hands-on science

An Inquiry Approach

Grade 3

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An Inquiry Approach

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Introduction to *Hands-On Science*

Program Introduction

Hands-On Science helps develop students' scientific literacy through active inquiry, problem solving, and decision making. With each activity in the program, students are encouraged to explore, investigate, and ask questions as a means of heightening their own curiosity about the world around them. Students solve problems through firsthand experiences, and by observing and examining objects within their environment. In order for young students to develop scientific literacy, concrete experience is of utmost importance – in fact, it is essential.

The Foundations of Scientific Literacy

Hands-On Science focuses on the four foundation statements for scientific literacy in Canada, as outlined in the Pan-Canadian Protocol.[1] These foundation statements are the bases for the learning outcomes identified in Hands-On Science.

Foundation 1: Science, Technology, Society, and the Environment (STSE)

Students will develop an understanding of the nature of science and technology, of the relationships between science and technology, and of the social and environmental contexts of science and technology.

Foundation 2: Skills

Students will develop the skills required for scientific and technological inquiry, for solving problems, for communicating scientific ideas and results, for working collaboratively, and for making informed decisions.

Foundation 3: Knowledge

Students will construct knowledge and understandings of concepts in life science, physical science, and earth and space science, and apply these understandings to interpret, integrate, and extend their knowledge.

Foundation 4: Attitudes

Students will be encouraged to develop attitudes that support responsible acquisition and application of scientific and technological knowledge to the mutual benefit of self, society, and the environment.

NOTE: While these foundation statements form the bases for the science program, it is important for teachers to recognize and honour that some students might identify with science from a cultural knowledge base. For example, Indigenous students might not respond to in-class questioning, as they might view this as opposing traditional protocol of respectful listening; therefore, the teacher may have to clarify the intent of questioning in the classroom and acknowledge the different ways students may demonstrate knowledge, basic skills, values, and attitudes.

Program Principles

1. Effective science programs involve hands-on inquiry, problem solving, and decision making.
2. The development of students' skills, attitudes, knowledge, and understanding of STSE issues form the foundation of the science program.
3. Children have a natural curiosity about science and the world around them. This curiosity must be maintained, fostered, and enhanced through active learning.
4. Science activities must be meaningful, worthwhile, and relate to real-life experiences.

1 *Common Framework of Science Learning Outcomes: Pan-Canadian Protocol for Collaboration on School Curriculum*, 1997

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5. The teacher's role in science education is to facilitate activities and encourage critical thinking and reflection. Children learn best by doing, rather than by just listening. The teacher, therefore, should focus on formulating and asking questions rather than simply telling.
6. Science should be taught in correlation with other school subjects. Themes and topics of study should integrate ideas and skills from several core areas whenever possible.
7. The science program should encompass, and draw on, a wide range of educational resources, including literature, nonfiction research material, audio-visual resources, technology, as well as people and places in the local community.
8. The science program should be infused with knowledge and world-views of the Indigenous Peoples of North America, as well as other diverse multicultural perspectives.
9. Assessment of student learning in science should be designed to focus on performance and understanding, and should be conducted through meaningful assessment techniques carried on throughout the unit of study.

Program Implementation

Program Resources

Hands-On Science is organized in a format that makes it easy for teachers to plan and implement. The book is divided into four units, which are the selected topics of study for the grade level, as well as a main introduction at the beginning of the book. The units relate directly to the learning outcomes, which complement those established in the Pan-Canadian Protocol and related provincial/territorial documents.

Each unit also has its own introduction, which summarizes the general goals for the unit. This introduction provides background information for teachers, planning tips, lists of vocabulary related to the unit, as well as other pertinent information such as how to embed technology, sustainability, and Indigenous and multicultural perspectives into units of study.

Also included at the beginning of each unit is a Curriculum Correlation Chart for Knowledge and Understanding Outcomes, and another for Scientific Inquiry and Design Process Skills Outcomes. These are based on the Pan-Canadian Protocol for Science outcomes, as well as on provincial/territorial science curriculum documents.

Additionally, the introduction to each unit includes a list of related books suitable for students and a list of annotated websites. References for Teachers is located at the end of the book.

Each unit is organized into numbered lessons comprised of topics and activities based on the learning outcomes. Lessons are arranged in the following format:

Lesson Title: The title of each lesson is posed as a guided inquiry question, which identifies the outcomes students will be addressing or the question they will be answering.

Information for Teachers: Some lessons provide teachers with the basic scientific knowledge they will need to present the activities. This information is offered in a clear, concise format, and focuses specifically on the topic of study.

Materials: A complete list of materials required to conduct the main activities is provided. The quantity of materials required will depend on how you conduct activities. If students are working individually, you will need enough materials for each student. If students are working in groups, the materials required will

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be significantly reduced. Many of the identified items are for the teacher to use for display purposes, or for making charts for recording students' ideas. In some cases, visual materials (large pictures, sample charts, and diagrams) have been included with the activity to assist the teacher in presenting ideas and questions, and to encourage discussion. You may wish to reproduce these visuals, mount them on sturdy cardstock, and laminate them so they can be used for years to come.

Engage: This activity is intended to activate prior knowledge, review previous lessons, and engage students in the lesson. The guided inquiry question for the lesson is also introduced in this section. Teachers may choose to record the question for display throughout related investigations. For example, the guided inquiry question might be recorded on a sentence strip and displayed.

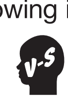
Explore: This section details a step-by-step procedure, including higher-level questioning techniques, and suggestions for encouraging the acquisition of new knowledge and skills. In some cases, one lesson may involve several Explore activities, which are identified as Explore: Part One, Explore: Part Two, and so on.

Learning Centre: Included with most lessons are independent student learning opportunities that focus on the learning outcomes. They are designed as learning centres, and to promote differentiated instruction, the centres are based upon multiple intelligences research.[2] Each centre focuses on a different multiple intelligence, to provide opportunities for students to use areas of strength and also to expose them to new ways of learning. The following intelligences, identified by the accompanying icons, are focused on in ***Hands-On Science***:

- **Verbal-Linguistic**: These learners think in words and enjoy reading, writing, word puzzles, and oral storytelling. When a learning centre focuses on Verbal-Linguistic intelligence, the following icon is used:

- **Logical-Mathematical**: These learners think by reasoning and enjoy problem-solving, puzzles, and working with data. When a learning centre focuses on Logical-Mathematical intelligence, the following icon is used:

- **Visual-Spatial**: These learners think in visual pictures and enjoy drawing and creating visual designs. When a learning centre focuses on Visual-Spatial intelligence, the following icon is used:



- **Bodily-Kinesthetic**: These learners think using their physical bodies, and enjoy movement, sports, dance, and hands-on activities. When a learning centre focuses on Bodily-Kinesthetic intelligence, the following icon is used:

- **Musical-Rhythmic**: These learners think in melodies and rhythms and enjoy singing, listening to music, and creating music. When a learning centre focuses on Musical-Rhythmic intelligence, the following icon is used:

2 Conklin, Wendy. *Differentiation Strategies for Science*. Huntington Beach, CA: Shell Education, 2004.
Katz, Jennifer. *Teaching to Diversity: The Three-Block Model of Universal Design*. Winnipeg: Portage and Main Press, 2012.

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- **Interpersonal**: These learners think by talking to others about their ideas and enjoy group work, planning social events, and taking a leadership role with friends or classmates. When a learning centre focuses on Interpersonal intelligence, the following icon is used:

- **Intrapersonal**: These learners think within themselves and enjoy quietly thinking, reflecting, and working individually. When a learning centre focuses on Intrapersonal intelligence, the following icon is used:

- **Naturalistic**: These learners learn by classifying objects and events and enjoy anything to do with nature and scientific exploration of natural phenomena. When a learning centre focuses on Naturalistic intelligence, the following icon is used:

- **Existential**: These learners learn by probing deep philosophical questions and enjoy examining the bigger picture as to why ideas are important. When a learning centre focuses on Existential intelligence, the following icon is used:

Teachers are encouraged to explore the topic of multiple intelligences with their students and to have students identify ways they learn best, and ways that are challenging for them. Guidelines for this process are included in the book *Teaching to Diversity (*cited in the footnote on the previous page).

Each learning centre is described on a task card that remains at the centre, along with any required supplies and materials. When implementing the learning centres, it is important to review the task card prior to having students work at the centre, to ensure they are familiar with the content and the expectations.

NOTE: Many of the learning centre tasks also offer excellent assessment opportunities – both formative and summative – that teachers can take advantage of through student conferences/interviews. Teachers can then use the Individual Student Observations sheet, on page 18, to record assessment data. See the next section of *Hands-On Science,* Assessment Plan, for more information on assessment.

Embed: Part One: The activities in this section are intended to review the main ideas of the lesson, focusing on specific learning outcomes. The guided inquiry question for the lesson is also reviewed in this section, and students are encouraged to share their knowledge, provide examples, and ask further inquiry questions. This section also includes directions for any reproducible activity sheets found in the lesson, which are designed to correlate with the learning outcomes of the main activity. Activity sheets are included to be used during the main activity in a lesson, often to record results of investigations. In some lessons, the same activity sheets are used as follow-up to the main activities.

Students may work independently on the sheets, in small groups, or you may read over the sheets together and complete them in a large group setting. Activity sheets can also be made into overheads or large experience charts. Since it is important for students to learn to construct their own charts and recording formats, teachers may decide to use the activity sheets as examples of ways to record and communicate ideas about an activity. Students can then create their own sheets rather than use the ones provided.

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NOTE: Activity sheets are meant to be used only in conjunction with, or as a follow-up to, the hands-on activities. The activity sheets are not intended to be the science lesson in itself or the sole assessment for the lesson.

Embed: Part Two: With each lesson, teachers are also encouraged to embed learning by adding to graphic organizers; having students record, describe, and illustrate new vocabulary; and adding new vocabulary to the classroom word wall (a bulletin board or piece of poster paper for displaying new science terminology. Both teachers and students can then add to the word wall throughout the unit, or even all year.) New vocabulary may include terminology in Indigenous and other languages that reflect the cultural diversity of the classroom and the community.

Enhance: This section includes optional activities to extend, enrich, and reinforce the learning outcomes. Many lessons can be enhanced with interactive whiteboard activities, available through Portage & Main Press's website. For directions on how to access an activity, check the Enhance section of each lesson. Activities can be used on interactive whiteboards and on computers and/or tablets.

Assessment *for*, *as*, and *of* Learning: Based on current research about the value of quality classroom assessment (Davies 2011), suggestions are provided for authentic assessment, which includes assessment *for* learning, assessment *as* learning, and assessment *of* learning. These assessment strategies focus specifically on the learning outcomes that are related to a particular lesson.

Keep in mind that these suggestions are merely ideas to consider; teachers are also encouraged to use their own assessment techniques and to refer to the other assessment strategies outlined in detail in the Assessment section of ***Hands-On Science,*** on pages 14 to 27.

Classroom Environment

The classroom setting is an important aspect of any learning process. An active environment, one that gently hums with the purposeful conversations and activities of students, indicates that meaningful learning is taking place. When studying a specific topic, teachers are encouraged to display related objects and materials, student work, pictures and posters, graphs and charts made during activities, and summary charts of important concepts taught and learned. An active environment reinforces concepts and skills that have been stressed during science activities.

Timelines

No two groups of students will cover topics and material at the same rate, and so planning the duration of units is an important responsibility of the teacher. In some cases, students will not complete the lesson's activities during one block of time, and students may be especially interested in one topic and want to expand upon it. The individual needs of the class should be considered; there are no strict timelines involved in ***Hands-On Science***. It is important, however, to spend time on every unit in the program so that students focus on all the curriculum outcomes established for the grade level.

Classroom Management

Although hands-on activities are emphasized throughout this program, how these experiences are handled is up to the individual teacher. In some cases, teachers may have all students manipulating materials individually; in others, teachers may choose to organize the class into small group settings. Small groups encourage the development of social skills, enable all students to be active in the learning process, and mean less cost in terms of materials and equipment.

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Classroom Safety

Occasionally, especially when safety concerns are an issue, teachers may decide to demonstrate an activity, while still encouraging as much student interaction as possible. Again, classroom management is up to the individual teacher, since it is the teacher who ultimately determines how the students in his or her care function best in the learning environment.

The nature of science and of scientific experimentation means that safety concerns do arise from time to time. Throughout ***Hands-On Science***, when there is a potential safety issue that teachers need to be aware of, the concern is flagged with the following safety icon:

Scientific Inquiry Skills: Guidelines for Teachers

The ***Hands-On Science*** program is based upon a scientific inquiry approach. While involved in the activities of ***Hands-On Science***, students use a variety of scientific inquiry skills as they answer questions, solve problems, and make decisions. These skills are not unique to science, but they are integral to students' acquisition of scientific literacy. The skills include initiating and planning, performing and recording, analyzing and interpreting, as well as communicating and the ability to work in teams. In the early years, basic skills should focus on scientific inquiry and design.

The following guidelines provide a framework that can be used to encourage students' skill development in specific areas.

Observing

Students learn to perceive characteristics and changes through the use of all five senses. Students are encouraged to use sight, smell, touch, hearing, and taste safely, in order to gain information about objects and events. Observations may be qualitative (by describing properties such as texture or colour), or quantitative (such as size or number), or both. Observing includes:

- gaining information through the senses
- identifying similarities and differences, and making comparisons

It is important to encourage students to communicate their observations in a variety of ways, including orally, in writing, and by sketching labelled diagrams.

Exploring

Students need ample opportunities to manipulate materials and equipment in order to discover and learn new ideas and concepts. During exploration, students need to be encouraged to use all of their senses and observation skills. Oral discussion is also an integral component of exploration; it allows students to communicate their discoveries.

Classifying

Classification is used to group or sort objects and events and is based on observable properties. For example, trees can be classified as those with leaves (deciduous) and those with needles (coniferous). One strategy for sorting involves the use of a sorting mat or Venn diagram. Sorting mats show distinct groups, while Venn diagrams intersect to show similar characteristics among sets.

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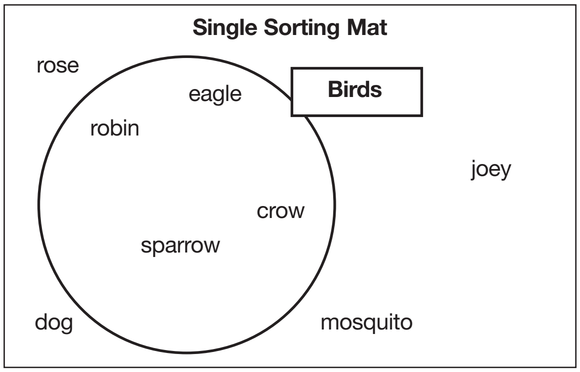
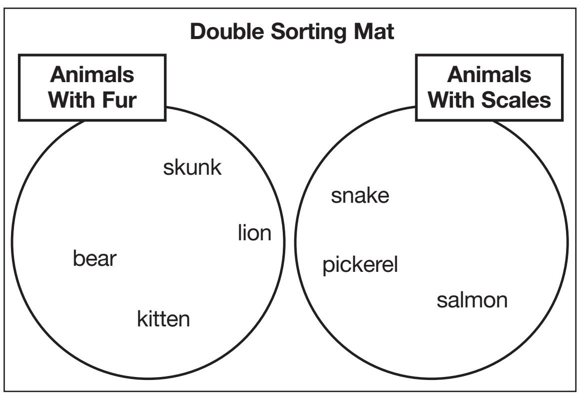
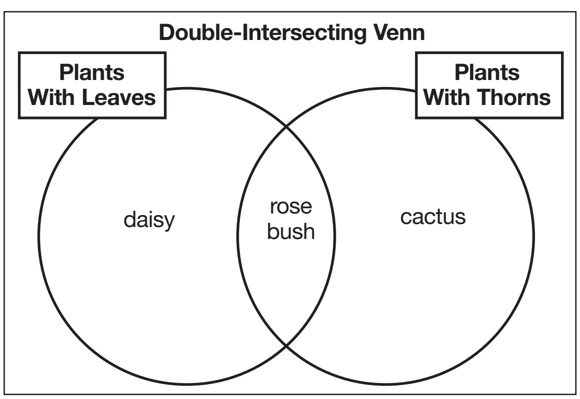
For example:







Measuring

Measuring is a process of discovering the dimensions or the quantity of objects or events. In the early years, measuring activities first involve the use of nonstandard units of measure, such as interlocking cubes or paper clips to determine length. This allows students to build understanding of how to observe, compare, and communicate dimensions and quantity. This is a critical preface to measuring with standard units. By grade 3, students use standard measuring tools. For example, they will measure mass/weight, length, volume, and temperature using standards units. They will also measure the passage of time using seconds, minutes, and hours.

An essential skill of measurement is estimating. Students should be encouraged regularly to estimate before they measure, whether in nonstandard or standard units. Estimation allows students opportunities to take risks, use background knowledge, and learn from the process.

Communicating, Analyzing, and Interpreting

In science, one communicates by means of diagrams, graphs, charts, maps, models, and symbols, as well as with written and spoken languages. Communicating includes:

- reading and interpreting data from tables and charts
- making tables and charts
- reading and interpreting data from pictographs
- making pictographs
- making labelled diagrams
- making models
- using oral and written language
- sequencing and grouping events, objects, and data according to attributes

When presenting students with charts and graphs, or when students make their own as part of a specific activity, there are guidelines that should be followed:

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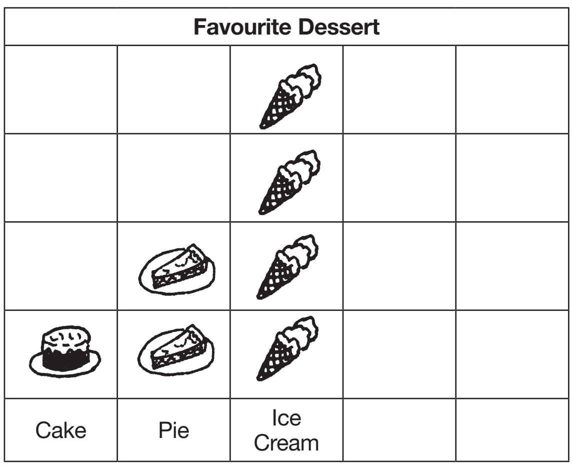
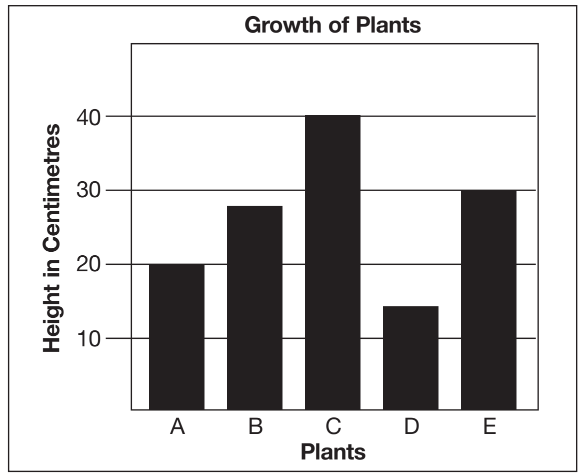
- A **pictograph** has a title and information on one axis that denote the items being compared (note that the first letter on both the title and the axis text is capitalized). There is generally no graduated scale or heading for the axis representing numerical values.



- A **tally chart** is a means of recording data as an organized count. The count is grouped in 5s for ease of determining the total by counting by 5s.

Favourite Sport		
Sport	**Tally**	**Total**
Baseball	𝍸 |	6
Hockey	𝍸 𝍸	10
Soccer	𝍸 𝍸 ||	12

- A **bar graph** is another common form of scientific communication. Bar graphs should always be titled so the information communicated is easily understood. These titles should be capitalized in the same manner as one would title a story. Both axes of the graph should also be titled and capitalized in the same way. In most cases, graduated markings are noted on one axis and the objects or events being compared are noted on the other. On a bar graph, the bars must be separate, as each bar represents a distinct piece of data.



- A **chart (table)** requires an appropriate title, and both columns and rows need specific headings. Again, all titles and headings require capitalization of the first letter as in the title of a story. In some cases, pictures can be used to make the chart easier for young students to understand. Charts can be made in the form of checklists or can include room for additional written information and data.

Checklist Chart

What Substances Dissolve in Water?		
Substance	**Dissolves in Water**	**Does Not Dissolve in Water**
Beads		√
Sugar	√	
Drink mix	√	
Rice		√
Pepper		√

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Data Chart

Local Snowfall		
Month	**2014 Snowfall (cm)**	**Average Snowfall (cm)**
October	7	5
November	9	8
December	23	20
January	29	25
February	16	18
March	11	10

Communicating also involves using the language and terminology of science. Teachers should encourage students to use the appropriate vocabulary related to their investigations (e.g., *object, metal, pliable, absorbent,* and *characteristic).* The language of science also includes terms such as *predict, infer, estimate, measure, experiment*, and *hypothesize*. Teachers should use this vocabulary regularly throughout all activities and encourage their students to do the same. As students become proficient at reading and writing, they can also be encouraged to use the vocabulary in written form. Consider developing whole-class or individual student glossaries in which students can record the terms they have learned and define them in their own words.

Predicting

Predicting refers to the question, "What do you think will happen?" For example, ask students to predict what they think will happen to a blown-up balloon that is placed in a basin of water. It is important to provide opportunities for students to make predictions and for them to feel safe doing so.

Inferring

In a scientific context, inferring generally refers to asking why something occurs. For example, ask students to infer why a blown-up balloon floats when placed into a basin of water. Again, it is important to encourage students to take risks when making such inferences. Before explaining scientific phenomena to them, they should be given opportunities to infer for themselves, using a variety of perspectives.

Inquiry Through Investigating and Experimenting

When investigations and experiments are conducted in the classroom, planning and recording both the process and the results are essential. There are standard guidelines for leading these hands-on inquiries:

- Purpose: what we want to find out, or a testable question we want to answer
- Hypothesis: a prediction; what we think will happen, and why
- Materials: what we used to conduct the experiment or investigation
- Method: what we did
- Results: what we observed and measured
- Conclusion: what we found out
- Application: how we can use what we learned

Both the purpose and the hypothesis should be in present tense, as these are determined by students prior to the hands-on experiment. In ***Hands-On Science*** lessons, there are often investigations that can be explored using this version of the standard experimental design.

Teachers are welcome to use these guidelines and terminology with early-years students; they may also differentiate by using a modified format whereby students indicate:

- what we want to know
- what we think might happen
- what we used
- what we did
- what we observed
- what we found out

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Throughout the inquiry process, it is important that students be guided through these steps, and be given the opportunity to communicate their questions, predictions, observations, and conclusions. This may be done in a variety of ways: orally as a class, recording findings as a class, having students use drawings and writings, or a combination of these.

Inquiry Through Research

Research is another aspect of inquiry that involves finding, organizing, and presenting information related to a specific topic or question. Scientific inquiry involves making observations, exploring, asking questions, and looking for answers to those questions. Even at a young age, students can begin to research topics studied in class if they are provided with support and guidelines. Accordingly, guided research is a teaching/learning strategy that is encouraged throughout ***Hands-On Science***. Guided research provides an opportunity for students to seek further information about subjects of inquiry, personal interest, or topics of their choice. As such, students are empowered and engaged in the process. Guided research encourages students to:

- Ask questions of interest related to a topic being studied by the class.
- Choose resources.
- Collect information.
- Make a plan to present findings.
- Present research in a variety of ways.

Guided research encourages teachers to:

- Provide opportunities for students to ask questions of personal interest.
- Provide accessibility to appropriate resources.
- Model and support the research process.
- Offer opportunities for students to present their findings in a variety of ways and to a variety of audiences.

In ***Hands-On Science***, the approach for scientific inquiry is one of gradual release. The teacher provides substantial support in initial inquiry experiences, and gradually presents students with more and more opportunities for directing their own research. Suggestions for guiding research are presented regularly throughout ***Hands-On Science***.

Addressing Students' Early Literacy Needs

The inquiry process involves having students ask questions, and conduct investigations and research to answer these questions. At the grade-3 level, students may benefit from support for research, reading, and writing. Consider having volunteers, student mentors, or educational-assistance support students during these processes to help young students with reading, research, and writing.

Using the Design Process

Throughout ***Hands-On Science***, students have opportunities to use the design process to plan (design) and construct objects. For example, in unit 1, lesson 8, students design and construct a terrarium to sustain living things.

The design process involves having students seek solutions to practical problems. There are specific steps to the process:

1. Identify a need: Recognize practical problems and the need to solve them.
2. Create a plan: Seek alternate solutions to a given problem, create a plan based on a chosen solution, and record the plan in writing and using labelled diagrams.
3. Develop a product: Construct an object that solves the given problem, and use predetermined criteria to test the product.
4. Communicate the results: Identify and make improvements to the product, and explain the changes.

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The design process also involves research and experimentation.

When the design process is featured in a lesson of ***Hands-On Science***, the following icon is used:

Developing Attitudes Related to Science, Technology, and Society

According to the *Manitoba Curriculum Framework of Outcomes: Kindergarten to Grade 4 Science* (1999):

> Attitudes refer to generalized aspects of behaviour that are modelled for students and reinforced by selective approval. Attitudes are not acquired in the same way as skills and knowledge. They cannot be observed at any particular moment, but are evidenced by regular, unprompted manifestations over time. Development of attitudes is a lifelong process that involves the home, the school, the community, and society at large. The development of positive attitudes plays an important role in students' growth by interacting with their intellectual development and by creating a readiness for responsible application of what they learn (p. 2.10).

The science-, technology-, and society-related attitudes focused on at the grade-3 level and which are fostered and encouraged throughout ***Hands-On Science*** lessons include:

- Recognize that valid experiments normally have reproducible results, which may vary slightly.
- Recognize that scientists develop explanations from observations and what they already know about the world, and that good explanations are based on evidence.
- Recognize that designing a solution to a simple problem may have considerations, such as cost, materials, time, and space.
- Listen to and consider differing opinions.
- Express enjoyment when sharing and discussing science-related experiences from daily life.
- Take the time to repeat a measurement or observation for greater precision or detail.

Cultural Connections

To acknowledge and celebrate the cultural diversity represented in Canadian classrooms, it is important to infuse cultural connections into classroom learning experiences. It is essential for teachers to be aware of the cultural makeup of their class, and to celebrate these diverse cultures by making connections to curricular outcomes. In the same way, it is important to explore other cultures represented in the community and beyond, to encourage intercultural understanding and harmony. Throughout the ***Hands-On Science*** program, suggestions are made for connecting science topics to cultural explorations and activities.

Indigenous Connections

As the original human inhabitants of Canada, Indigenous peoples are central to the Canadian context. As such, it is important to infuse the knowledge of our Indigenous forebears and their descendants into the learning experiences of all students. There are three groups of Indigenous peoples in Canada: First Nations, Métis, and Inuit.

Throughout the ***Hands-On Science*** program, there are many opportunities to incorporate culturally appropriate teaching methodologies from an Indigenous world-view. As one example, Indigenous Elders offer a wealth of knowledge that can be shared with students. Consider inviting an Elder as a guest into the classroom in connection with specific topics being studied (as identified within the given lessons throughout the unit). An Elder can guide a nature walk,

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share stories and legends, and help students understand an Indigenous perspective of the natural world. An Elder will provide guidance for learners and opportunities to build bridges between the school and the community.

It is important to acknowledge any visiting (or visited) Elder, as Elders have traditionally been recognized within Indigenous communities as highly esteemed individuals. There are certain protocols that should be followed when inviting an Elder into your classroom; “TPAC Elder Protocol – Policies and Procedures” is a document from the University of Manitoba Student Affairs Aboriginal Student Centre that includes helpful information in this regard. See: <www.umanitoba.ca/student/asc/tpac/protocol.html>.

NOTE: Although both cultural connections and Indigenous connections are generally included in the Enhance section of a lesson of *Hands-On Science*, teachers should not regard this content as supplementary. First and foremost, the central science outcomes are focused on in the Engage and Explore sections of each lesson, while other curricular connections – such as literature, art, Indigenous connections, and other cultural connections – are usually featured in the Enhance section.

Technology

Digital learning, or learning with information and communication technology (LwICT), is an important component of any classroom. As such, technological supports available in schools – including digital cameras, computers/tablets, interactive whiteboards (IWB), projectors, document cameras, and even calculators – can be used with and by students to enhance their learning experiences. When technology connections are made in ***Hands-On Science*** lessons, the following icon is used:

Sustainability

Hands-On Science provides numerous opportunities for students to investigate issues related to sustainable development. Asking students the following question can often help to clarify for them what is meant by sustainability: “Is there enough for everyone, forever?” Exploring sustainability also connects to the Indigenous world-view about respecting and caring for the earth.

The three pillars of sustainability are the environment, society, and the economy. When sustainability links are made in ***Hands-On Science*** lessons, any or all of the sustainability pillars may be the focus of this connection, and are identified by the following icon:

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The Hands-On Science Assessment Plan

Hands-On Science provides a variety of assessment tools that enables teachers to build a comprehensive and authentic daily assessment plan for their students. Based on current research about the value of quality classroom assessment (Davies 2011), suggestions are provided for authentic assessment *for* learning, assessment *as* learning, and assessment *of* learning:

Assessment *for* Learning

It is important to assess student understanding before, during, and after a science lesson. The information gathered helps teachers determine students' needs and then plan the next steps in instruction. Students may come into class with misconceptions about science concepts. By identifying what they already know, you can help them make connections and address any problem areas.

To assess students as they work, use the assessment for learning suggestions and questions provided with many of the activities. Questions focus on the lesson outcomes and are intended to promote higher-level thinking skills, active inquiry, and decision making.

While observing and conversing with students, use the **Anecdotal Record** sheet, as well as the **Individual Student Observations** sheet to record assessment for learning data:

- **Anecdotal Record:** To gain an authentic view of a student's progress, it is critical to record observations *during* science activities. The **Anecdotal Record** sheet, presented on page 17, provides the teacher with a format for recording individual or group observations.
- **Individual Student Observations:** When teachers wish to focus more on individual students for a longer period of time, consider using the **Individual Student Observations** sheet, found on page 18. This reproducible provides more space for comments and is especially useful during conferencing, interviews, or individual student performance tasks.

When assessment *for* learning is suggested in a lesson, the icon shown at left is used.

Assessment *as* Learning

It is also important for students to reflect on their own learning about science. For this purpose, teachers will find a **Student Self-Assessment** sheet on page 24.

NOTE: This reproducible requires students to describe a science skill on which they are working. This offers a valuable opportunity to discuss with students the scientific inquiry skills emphasized in grade 3, and to encourage a focus on these skills during all science activities. Refer to the description of these skills in the subsection of the introduction, Scientific Inquiry Skills: Guidelines for Teachers (pages 7–10), as well as to the Curriculum Correlation Chart: Scientific Inquiry and Design Process Outcomes, at the beginning of each unit.

In addition, a **Science Journal** sheet, found on page 19, will encourage students to reflect on their own learning. Teachers can copy several sheets for each student, cut them in half, add a cover, and bind the sheets together. Students can then create title pages for their own journals. For variety, you may also have students use the blank reverse sides of each page for other reflections. For example, have students draw or write about:

- new science challenges
- favourite science activities
- real-life experiences with science
- new science terminology

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Students should also be encouraged to reflect on their cooperative group work skills. For this purpose, a **Cooperative Skills Self-Assessment** rubric is included on page 25.

Student reflections can also be done in many ways other than in writing. For example, students can:

- Interview one another to share their reflections on science.
- Write an outline or brief script, and make a video reflection.
- Create an electronic slide show with an audio recording of their reflections.

When assessment *as* learning is suggested in a lesson, the icon shown on the preceding page is used.

Assessment *of* Learning AOL

Assessment of learning provides a summary of student progress related to the accomplishment of the outcomes at a particular point in time. It is important to gather a variety of assessment data to draw conclusions about what a student knows and can do. As such, consider collecting student products, observing processes, and having conversations with students. Teachers should also consider which student work is formative and which is summative in their deliberations. Only the most recent and consistent evidence should be used.

Assessment of learning suggestions are provided throughout the ***Hands-On Science*** program. Use the **Anecdotal Record** sheet, found on page 17, and the **Individual Student Observations** sheet, found on page 18, to record student results.

Always assess the individual student's accomplishments, not group work. However, you may also assess how the individual student works within a group. Such skill development includes the ability to "respond respectfully to the ideas and actions of others … assume roles and share responsibilities as group members … listen to and consider differing opinions."[3] For this purpose, a **Cooperative Skills Teacher Assessment** form is included on page 23.

When assessment of learning is suggested in a lesson, the icon shown on the preceding column is used.

Performance Assessment

Assessment of learning also includes performance assessment, which is planned, systematic observation and assessment based on students actually doing a specific science activity. Teacher- or teacher/student-created rubrics can be used to assess student performance.

A **Sample Rubric** and a **Rubric** for teacher use are included on pages 20 and 21. For any specific activity, the teacher and students discuss criteria for completing a task successfully before the work is done. The teacher then selects four criteria that relate directly to the learning outcomes, and records these criteria on the **Rubric**. Students receive a check mark point for each criterion accomplished to determine a rubric score from a total of four marks. These rubric scores can then be transferred to the **Rubric Class Record** form found on page 22.

NOTE: Performance tasks can be used for both assessment *for* learning and assessment *of* learning.

Consider using four levels of achievement for your rubrics, to determine performance levels:

3 Manitoba Education and Training, 1999, p.3.37

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4. Thorough understanding and in-depth application of concepts and skills
3. Very good understanding and application of concepts and skills
2. Basic understanding and some application of concepts and skills
1. Limited understanding and minimal application of concepts and skills[4]

Hands-On Science provides numerous opportunities for students to apply their skills. By considering the same levels throughout the year, you should be able to track skill development and determine when students have a thorough understanding and in-depth application of concepts and skills.

Portfolios

A portfolio is a collection of work that shows evidence of a student's learning. There are many types of portfolios; the showcase portfolio and the progress portfolio are two popular formats. Showcase portfolios highlight the best of the students' work, with students involved in the selection of pieces and justification for choices. Progress portfolios reflect the students' progress as they improve, and aim to demonstrate an in-depth understanding of the material over time.

Select, with student input, work to include in a science portfolio or in a science section of a multi-subject portfolio. This should include representative samples of student work in all types of science activities. Reproducibles are included to organize the portfolio (**Portfolio Table of Contents** sheet is on page 26, and **Portfolio Entry Record** sheets are on page 27).

NOTE: In an Indigenous context, portfolio creation may differ in that the student and teacher may select completed work from a coming-to-know perspective that reflects participatory learning. Students reflect on their own understanding of the world around them or a sense of negotiating another point of view.

4 Manitoba Education, 2012, p. 22

An Important Note to Teachers

Throughout the ***Hands-On Science*** program, suggestions are provided for assessment *for* learning, assessment *as* learning, and assessment *of* learning. It is important to keep in mind that these are merely suggestions. Teachers are encouraged to use the assessment strategies presented in a wide variety of ways, and to ensure that they build an effective assessment plan using these assessment ideas, as well as their own valuable experience as educators.

NOTE: From an Indigenous perspective, assessment is community-based, qualitative, and holistic, and includes input from all the people who influence an individual student's learning – parents, caregivers, Elders, community members, and educators. An assessment that includes all these perspectives provides a balanced understanding of what represents success for Indigenous students and their families/community. A strong partnership between parents/guardians/communities and school improves student achievement. Teachers should be aware some Indigenous students may feel apprehensive about a formal process of assessment; others may find Western achievement goals do not fit their Indigenous world-view.

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Unit 1

Growth and Changes in Plants

Introduction

This unit of ***Hands-On Science, Grade 3*** focuses on the study of plants: their physical characteristics, along with each characteristic's specific function, the requirements plants need to survive, and their patterns of growth. Students investigate, grow, and observe plants in their local environment. They learn about similarities and differences in the physical characteristics of different plant species, as well as the changes that take place in different plants as they grow. Students also learn about the importance of plants for the survival of humans and other animals, and the effects of both human activities and of changes in environmental conditions on plants.

Planning Tips for Teachers

- Collect a variety of live plants and an assortment of seeds and bulbs for examination and use in the classroom. Bean plants grow well and quickly, so students can observe them develop from seed to adult plant in a reasonably short period of time.
- Collect a variety of containers in which to put soil, as well as to grow these plants.
- Consider setting up a plant centre in a sunny area of the classroom or another location in the school, where students can observe, record, and discuss changes in plants on a regular basis.
- Collect numerous photos and pictures of plants for use in lesson activities and at learning centres. Resources for collecting pictures include:
  - wall calendars (current or outdated)
  - departments of forestry and natural resources
  - seed catalogues
  - forestry and environmental associations
  - gardening and plants magazines
  - horticultural societies
  - brochures and flyers
  - simplified plant guides/books
  - gardening books
  - nature-walk brochures from local, provincial, and national parks
  - photographs from home (Some photos/pictures should be electronic/online for use with a whiteboard/projection system.)
- Contact government departments and associations well in advance of studying the unit. Teachers may be able to obtain other related materials and services such as booklets, posters, videos, and presentations for classroom use.

It is not necessary to teach this unit (or any other unit) in one block. Some teachers might consider splitting up the unit's activities to focus on plants during fall and spring when outdoor plant life is abundant; others might choose to study plants on an ongoing basis throughout the year.

Indigenous perspective on the natural environment is based on the idea of sustainability. Many plants traditionally used by Indigenous peoples in Manitoba are either no longer in existence or in danger of being lost forever. Indigenous perspectives, which are common to many other cultures as well, are embedded throughout this unit of ***Hands-On Science, Grade 3*** with the following understandings in mind:

- People from all cultures respect and appreciate Nature's gifts.
- All life forms, no matter how small, are considered important and significant.
- By respecting plants, we are protecting the earth.
- Plants have homes and communities just like animals and people.
- Plants have powers to heal. Plants help animals and people survive.

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- Indigenous science helps us understand how plants grow and develop.
- Western science helps us understand how plants grow and develop.
- We can learn about plants from each other.

Indigenous Uses for Plants

- **Food Plants**: Before the arrival of Europeans, cultivation of food crops was practised by Indigenous peoples of Canada in southern Ontario and the St. Lawrence lowland. Crops included the “three sisters” – corn, beans, and squash – as well as sunflowers, tobacco, and, possibly, Jerusalem artichoke. Over 500 species of wild plants provided foods for Indigenous peoples in Canada. Some of these are similar to those eaten today: root and green vegetables, fruits, nuts, seeds, mushrooms, and wild rice. Others are not normally part of our modern diet – some types of lichens, marine algae, and inner-bark tissues of some trees. Plants were also used as sweeteners, flavourings, and beverages. Many wild plants provided more than one type of food. Today, maple syrup, wild rice, and many wild fruits are enjoyed by both Indigenous and non-Indigenous Canadians.
- **Medicinal Plants**: Plants traditionally were, and still are, an important component of Indigenous medicine. More than 500 plants were used in Indigenous medicine.
- **Utility Plants**: Various plant materials from several hundred different species were used by Canadian and American Indigenous peoples. Woods were of prime importance as fuels, and as major components of utilitarian items: buildings, dugout canoes, boxes, totem poles, and implements (e.g., paddles, digging sticks, spear shafts, bows, arrows, snowshoe frames). Sheets of bark, especially birch, were made into containers and canoes. Bark was also used to cover roofs and line storage pits. Fibrous tissues from stems, roots, bark, and leaves served as twine, rope, and weaving materials for baskets, mats, and clothing. Tree resin was used as glue and for waterproofing. Plants provided dyes and pigments, scents, absorbent materials, abrasives, linings and wrappings, insect repellents, toys and recreational items, and personal adornment.
- **Sacred Plants**: Sweetgrass, sage, cedar, and tobacco encompass the four sacred plants for Indigenous peoples. Burning one of these is a sign of deep spirituality in Indigenous practice, and they are used in both individual and group ceremonies. Tobacco is offered back to the earth in appreciation for the gift of animal life. Today, many Indigenous peoples also lay down tobacco as an offering when collecting plants, berries, and corn, or when they have taken an animal’s life for food. As well, tobacco may be offered to an Elder or another community member for sharing his or her wisdom and knowledge. Cedar and sage are burned to drive out negative forces when prayer is offered. Sweetgrass, which signifies kindness, is burned to invite good spirits to enter. Participants also use these purification rituals to smudge regalia, drums, and other articles before taking part in a powwow. Each plant was originally given individually to a specific tribe. Now, the plants are used together or singly as incense, which is generally ignited in an abalone shell or another type of container to be passed from person to person in a circle.

Science Vocabulary

Throughout this unit teachers should use, and encourage students to use, vocabulary such as:

- *adaptation, air, basic needs, carbon dioxide, coniferous, deciduous, fibrous, flowers, growing medium, leaves, life cycle, light, nutrients, ovule, oxygen, photosynthesis,*

▶

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pistil, pollen, root, seeds, soil, space, stamen, stem, taproot, water.

Also, consider including vocabulary related to scientific inquiry skills. The terms could be displayed in the classroom throughout the year, as they relate to all science clusters/units. Teachers and students can then brainstorm which skills they are using as they work on specific activities and discuss what that skill looks and sounds like as students explore and investigate. Vocabulary related to scientific inquiry skills includes:

- *access, ask, brainstorm, collect, compare, connect, consider, construct, cooperate, create, describe, develop, diagram, display, draw, estimate, examine, explain, explore, find, follow, graph, identify, improve, investigate, label, measure, observe, order, plan, predict, recognize, record, repeat, research, respond, select, sequence, test.*

Throughout this unit of ***Hands-On Science, Grade 3***, you will find reference to both a Science Glossary and a class word wall. A science word wall can be created on a bulletin board or simply on a sheet of poster paper, so as not to take up too much space. On the bulletin board or poster paper, record new vocabulary as it is introduced throughout the unit. Ensure that the word wall is placed in a location where all students can see and access the words.

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2 What Are the Parts of a Plant?

Information for Teachers

The basic parts of plants include: root, stem, leaf, flower, pistil, stamen, sepal, petals, and seeds.

In this lesson, students will be removing potted plants from their pots, and examining all the parts of a plant. A day or two before conducting this activity, water the plants to be used (see Materials, below), as it is easier to remove a plant from moist soil than from dry soil.

Materials

- newspaper
- variety of small plants in flower, one for each student or pair of students (Plants suitable for classroom use can often be found at local gardens, grocery stores or markets, or florists. Ask for plants that are a bit "tired" and not suitable for sale, explaining these can still be used for teaching purposes. If live plants are unavailable, print pictures from the Internet, or cut out pictures from magazines.)
- soft paintbrushes
- chart paper
- markers
- transparent containers (optional)
- digital camera (optional)
- Activity Sheet: What Are the Parts of a Plant? (1.2.1)
- Learning-Centre Task Card: Building a Model of a Plant (1.2.2)
- toothpicks
- paper
- various art supplies
- range of recycled materials
- KWHL chart (from lesson 1)
- Science Glossary (1.1.1)

SAFETY NOTE: Be aware of any student allergies in class. An easy entry point to a discussion about allergies is to talk about plants not allowed in hospital rooms (usually lilies).

Engage

Review the previous lesson. Ask students:

- What is a plant?

Have students explain the characteristics of plants with which they are familiar.

On chart paper, construct a chart for recording students' ideas. For example:

Name of Plants	Similarities	Differences

Ask:

- What were some of the plants we looked at?

Record the names of two plants in the first column. Ask:

- What were some of the plants' similarities (things in common) we discussed in the last lesson?

Record these in the second column. Ask:

- What were some of the plants' differences we discussed in the last lesson?

Record these in the third column. Repeat this process, comparing other pairs of plants.

Introduce the guided inquiry question: **What are the parts of a plant?**

Explore

Have students brainstorm a list of all the plants they know that have not already been recorded on the chart. Record these in the first column on the chart, "Name of Plant." Discuss the similarities and differences for each plant, and record these on the chart.

Have students work individually or in pairs, and give each student or pair of students some

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newspaper, a dry paintbrush, and a flowering plant (or a picture of a flowering plant).

If actual plants are being used (rather than pictures), distribute newspaper, and ask students to cover their desks. Then, slowly go through the following steps with students for gently removing the plant from its pot:

1. Put your hand over the top of the pot, and hold the plant stem gently between your fingers.
2. Turn the pot upside down while holding it in this way, supporting the plant and the soil.
3. Tap the edge of the pot against something hard, such as a table.
4. Gently use your other hand to pull the pot upwards to remove the plant.
5. If the plant does not come out easily, repeat steps 3 and 4.

NOTE: Remind students it is quite easy to break or damage a plant when removing it from a pot. It may be easier for pairs of students to work together to remove the plants from the pots, one student holding the plant and turning over the pot (steps 1 and 2) and the other student pulling on the pot. For stubborn plants, it sometimes helps to slide the blade of a knife around the inside edge of the pot, to cut any roots that are protruding through the drainage holes. If all else fails, breaking or cracking the pot (if plastic) can help to remove the plant.

Tell students to lay their potless plants on top of the newspaper. Have them use a paintbrush to carefully brush away as much of the soil clinging to the roots as they can. Then, have them identify any parts of the plant they know by writing the names beside the parts, directly on the newspaper. If a digital camera is available, have students take pictures of their labelled plant parts. Then, have students circulate the classroom, observing the other students' plants and parts labels. Ask:

- What do these plants all have in common?

As students identify the plant parts – including roots, stem, leaves, flowers, and seeds – record the name of each part under "Similarities" on the chart (if not already noted). Once all of the plant parts have been identified, distribute a copy of Activity Sheet: What Are the Parts of a Plant? (1.2.1) to each student. Have students sketch their plants and label their diagrams.

NOTE: Some of the similarities (and/or differences) students may notice in the plants are shape of the leaves, type of roots, number of petals on flowers, and so on. Encourage students to be specific in their observations (as well as later on, in their drawings).

Keep the plant specimens for future observation and examination. They can be placed in transparent containers or allowed to dry, to observe what happens as they die. Alternatively, if plants have not been damaged, they may be replanted and used in subsequent lessons.

Activity Sheet
Directions to students:

Draw a diagram of your plant. Label these parts: root, stem, leaf, flower, seeds, and predict the function of each part. Identify your plant, and name five other plants you know (1.2.1).

NOTE: Seeds and flowers may not be visible on all plants, so consider having students research their plants to draw more accurate diagrams.

Learning Centre

At the learning centre, provide toothpicks, paper, art supplies, a range of recycled materials, pictures of plants, and a copy of the Learning-Centre Task Card: Building a Model of a Plant (1.2.2). Have students use the materials to create 3-D models of one of the plants at the centre. Students can use toothpicks and paper to label all the plant parts. Have students take photos of their models with a digital camera (if available). Print the photos, and display these at the centre.

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2

Embed: Part One

Revisit the guided inquiry question: **What are the parts of a plant?** Have students share their knowledge, provide examples, and ask further inquiry questions.

Embed: Part Two

- Add to the KWHL chart as students learn new concepts, answer some of their own inquiry questions, and ask new inquiry questions.
- Add new terms and illustrations to the class word wall. Include the words in other languages, as appropriate.
- Have students add new terms, definitions, and illustrations to their Science Glossary (1.1.1). When possible, encourage them to add words (and examples) in other languages, including Indigenous languages, reflective of the classroom population.

Enhance

- Have a language-arts novel study, using the book *The Secret Garden*, by Frances Hodgson Burnett, or read the novel aloud to the class.
- Along with English words, students may learn science-related words in Indigenous languages such as Anishinaabe, Cree, and others. In the same way, students may share science-related terminology in other foreign languages that they speak at home. Also, consider opportunities to integrate basic French into a lesson by learning the terms in Canada's other official language. Words in other languages can be added to the Science Glossary along with the English words, or students may keep a log of Indigenous/foreign words that they learn. Elders or other community members may also be able to help students to build science vocabulary.
- Have students interview their parents/guardians or grandparents about plants that are native to your region. Have them write a journal entry with a drawing of the plant and a story that their parents/guardians or grandparents shared.
- Access the interactive activity, Lesson 2: What Are the Parts of a Plant?, in the Unit 1 folder at: <portageandmainpress.com/HOS-MB/gr3>.

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Date: ____________________ **Name:** ______________________________

What Are the Parts of a Plant?

Draw a picture of your flowering plant in the large box below. Label these parts on your diagram:

root(s)	**stem**	**flower**	**leaf**	**seed(s)**

Beside each labelled part, predict that part's function or job.

The plant I drew is a ______________________________ **.**

Five other plants I know are:

1. ______________________________

2. ______________________________

3. ______________________________

4. ______________________________

5. ______________________________

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Building a Model of a Plant

1. **Use any of the materials at this centre to create a three-dimensional model of a flowering plant.**
2. **Try to use different materials to represent the different parts of the plant.**
3. **Be sure to label the following parts using the toothpicks and paper:**
   - **root(s)**
   - **stem**
   - **leaves**
   - **flower(s)**
   - **seed(s)**
4. **Take a photograph of your model to display at the centre.**

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