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Introduction to
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**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. 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.

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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 are located at the end of every unit.

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
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. 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:

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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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**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:

![Interpersonal Icon]

**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:

![Intrapersonal Icon]

**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:

![Naturalistic Icon]

**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:

![Existential Icon]

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).
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.

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.
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. Objects can be sorted by material from which they are made, and animals can be grouped according to characteristics (e.g., fur/scales, lungs/gills, live babies/eggs). 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.
For example:

Measuring is a process of discovering the dimensions or the quantity of objects or events. In the early years, measuring activities first involves 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 the time students are in grade 2, they begin to use, with guidance, standard measuring tools. For example, they will be involved in activities that require them to measure length using standard units (e.g., centimetres and metres), as well as activities to measure the passage of time related to 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:
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.

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.

Communicating also involves using the language and terminology of science. Teachers should encourage students to use the appropriate vocabulary related to their investigations, for example, object, metal, pliable, absorbent, and characteristic. The language of science also includes terms like 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

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.
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-2 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. In some cases, such helpers may also scribe for students to communicate their findings.

### 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 10, students use the design process to design, construct, and test mealworm habitats.

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.

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


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-2 level and which are fostered and encouraged throughout Hands-On Science lessons include:

- Recognize learning can come from careful observations and investigations.
- Recognize tools are developed in response to human needs.
- Willingly consider other people’s views.
- 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 the 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, 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, culture, 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:
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 2, 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
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

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”.

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
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

*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

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**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 that some Indigenous students may feel apprehensive about a formal process of assessment; others may find that Western achievement goals do not fit their Indigenous world-view.
Unit 1

Growth and Changes in Animals
Introduction

This unit of *Hands-On Science, Grade 2* focuses on the study of animals, specifically patterns of growth and change. Students will investigate and compare the growth patterns of different animals with their own growth. They will also learn about the conditions necessary to foster healthy development in an animal.

Students will learn about the similarities and differences among various types of animals and the ways in which animals adapt to different environmental conditions. They will also investigate physical and behavioural characteristics and the process of growth of different types of animals, and they will learn about ways that humans can affect other animals.

**Planning Tips for Teachers**

- Collect pictures of both adult and baby animals. Be sure to represent a range of animals from all six animal groups: mammals, birds, insects, fish, amphibians, and reptiles. If possible, laminate the pictures, which can then be used throughout the unit. Good resources for pictures include:
  - old calendars
  - magazines (e.g., *Ranger Rick*, *Owl*, *Chickadee*, *Highlights for Children*, *Canadian Geographic*, *National Geographic*)
  - departments of agriculture and forestry, agricultural and forestry associations
  - environmental associations (e.g., *Greenpeace*, *World Wildlife Fund*, *Canadian Environmental Network (RCEN)*)
  - zoological, humane, and naturalist societies

If contacted in advance, some of the groups named above may provide booklets, posters, reference materials, or even kits or presentations for classrooms.

- Collect books, magazines, and other reading material about animals, including as many different genres as possible – fiction, nonfiction, poetry, comic books, riddle books, weird-fact books. Keep these reading materials in a separate part of the classroom library or set up an “Animal” library, where students can refer to them during activities, research, and free time.

- Review Books for Students, on page 36, and order relevant books for the unit from your local library or education library.

- Decide if you are going to have a class pet— or bring in caterpillars (to hatch into butterflies) or mealworms for studying life cycles. Including live animals in your lessons will enhance the concepts that students are learning and will provide them with firsthand observation experiences.

Many animals are suitable for the classroom and are relatively easy to look after. Fish, for example, are easily cared for, and a fish tank provides an excellent observation centre for students. Guinea pigs are one of the best animals for the classroom, as they are large enough for students to handle, not fast enough to escape, and usually gentle and affectionate. To introduce a greater variety of animals to students, you may also choose to have guest pets (e.g., bird, rabbit, gerbil, snake) visit the classroom for a month at a time.

**SAFETY NOTE:** Be sure to consider any student allergies when selecting a classroom animal.

Since mealworms are one of the easiest animals to acquire (they can usually be purchased from a local pet store), they have been chosen to use for the experiments in this unit. Teachers will need to collect a variety of materials in order to house the
mealworms and perform the mealworm experiments, including the following:

- 50–60 mealworms
- 5–10 plastic containers
- mesh screen
- aluminum pie plate
- paper towels
- stopwatch
- scissors
- sharp knife
- strong tape
- oatmeal
- cornmeal
- wheat flour
- bran
- potato slices

Read through the activities in each learning centre found in the unit, and prepare necessary activity cards and materials for centres ahead of time.

A great way to conclude this unit is to have students work in groups, pairs, or individually on an animal project of their choice. If you decide to use the “Animal in a Can” idea in lesson 14 for students to store and display their research, collect enough large coffee cans for each group/pair/individual in your class.

Throughout the unit, as you conclude a lesson, be sure to keep all charts and displays created during the lesson, as well as activity sheets and other work done. Sometimes, these are referred to again in subsequent lessons, and all charts and other materials created throughout the unit are used in the concluding lesson, which is a final inquiry project.

Teachers are reminded of the value of incorporating Indigenous perspectives and world-views into lessons whenever possible, such as having a respectful relationship with nature, with an intention to sustain natural resources for generations to come; the belief that all life – plants, animals, and humans – is equal and that all living things depend upon one another for survival; and the idea that humans have special relationships with animals, who are seen as teachers, guides, and companions and are key to human survival.

This unit of *Hands-On Science, Grade 2* provides an opportunity for students to learn more about having a respectful relationship with animals, and that humans, as well as all other animals, grow and change or metamorphose as part of their life cycle.

Traditionally, when an animal was hunted, every part of it was used for food, clothing, tools, transportation, and shelter. People also depended on animals to signal seasonal changes and to assist with agricultural pursuits. Indigenous belief was that the animal gives up its soul in order to provide humans with what they need for survival; therefore, out of respect to the animal, no part of it would go to waste. Indigenous peoples had a true appreciation of where their food came from, as well as an in-depth knowledge of hunting and of the animals they hunted. Through this interaction, people developed relationships with animals and the natural world.

For more information about incorporating Indigenous perspectives, refer to the Introduction to *Hands-On Science, Grade 2*, on page 2.

**Science Vocabulary**

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

- adult, behaviour, Canada Food Guide, caterpillar, chrysalis, cocoon, egg, food group, larva, life cycle, nymph, offspring, pupa, stage.
Also, consider including vocabulary related to scientific inquiry skills. These might be displayed in the classroom throughout the year, as they are related to all units. Teachers and students could then brainstorm which skills they are being asked to use as they work in particular lessons. They could also discuss what that skill looks and sounds like as they explore and investigate. Vocabulary related to scientific inquiry skills includes:

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

Throughout the unit, a science glossary is referred to, as well as a class word wall. A science word wall can be created on a bulletin board or simply on a piece 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 in the unit. Ensure the word wall is placed in a location in the classroom where all students can see and access the words.
What Do We Know About Growth and Changes in Animals?

Information for Teachers
Growth is the process of developing and changing.

Materials
- pictures of animals, including both the adult and the baby (in separate photos) for each type of animal, from magazines or calendars (be sure to include humans). (You will need at least one picture for each student in the class.)
- envelopes (each large enough to hold one animal picture) or file folders
- sticky notes (large)
- markers
- masking tape or sticky tack
- chart paper
- scissors
- Learning-Centre Task Card: What Can I Learn About Animals? (1.1.1)
- Learning-Centre Sample Slips (Photocopy, and cut apart.) (1.1.2)
- Learning-Centre Activity Slips (Make several copies, and cut apart.) (1.1.3)
- Activity Sheet: Science Glossary (1.1.4)

Engage
Have students imagine they are a group of scientists who are experts at identifying animals. Provide each student with an envelope or file folder with one of the animal pictures (adult or baby) and one large sticky note inside. Ensure students keep their pictures to themselves at this stage of the activity. Have students open their envelopes/file folders and examine their pictures. On the sticky notes have students record:

1. the name of the animal shown in the picture.
2. the word adult or baby to indicate if the picture shows a mature animal or a baby animal.

Explain to students that one way to tell if an animal is an adult or a baby is by its fur (if it is an animal that has fur). If the animal has no fur but normally would, it is likely a baby.

Tell students there are two pictures of each type of animal in the collection: one of it as a baby and one as a mature (adult) animal. One student in the class will have a picture of the adult and another will have a picture showing the same animal as a baby. Challenge students to find their animal partners. Once all students are in pairs, have them share the following with each other:

1. The name of their animal. Encourage students to use both the adult animal name and the baby animal name, if possible (e.g., frog/tadpole; dog/puppy).
2. As many differences as they can observe between the baby animal and the adult.

When all pairs have shared, ask:

- What do the picture pairs have in common? (They are all animals.)
- What do you think you are going to learn about in science now? (animals, and how baby animals grow and change into adults)

Introduce the guided inquiry question: **What do we know about growth and changes in animals?**

NOTE: Be sure to save the collected adult and baby animal pictures; they are used again later in the unit.

Explore
On chart paper, construct a KWHL chart for recording ideas, as in the following example:

<table>
<thead>
<tr>
<th>Growth and Changes in Animals</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>What We Know</strong></td>
</tr>
<tr>
<td>------------------------</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

www.portageandmainpress.com
Discuss the title of the chart with students. Ask:

- What do you already know about growth and changes in animals?
- What is an example of growth in an animal? (e.g., animal gets bigger, longer, taller in size)
- What is an example of change in an animal? (e.g., baby bird, which hatches with few or no feathers, later grows feathers)

Have students share ideas, and record this information in the first column of the chart.

Now, have students focus on the second column of the chart. Ask:

- As you begin to study animals and their changes from baby to adulthood, what questions do you have?
- What would you like to learn about baby and adult animals?

Have students share their ideas, and record these in the second column of the chart. This provides an opportunity for students to share special interests and to consider these interests when planning future activities.

**NOTE:** This is a good time to encourage students to begin thinking about an animal that fascinates them – an animal they may already know something and want to learn more about, or one they have always been curious about but know little or nothing. Explain that at the end of this unit they will be doing an animal project about an animal of their choice. Teachers are encouraged to introduce a range of animals from all animal classes (fish, mammals, birds, amphibians, reptiles, and insects), and also to include some animals from the local area.

As students share their questions and concepts about which they want to know more, discuss ways that they might find the answers to these questions. Encourage students to think of a wide variety of ways to learn new ideas or to answer scientific questions. For example:

- classroom books and other resources
- videos
- websites, blogs
- library resources
- resources from home (books, artifacts, interviews with family or other experts)
- guest speakers
- community Elder(s)
- field trips
- writing letters to experts
- making observations
- photography

Explain to students that as they learn new things about the growth and changes in animals, their ideas will be recorded in the fourth column of the chart.

Display the chart in an area of the classroom visible to all students throughout the unit.

**Learning Centre**

At the learning centre, set up an “Animal” library corner. Provide books (fiction and nonfiction), magazines, posters, weird facts, riddles, and any other animal materials at the centre, along with a copy of the Learning-Centre Task Card: What Can I Learn About Animals? (1.1.1) and Learning-Centre Sample Slips (1.1.2), and copies of the Learning-Centre Activity Slips (1.1.3).

Encourage students visiting the centre to choose anything they want to read from the Animal library. Then, have students do one of the following written tasks, using one of the Learning-Centre Activity Slips (1.1.3):

1. Recommend a book.
   
   For example:
   
   I recommend this book because: it has many interesting facts about farm animals.
2. Complete a “Did You Know?” fact slip:
   For example:
   Did you know a baby seahorse is born from its father? It pops out from its father’s pouch.
3. Write an animal riddle using information read or discovered at the Animal library.
   For example:
   I have two large back legs and two smaller front legs. I travel by hopping. I keep my joey in my pouch. What am I?

Encourage students to complete a different form each time they visit the centre.

Display students’ work at the Animal library for everyone to enjoy.

**Embed: Part One**

Distribute several copies of Activity Sheet: Science Glossary (1.1.4) to each student, and have students begin a glossary for the unit. At the end of the unit, students can cut apart the rows on their sheets, alphabetize their words, and create booklets of terminology related to growth and change in animals.

**Activity Sheet**

Directions to students:
Record the term *growth* on the top blank line in the left-hand column. Draw an illustration to describe that word in the right-hand column (1.1.4).

**NOTE:** Suggest to students that they use the animal in their envelope or file folder to help them illustrate the term *growth*.

Revisit the guided inquiry question: **What do we know about growth and changes in animals?**
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.
- Begin a class word wall to display new terminology and illustrations that students learn throughout the unit. Also, include the words in other languages, as appropriate.

**Enhance**

- Have students research Canadian provinces, as well as other places that display animals on their flags. Have each student select a flag to draw and research the significance of the animal on the flag.
- Have students research which animals were important traditionally to the survival of local Indigenous peoples (e.g., bison, deer, rabbit, fish, caribou, elk, moose).
- Have students use clip art and pictures from various websites to add to the set of adult and baby animal pictures used in the lesson, including endangered species. This could lead to discussion about animals that are more common and those that are not – and why!
- Celebrate cultural diversity by having students research the names of animals in different languages, especially those reflective of students’ origins. Students could also learn Anishinaabe and Cree terms for various animals. Teachers can consider dedicating a classroom bulletin board or creating a poster for this purpose, as in the example on page 43:
### Indigenous Language Animal Words

<table>
<thead>
<tr>
<th>Animal Picture/Drawing</th>
<th>English Word</th>
<th>Anishinaabe Word</th>
<th>Cree Word</th>
</tr>
</thead>
<tbody>
<tr>
<td>Squirrel</td>
<td></td>
<td>Ajidamoo</td>
<td>Anikwacás</td>
</tr>
<tr>
<td>Wolf</td>
<td></td>
<td>Ma’iingan</td>
<td>Mahihkan</td>
</tr>
<tr>
<td>Bear</td>
<td></td>
<td>Makwa</td>
<td>Maskwa</td>
</tr>
<tr>
<td>Elk</td>
<td></td>
<td>Muwin</td>
<td>Wäwäskisiw</td>
</tr>
<tr>
<td>Bison</td>
<td></td>
<td>Mashkode-bizhiki</td>
<td>Päswawimistó</td>
</tr>
</tbody>
</table>

- Have students use the research medicine wheel as another graphic organizer to record information and research about animals studied, as in the example below:

- Have students research animals that are found in different countries and then display pictures of the animals along with their names on a world map.
What Can I Learn About Animals?

Welcome to the Animal library!

1. Choose something you want to read, and then relax at the centre, and read your selection.

2. Decide how you want to share something you have read with your classmates. You can:
   - Recommend a book.
   - Write a “Did You Know?” fact about a specific animal.
   - Write a riddle about a specific animal.
Learning-Centre Sample Slips

Book Recommendation

Title: If You Were Born a Kitten
Author: Marion Dane Bauer

I recommend this book because: you learn about animals that you might not know anything about, like seahorses and opossums.

This book is recommended by: Susan

Did You Know?

Did you know a baby seahorse is born from its father?

It pops out from its father’s pouch!

Fact written by: Susan

Animal Riddle

What baby animal has a halo of long brown hair when it is born, and sometimes sucks its trunk like a thumb?

Answer: look on the back of this card.

Riddle writer: Susan
Learning-Centre Activity Slips

Book Recommendation
Title: ____________________________________________________

Author: __________________________________________________

I recommend this book because: ________________________________

This book is recommended by: ________________________________

Did You Know?
Did you know ______________________________________________

__________________________________________________________

__________________________________________________________

__________________________________________________________

Fact written by: ____________________________________________

Animal Riddle

__________________________________________________________

__________________________________________________________

__________________________________________________________

__________________________________________________________

Answer: __________________________________________________

Riddle writer: ______________________________________________
## Science Glossary

<table>
<thead>
<tr>
<th>Word</th>
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