student's name or longer word) - Students can also use their binary windows to practice spelling their own words once they understand the code - Make sure to rotate through the students who get to hold the binary cards at the front of the class		with each of the letters represented in the code	○ Participation in group spelling with binary
Lesson #5 **Sorting Networks with Bells ~** Reinforcing Numeracy through a Sorting Network **Objective:** Explore patterns to connect how information can be sorted from a random series into an ordered series. *See expanded lesson plan*	<u>Introduction Activity</u> -Introduce students to the bells, reminding them about different notes (perhaps sing 'do-re-mi' while ringing each bell) -Give each student a bell and have them all move through the space to find the other people who have the same note that they do. <u>Sorting Network Game</u> -Whole class watches as groups of 8 (each with a different note) move through a decision-tree game. -In pairs students compare their notes and take a step forward in the appropriate direction, with higher notes moving left and lower notes moving right -Students will eventually end lined up from right to left in order of lowest note to highest note.	-3-4 sets of 8 note diatonic handbells (enough sets for each student to have a bell) -Chalk (for outside) -Poly spots or painter's tape (for inside) -rope or string to (for inside)	-This activity can be done either in the classroom or outside. -This activity can also be reversed, where students go from ordered to random through the same process. -This activity can be loud! Set expectations about when it's ok to ring a bell. Students can put the bells, rim down, at their feet during talking times.	-Teacher makes observations of each student's -understanding of the diatonic scale -participation in both activities -contributions to discussions (and how this shows level of understanding) -Teacher should record one observations for each student

	-Repeat with other groups of 8 so that all students get the chance to both participate and watch. -End with a whole group discussion on what students experienced and observed.			
Lesson #6 **Sorting Networks with Numbers ~** Reinforcing Numeracy through a Sorting Network **Objective:** Reinforce number fluency by comparing and organizing numbers	- Discuss tasks that are efficient for one person to accomplish as opposed to several and vise versa ○ Delivering letter ○ Putting books away - Have Sorting Network Tree drawn/taped in large area using template example - Provide number cards K(0-10), Gr.1(0-20) -Six students are given cards and placed randomly at one end of the network tree. -While comparing numbers in groups of 2 as they move forward within the tree to compare against someone else, until they reach the end where numbers will be organized in numerical order	- Number cards for organizing - Tools for marking ○ Chalk ○ Painters tape	-This activity can be done inside the classroom but gives a great opportunity to take the class outdoors. -Consider weather, and sunscreen/hats etc. -You can create a game board version using template and pawns	- Anecdotal observation notes during activity. ○ Individual response ○ Engagement ○ Conversation
Lesson #7 **How Many Guesses? ~** Sequential and binary searches **Objective:** Develop and use multiple strategies to engage in problem solving AND financial literacy — attributes of coins, and financial role-play	-Students will explore computational thinking, generalizing patterns, algorithms, and statistics using simple and fun activities -Students will try to guess the location of a number in a card deck and will only have a limited number of guesses allowed -Students will use a payment system (such as tokens or marbles) to "pay" for each guess	○ Printables: ○ Searching Cards ○ Paper ○ Payment system such as tokens or marbles ○ Pens	○ Teacher can create a smaller deck for those students who have trouble strategizing their guesses ○ Use pictures instead of numbers as the thing students must guess	○ Reflection questions: ○ What is the algorithm for a sequential search? ○ What would happen if we increased the number of cards in the deck?

Lesson #8 **Parity Magic ~** Error Detection and Correction **Objective:** Use patterns to understand parity with respect to storing information and error detection AND Use problem-solving skills to engage in error detection	- Start by performing the "parity magic trick" using the parity cards ○ Have a student set up a 5x5 grid of the parity cards with some white cards and some black cards face up with no pattern ○ Add another row & column, ensuring an even number of face up black cards in each row and column is achieved ○ Close your eyes and have a student flip one of the cards ○ Use the parity rules (even number of face up black cards in each row/column) to determine which card has been flipped ○ Repeat to demonstrate that it is repeatable - Discuss how the "trick" works ○ Have students "Think, Pair, Share" ideas ○ Remove the additional row/column you added & explain how you chose whether the card is black or white ○ Walk the students through the trick and have them determine which card has been flipped - If time and understanding are sufficient, have students break into small groups and attempt this trick	Printables: ○ Parity Cards (two pages per student)	- Students must understand even and odd numbers for this lesson - Possible to work with a smaller grid, though the trick is less impressive - While student involvement is low in this lesson, they tend to be very interested in the "magic trick" and are engaged	- Students will be able to explain how the trick works using mathematical terms including ○ Even ○ Odd - Participation in class discussion - If students broke into groups, being able to repeat the magic trick with a partner can be observationally assessed
Lesson #9 **Divide and Conquer ~** Sequential and binary searches	-The teacher demonstrates the Divide and Conquer game to the whole class, playing as Person 1, and the class as Person 2. -Students then play the game in pairs.	-Sets of cards, with numbers 1-20 on the back, enough sets for whole class to play in pairs	-Students should be encouraged to share their reasoning for the selections that they make.	-Observation of student's explanations of their choices during the paired games and of student's answers and understanding of

Objective: Practice our number concepts to 20 to explore the divide and conquer strategy in sequential binary searches.	<u>Game Instructions</u> -Person 1: Randomly pull 10 cards, and select one card for the other person to search for. Lay out the 10 cards (face down) in numerical order. -Person 2: Pick the card they think is most likely to be the right number. -Person 1: If the guess is incorrect, remove that card and all other cards that the number can't be (which will either be all cards to the right or to the left of the chosen one) -Person 2: Keep picking cards, until the correct one is found. -Switch roles and play again. <u>Discussions</u> Why is this game called Divide & Conquer? What is the algorithm (rule) for a binary search? What is the maximum number of guesses you can make before finding the correct number?		-Students who don't yet have a good grasp of number concepts from 1-20 can be paired with a peer -In "divide and conquer" - you break the problem into (two) parts, and deal with each part separately, in turn break them into two parts. This is a great strategy for reducing any big task or challenge to achievable goals! You can use this lesson to discuss other challenges in life and how students might apply this same type of strategy. (PHE content)	binary searches during the discussion. Students should be able to explain an algorithm connected to their experiences in the game.
Lesson # 10 **Colour by Numbers** **Objective:** Visualize to explore mathematical concepts	-Key Questions: ○ How do you think computers display images on a screen? ○ How do computers store images if they store all information as digits? -Students will use knowledge of binary numbers to create black & white pictures -Students will work as a class to put individual worksheets into a grid that makes up a large image	○ Printables: ○ Pixel Painter ○ Erasers ○ Pencils ○ Put the instructions clearly on the board so students don't forget that 0=White and 1=Black	○ Students may choose to extend and work out how to create colours ○ Students who do not have a grasp on binary systems can work with partners or in small groups	○ Students will successfully create an individual image and contribute to the class image ○ Reflection questions: -Why could we only create Black&White images? What would we have to change to add colour?

Lesson #11 **The Cows & the Giant Hunter ~** Searching algorithms **Objective:** Represent mathematical thinking about searching algorithms through narrative and drama.	-Review the features of sequential and binary searches from previous lessons -Read the story of the cows and the giant hunter ~ found at this link: https://csunplugged.org/en/topics/searching-algorithms/integrations/drama-video/ -Students work in groups of 4-5 to create a short play that demonstrates that the giant is using a sequential search to eat the cows in order from heaviest to lightest and that the giant slayers can easily find the giant by using a binary search. -Have each group share their play with the class and discuss what is important in binary searches.	-The story (the teacher could embellish & expand it) -space for students to practice their plays -space for students to perform their plays	-It is important to remind students that a searching algorithm follows the same rules every time to find an answer. -This activity could be adapted to any story that explores sequential and binary searches.	Observations of student plays and contributions to the discussion afterwards can be used as a summative assessment of what students understand about sorting networks as well as their ability to problem solve and apply their mathematical thinking to other contexts.
Lesson #12 **Fitness Unplugged** **Objective:** Repeat elements in pattern and addition with numbers modeled pictorially to develop fluency *See expanded lesson plan*	-Relate programming language to set of instructions -Collaboratively brainstorm different fitness exercises to include in programming. -Fitness app will be created by groups of 3 - Programmer, -Create programming cards to create app by drawing fitness activity chosen by group ○ Green"Go" card ○ 4 fitness activity cards ○ Red "Stop" card to depict an action to finish app, like a pose -Groups layout cards and go around to different apps created to follow fitness app -Once fluent with previous app, add the component of repeating action, a loop, using hoola hoop to indicate what needs repeating	○ Printables ○ Programming Card Template ○ Job Badges ○ Clipboards ○ Handheld whiteboards ○ Hula hoop ○ Paper ○ Pens ○ Whiteboard pens	-Activity can be done indoors or outdoors -Consider students mobility -Encourage realistic numbers with regards to activity frequency when creating parameters so all students can complete fitness app -Motor activities images can be provided verses having student draw them out	- Anecdotal observation notes during activity. ○ Group response ○ Engagement ○ Conversation Observation key because students that understand the unplugged activity app will create using coding layout and follow instructions sequentially.