Planning a Plant Sale

Strands	Suggested time
Algebra Data Spatial Sense Financial Literacy Social Emotional Learning Skills in Mathematics and the Mathematical Processes Cross Curricular Connections Science - Growth of Plants & Soils in the Environment Language - Writing & Media Literacy	5-7 math periods spread over a three month period These are interspersed with science periods and ongoing seed germination. Culmination includes a plant sale at another time
Topic	**Grade**
Using mathematical modelling to determine the number of plants to grow for a fundraiser as well as when and how best to grow them.	3
Overall and Specific Expectations:	

Algebra - Mathematical Modelling

- C4. apply the process of mathematical modelling to represent, analyse, make predictions, and provide insight into real-life situations.

Data

- D1. manage, analyse, and use data to make convincing arguments and informed decisions, in various contexts drawn from real life
    - D1.2 collect data through observations, experiments, and interviews to answer questions of interest that focus on qualitative and quantitative data, and organize the data using frequency tables
    - D1.5 analyse different data sets presented in various ways, including in frequency tables and in graphs with different scales, by asking and answering questions about the data and drawing conclusions, then make convincing arguments and informed decisions

Spatial Sense

- E2. compare, estimate, and determine measurements in various contexts
    - E2.1 choose and use non-standard units appropriately to measure lengths, and describe the inverse relationship between the size of a unit and the number of units needed
    - E2.2 explain the relationship between centimetres and metres as units of length, and use benchmarks for these units to estimate lengths

Financial Literacy

- F1. demonstrate an understanding of the value and use of Canadian currency
    - F1.1 estimate and calculate the change required for various simple cash transactions involving whole dollar amounts and amounts of less than one dollar

Social Emotional Learning Skills in Mathematics and the Mathematical Processes

- A1. Throughout this grade, in order to promote a positive identity as a math learner, to foster well-being and the ability to learn, build resilience, and thrive, students will apply, to the best of their ability, a variety of social-emotional learning skills to support their use of the mathematical processes and their learning in connection with the expectations in the other five strands of the mathematics curriculum.

  In this lesson, to the best of their ability, students will learn to **recognize sources of stress and cope with challenges**

as they apply the mathematical processes **reflecting** (demonstrate that as they solve problems, they are pausing, looking back, and monitoring their thinking to help clarify their understanding (e.g., by comparing and adjusting strategies used, by explaining why they think their results are reasonable, by recording their thinking in a math journal) and **communicating** (express and understand mathematical thinking, and engage in mathematical arguments using everyday language, language resources as necessary, appropriate mathematical terminology, a variety of representations and mathematical conventions), so they can work through challenging math problems, understanding that their resourcefulness in using various strategies to respond to stress is helping them build personal resilience.

Science

- Growth and changes in plants: 2. investigate similarities and differences in the characteristics of various plants, and ways in which the characteristics of plants relate to the environment in which they grow
    - 2.3 germinate seeds and record similarities and differences as seedlings develop (e.g., plant quick-growing seeds – nasturtium, morning glory, sunflower, tomato, beet, or radish seeds – in peat pellets to observe growth)
    - 2.5 use scientific inquiry/experimentation skills, and knowledge acquired from previous investigations, to investigate a variety of ways in which plants meet their basic needs
- Soils in the environment: 2. investigate the composition and characteristics of different soils;
    - 2.2 investigate the components of soil (e.g., nonliving things such as pebbles and decaying matter; living things such as organic matter, bacteria, earthworms, and insects), the condition of soil (e.g., wet, dry), and additives found in soil (e.g., pesticides, fertilizers, salt), using a variety of soil samples (e.g., sand, clay, loam) from different local environments, and explain how the different amounts of these components in a soil sample determine how the soil can be used
    - 2.3 use scientific inquiry/experimentation skills (see page 12), and knowledge and skills acquired from previous investigations, to determine which type(s) of soil (e.g., sandy soil, clay soil, loam) will sustain life

Language

- Writing: 1. generate, gather, and organize ideas and information to write for an intended purpose and audience;
- Writing: 2. draft and revise their writing, using a variety of informational, literary, and graphic forms and stylistic elements appropriate for the purpose and audience;
- Writing: 3. use editing, proofreading, and publishing skills and strategies, and knowledge of language conventions, to correct errors, refine expression, and present their work effectively;
- Media Literacy: 3. create a variety of media texts for different purposes and audiences, using appropriate forms, conventions, and techniques;
    - 3.1 identify the topic, purpose, and audience for media texts they plan to create (e.g., a collage of images

conveying the mood of a poem to help classmates understand the poem)
- 3.2 identify an appropriate form to suit the specific purpose and audience for a media text they plan to create (e.g., a tape-recorded interview to present a classmate's opinion about a favourite show, toy, or game)
- 3.3 identify conventions and techniques appropriate to the form chosen for a media text they plan to create (e.g., a pamphlet about a unit of study could require titles, headings, subheadings, captions, different font sizes, colour, and illustrations)
- 3.4 produce media texts for specific purposes and audiences, using a few simple media forms and appropriate conventions and techniques

Learning Goals:	**Success Criteria:**
We are learning ● to understand the initial problem by determining what information is needed. ● to analyze the information that we collected. ● to apply a mathematical model to help us make decisions and evaluate the success of what we do.	I can… ● ask good questions to better understand the problem and allow me to gather important information. ● analyze all the information collected. ● make assumptions about the situation. ● use my model to make decisions ● provide new information that can help me make decisions.
Prior Learning:	**Resources and Materials:**
Students should ● be familiar with asking good questions ● understand the word assumption ● have some experience with data collecting ● measure and draw lengths in centimetres, using a measuring tool	- Chart paper and markers - Materials to germinate and grow seeds or bulbs - these will vary depending on the class choices but may include: pots, peat pellets, trays, tray covers, various soils, fertilizer, trowels, watering can, ruler, etc. - Materials to create posters, signage, brochures, etc.

Lesson Overview

This lesson is designed to be woven into the grade three science curriculum providing a real life experience with mathematical modelling. It has five parts that will be spread over about three months. Between the mathematical modelling experiences, the students will engage in hands one science work and a range of data collection and interpretation.

The lesson parts comprise:
Part 1 - understanding a real life situation - growing plants to sell at a fundraiser.
In this part of the lesson the students will engage in the initial components of mathematical modelling by asking questions, determining information needed and planning ways to find the information. Students will have the opportunity to participate in a variety of tasks (one period).

This initial math work is followed by several weeks of science work involving plant germination, exploration of soils, the impact of the sun, and other elements of plant cultivation. They may also use the time to survey the community to learn more about the market for plants as well as investigate the costs of various plants.

Part 2 - analyzing the situation by sharing and discussing the information they have collected, identifying new questions or information needed and recognizing the assumptions being used as a foundation for the mathematical model.
In this part of the lesson the students will discuss their discoveries, identify gaps, and make plans for the next steps. They will identify assumptions they are making in the decision making processes (one-two periods).

Part 3 - developing the mathematical model.
In this part of the lesson, the students will be given the task of building a set of mathematical models that can be used to make decisions. They will be given the task of building these models for future classes. They will determine the information that would be useful for future sales. They will consider how they can mathematically record the necessary information and offer ways to calculate future plans (e.g., monitoring the number of seeds to plant to ensure the number of plants to sell).

These parts of the math lesson are followed by finding additional information (as needed) and several weeks of plant cultivation for the fundraiser. Students may also prepare advertising materials, information posters, etc. They may also be revisiting the early components of mathematical modelling (need new information) or moving ahead to the final component (analyze and evaluate the model) while tweaking the model(s).

Part 4 - analyzing and assessing the model(s).
The students will debrief after the plant sale. They will review their models and see how helpful they were and what needs to be revised for the future. (one period)

Part 5 - consolidation.
The class will review their mathematical modelling process and see how their real life work has developed a model that can be useful in the future. They will also see how what they did matches the modelling process used in many parts of life. Finally, they will have a chance to consider how they coped with the challenges and stresses of a long term project and their own social-emotional skills. (one period)

Additional activities and next steps are also suggested after the consolidation.

The grade three lesson What Size Pots offers a related mathematical modelling lesson with a focus on spatial skills, data, and science.

Teachers Note

It is anticipated that different groups will focus on different aspects of the problem, so each group will have a unique combination of exposure to the overall and specific expectations targeted by this mathematical modelling lesson. Cross strand and cross curricular connections will vary by student and group. Some students may engage in more spatial tasks (e.g., the area used to grow the plants), others may be more involved in data collection and interpretation, while others may be closely involved in the financial calculations. This is as it should be -- by collaborating after working on specific questions associated with the problem, each student will experience the mathematical modelling process in its truest form. However, all students will be involved in the science data gathering and analysis.

Students may move between, as well as return to, each of the four components of the mathematical modelling process as they change conditions to observe new outcomes.

Fundraiser timing and purpose: It will be necessary for the teacher to decide a logical time and purpose for the fundraiser. This will help determine which plants the students will grow as well as ensuring it meshes well with the science program and school events. Different plants may offer different options. Teachers will also need to consider their community (apartments, rural, suburban, etc.)
For example:

- **Herbs** - useful any time of the year. Could be grown to be kept on the window sill and used anytime of the year or could be grown for transfer to the garden or a container in the late spring. Easy to grow and many germinate quickly. A range of herbs can be selected and reflect the cultural and culinary traditions of the students.
- **Bulbs** - forcing bulbs for winter flowers may be a good choice for a winter project and fundraiser. They provide a great opportunity to discuss how far along the plant should be when sold (buds? flowers?).
- **Flowering plants** - may be good choices for a spring project. Some students may buy them for Mother's Day gifts or to celebrate the end of the school year. Several annual seeds germinate quickly. They could provide a good discussion of the size and maturity at sale time.
- **Vegetables** - common vegetables like tomato, pepper, beans, peas, lettuces could be grown for a spring sale to be transferred to containers or gardens. Vegetable choices could reflect the community cultures and traditions.

Learning and Teaching Activities

Understanding the Situation		
Part 1 - Present the situation Tell the students that the class will be growing and selling plants as a fundraiser. The hope is that this will be an annual event. They know (or will know) a lot about plants because they are learning about them in science. We need to decide how to get started. For example, you may wish to frame it in terms of... "The school wants to investigate an eco-friendly and healthy option for	**Teacher Moves**:	

fundraising and is considering switching from selling baked goods to selling plants that have been started from seed by students at the school. However, they have no idea how to do this or how much money it could raise. Since our class is studying growth and changes in plants, we feel that we might be able to do some mathematical investigations while we are learning science and then make some recommendations about how to manage this new fundraising activity." "What do we need to know to get this project started?" Have the students share two or three ideas to start them thinking, and then form groups of 2 or 3 students and have them brainstorm more ideas. Circulate and listen to student's ideas. After the students have developed lots of ideas, regroup as a class and sort their ideas.	"What do we already know ?" "What information do we need ?" After they have worked in pairs for a while you may wish to pause the class briefly and share some more thoughts from the small groups before having them continue to brainstorm in their small groups. The ideas students might share could include: ● "What will we grow ?" ● "What kinds of plants would people want to buy ?" (vegetables, flowers, herbs…) ● "Can we grow every kind of plant indoors in our classrooms, or do	**Opportunities for Differentiation** Provide some sample questions so that students can benefit from examples. It may be a good idea to pair 2 groups together to further their thinking.This may instigate more question ideas.  Students who are learning remotely can create their own lists of questions that need answering. Where possible, have students work together in a virtual classroom. These questions can be integrated with questions from students in a face-to-face classroom, then shared back.

<table>
<tr>
<td></td>
<td>we have to find the right kinds of plants ?”
● “When do we have to plant them?”
● “What tools do we need to have?”
● “What equipment do we need?”
● “Where do we get our plants and seeds ?”
● “How many plants should we grow ?”
● “How many plants do we have room for ?”
● “Where in the classroom will we grow them ?”
● “What will we grow them in ?”
● “How do we take care of them ?”
● “How much will the seeds, soil, and tools cost ?”
● “How do we choose the soil ?”
● “Do we need fertilizer ?”
● “When should we sell them ?”
● “How much should we charge ?”
● “How big should they be when we sell them ?”</td>
<td rowspan="3">Whenever possible, use a collaborative tool (Google Documents, Google Slides, Jamboard, Padlet, …) to encourage students to work together and capture their thinking.

Opportunities for Assessment
As you walk around the classroom, listen for students using the math process of communicating.
● Are they engaging in respectful discussions with each other?
● Are they listening to each other?
● Are they building on the ideas of their peers?
● Are they asking relevant questions?

Make a note of students who find it difficult to generate questions.</td>
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<tr>
<td colspan="2">Analyse the Situation</td>
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<td>Work with the students to narrow down the original list of questions.</td>
<td>Teacher Moves:</td>
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● Are some of the questions the same? ● Do some of the questions already have known answers? Organize the questions with the students to decide which ones need to be answered through reading, surveying and asking experts, and which ones are answered through experimenting with the actual plants. Students should prioritize the questions if they have a large number: ● Do some need to be answered before others? ● "Do we need to answer all our questions, or could we make some assumptions and work from there?" ● "What do we need to know before we can start planting?" Then, form groups of students and assign the various questions that need to be answered before they experiment with real plants.	Questions that need to be answered to get started might include: ● "What types of plants could we grow?" ● "Do we need to complete a survey of family, teachers, or other classes to find out what people might like to buy, or can we assume that they will buy whatever we grow?" ● "What type of soil and pots do we need ?" ● "How much will the seeds cost us?" ● "How will we set up our plant nursery?" ● "How will we take care of them?" ● "How much does it cost to grow plants?" ● "How do we decide on the price to sell them?" (Consider the cost of seeds & equipment, people's willingness to pay.)	**Opportunities for Assessment** Note which students are able to determine the information that is needed to move forward and which struggle to separate important and less important questions. Record how the students: ● explain their reasoning ● respond to and build on the ideas of others  Students who are studying remotely can be given the large class-determined list of questions and sort them as "those that are known" and "those that need to be answered" based on the specific problem they are electing to focus their investigation on. Where possible, have

After students have determined the initial information, they need to begin to sprout some seeds (e.g., what types of plants to grow). Use science periods and have the entire class work together to plant and monitor the seeds they select (collect data re growth, water, time, etc.) Use this germination and growing time to give students opportunities to practise their linear measurement skills as well as methods of collecting and recording data ready for interpretation. (Overall Expectations D1 and E2))	Questions that the students may answer with hands on experimenting might include: ● How long will it take until they grow? ● How big should they be to sell then? ● How many seeds will germinate? ● How many plants might die before we sell them? ● How many plants do we need to grow? ● How many seeds didn't germinate? So how many should we plant? ● How old should the plants be when we sell them (tiny?, well established?, flowering?) ● When should we have this event knowing the time it takes to grow the plants ? (Or when should we start the plants since we know the school event is on ____) (e.g., for spring planting, for Mother's Day, for another school event) ● How can we avoid having lots of plants die over a weekend or holiday?	students work together in a virtual classroom. **Opportunities for Differentiation** When forming groups, consider students' interests as well as strengths and needs.  Students who are learning remotely may be encouraged to get answers to their questions by visiting a local nursery, garden centre, or a retailer that sells plants, seeds, containers, etc. If that is not possible, such students could gather data by looking at local flyers or websites to check availability and costs of supplies. They could also use internet searches to determine what types of plants grow well outside in their region. Encourage students to add screen captures to their work to record their research efforts.  If there are students working at school at the same time as there are students working from home, have the class (both sets of students) design a tracking log so that students who are not able to get the

This is also an opportunity to explore resilience and response to stress. Discuss how plants respond to stress (lack of light, too crowded, lack of water) and what makes them resilient. Encourage the students to make connections to their own ways of coping with stress and showing resilience and to share knowledge they may have about other living organisms (e.g., pets, farm animals). **Part 2** “Think about what you know about the plants we tested and the information we learned about what people might like to buy. What new questions do we need to ask ourselves before we can start our new plants ?”	• When did you observe a plant adapting to stress? (What were the stresses? How did it adapt to them?) • Why is it important that all living things be able to adapt and respond to stress?	same degree of immediate feedback do not find themselves frustrated if the way they are collecting or recording their data does not meet the needs of their investigation. **Opportunities for Assessment** Observe the work of the various groups and individuals. Take note of their use of cross strand skills such as: • Linear measurement • Data collection and organization • Analysis and interpretation of data **Opportunities for Differentiation** Provide sample assumptions for students who have more difficulty with this concept.

“How can we find the answers to our questions ?” When the students have worked together to answer these new questions, tell them that they are learning a lot about growing and selling plants to raise funds and it would be useful to build a model that would help future students raise money too. Ask them: “What important decisions do we have to make ?” Model how we **make assumptions** to help with this decision making. For example: ● “We found that 7 plants grew when we planted 10 tomato plants. We are going to assume that 7 will grow again when we plant our new seeds.” ● “If 7 of the 10 plants survived, we might want to plant double the plants we think we would need.” Work with them to identify assumptions that need to be made about the sale.	**Assumptions** might include: ● The same number of plants will germinate this time. ● They will grow at the same rate (even if the sun in the classroom is different from our first attempt). ● People want to buy big and healthy plants. ● We can sell x plants of each kind. ● We will sell twice as many ___ plants as ___ plants.	 Students working from home may be challenged to ask their family members, friends, and neighbours to tell about a time they had expected some planting project to go a certain way and later found out that they had made an assumption that was incorrect. Some students may be able to relate this project to one from their lived experiences where assumptions were made, e.g., having a lemonade stand (assumed people would pass by and be thirsty, so maybe they assumed the day would be hot, assumed people would have cash on them to pay for the lemonade), running a garage sale (assumed it would not rain that day).
Create a Mathematical Model		

Part 3	**Teacher Moves**:	**Opportunities for Differentiation**
Explain to the students that they will be developing mathematical models that can be used in the future. The class may create a how-to manual for students in future years. This manual will give the new students lots of information to help them fundraise by selling plants. "The models we will be creating will build on our information and assumptions. After the sale, we can analyze our models and adjust them to help future students. What information needs to be thought about in our manual ?" Have the students brainstorm the information that would be helpful in the manual. Encourage them to explain ideas mathematically as much as possible. Select one topic and demonstrate and guide the class to develop a mathematical model together. For example, "How long before the sale we should plant the seeds?" Work with the class to determine how they would figure that out and what	Students may suggest a mathematical model would be needed to determine: ● when the plants should be started ● what plants are popular with potential customers ● how many should be planted (take in consideration that some plants might not survive) ● how to decide the price of each plant ● how to change the models if the school community gets much bigger or much smaller ● how many plants need to be started to have x plants to sell (how many extra plants should be started?) ● how many plants each student will need to care for	Carefully form the groups that will develop the models. Consider mathematical and personal strengths when selecting members and assigning tasks. Some students may need to be guided to create the actual model. Do a guided discussion by asking questions to help them make decisions. **Opportunities for Assessment** Keep records of the work of each group while creating their model. Observe how students are collaborating. Observe what students are doing to share the work and include others. Provide feedback to support student growth.

mathematical tools they would use. Together, design a model that incorporates germination time and the preferred maturity of the plants. Discuss the assumptions being made and how these could affect the model (eg., we want the same maturity for all plants, or, we want different maturity at different times of the year). Point out how the numbers might change (e.g., changing the plant species might change the germination time). Try a few imaginary scenarios with the students to check the initial model developed together. Once the class has developed a model, have the students form groups to create additional models. Once the class has made all the decisions about the sale and begun to develop their models, use science time to plant the seeds or bulbs needed for the sale. Then set up the sale and undertake the fundraiser.	• how many types of plants should be sold If possible, use whole dollar amounts for large plants and modest cent amounts under a dollar for small plants. This will allow the students to work within F1.1. Prior to the sale, review making change for whole dollar amounts as well as change under 100 cents. Role play the	Listen for student mathematical thinking e.g., How to adjust the numbers to have more plants in the future. • We need two times more (multiplicative thinking) • We need 3 more plants (additive thinking) Observe the work of the various groups and individuals preparing for and during the plant sale. Take note of their use of cross strand skills and processes such as: • Data collection • Problem solving • Communication • Adding money amounts • Making change • Cooperation/teamwork  Some students who are unable to participate in the at-school project may choose to grow plants and run a sale in their own neighbourhoods.

	plant sale and have the students make change for various purchases. You may also wish to explore the Financial Literacy Lesson "The Value of Small Change" to practise making change.	 Consider creating a virtual diary that captures students engaging in the various components of the process of mathematical modelling. Record student questions, assumptions, data gathering, work, results, and conclusions.  The results of the growing and the sale can be shared with the remote-learning student(s) so that they are able to provide their own insights.These students can also share their experience if they did organize a plant sale in their neighborhood.
Analyse and Assess the Model		

Part 4 After the sale is over, bring the students together and review the mathematical modelling and science processes they have undertaken. Tell them it is time to evaluate their models in their small groups. They will revisit the assumptions they made and consider if those assumptions still seem reasonable/valid. Have them decide if their model addresses the situation they are modelling. How might they improve it? Then have students prepare to present their models and solutions to the rest of the class.	**Teacher Moves**: As the students analyse and assess their models and the sale, prompt them with questions such as: ● "How did our model(s) work for us?" ● "How accurate were our assumptions? Should they be changed in the future?" ● "What would make the fundraiser more successful next year? How is this addressed in a model?" ● "What problems did we have growing our plants?" (e.g., too much sun at times, problems with watering, people forgetting their responsibilities)	
Consolidation of Learning		
Part 5		

Review the project with the students. What are they proud of (e.g., they raised x dollars, were sold out of plants)? Have them consider changes for the future, e.g., ● "We were sold out, so what should be done next year?" ● "We had a lot of plants left. Which ones sold? What should change in the future?" ● "How was the model useful?" ● "Was there something important we didn't include in our models and manual? What should be added to it?" ● "Can we use the same assumptions next year? Which ones need to be adjusted?" ● "What assumption(s) did we miss?" (e.g., some plants will be more popular than others) ● "What problems could be avoided?" (e.g., All the plants died over March Break so we had to sell smaller plants than we wanted) ● What kinds of plants did people like to buy the most (e.g., herbs versus marigolds)? Have we a model that addresses this? Discuss the experience with the students. ● "What parts of this project did you find challenging? " ● "What made it challenging?" ● "What did we do as a class to deal with the challenges? " ● "What did you do on your own when it was challenging for you?" ● "Why is it important to think about the process as we went through it as well as after?"	As you listen to students, observe the math process of reflecting: ● What did work and what did not work? ● How could this new knowledge be applied to future problems? How did they manage the stress when… ● collecting the data ● some of their plants died ● developing their model ● there were not enough plants to sell ● making change selling plants Could they recognize a stress trigger ? Were they able to take action or make better choices ? If they know any stress management strategies, can they share them ? (e.g. breaking a task or problem down into pieces and tackling one piece at a time, deep breathing and stretching, pausing and reflecting…)

Review the project with the students and point out the steps of the mathematical modelling process they used. Discuss points such as: ● "Why was each component important?" ● "What might have happened if we had not done the early steps?" ● "How did the assumptions help us make decisions?" ● "Why are mathematical models useful?" ● "Did the mathematical modelling process provide a connection to real-life situations? Explain. »	

Further consolidation/Next steps for students and teachers

Students may be given the opportunity to revise their mathematical models after the whole class has completed their presentations and feedback has been shared.

Cross-curriculum activities: Language - writing

- Have the students use the writing process to craft a procedural text for this project. Their text may relate to a range of elements of the overall project such as: how to plant and cultivate a specific species, how to develop, use, and interpret a survey, how to use the model (or a model) to determine how many to plant/when to plant/how to determine profit, etc.
- Have students develop an advertising campaign using a variety of media texts such as posters, emails, or brochures.
- Create a manual for the next grade three class presenting each of the models the groups developed.
- Have individual students or pairs create manuals about how to grow plants for their own use in the future.

Use the Financial Literacy Lesson "The Value of Small Change" to practise making change for amounts of less than one dollar.

The grade three lesson What Size Pots? offers a mathematical modelling lesson connected to this one that has a focus on spatial skills, data, and science.