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Ontario

hands-on science and Technology

An Inquiry Approach With STEM Skills and Connections

Grade 6

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Hands-On Science and Technology for Ontario, Grade 6
An Inquiry Approach With STEM Skills and Connections

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Introduction to *Hands-On Science and Technology for Ontario, Grade 6*

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Introduction to *Hands-On Science and Technology*

About *Hands-On Science and Technology*

Hands-On Science and Technology helps develop students' understanding of science and technology concepts and science, technology, engineering, and mathematics (STEM) skills. It also promotes scientific literacy through active inquiry, problem solving, and decision making. Each activity in ***Hands-On Science and Technology*** encourages students to explore, investigate, and ask questions as a means of heightening their curiosity about the world around them. Students solve problems through first-hand experiences and by observing and examining objects within their environment. For students to develop scientific and technological literacy, concrete experience is of the utmost importance—in fact, it is essential.

The Goals of the Science and Technology Program

Science and technology play fundamental roles in the lives of all Canadians. The Ontario science and technology curriculum identifies three main goals for students:

- to develop the skills and make the connections needed for scientific and technological investigation
- to relate science and technology to our changing world, including society, the economy, and the environment
- to explore and understand science and technology concepts

These goals are the foundation for the lessons in ***Hands-On Science and Technology***.

NOTE: *Hands-On Science and Technology* 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 Indigenous worldviews about respecting and caring for the Earth. The three pillars of sustainability are the environment, society, and the economy.

Hands-On Science and Technology Strands and Expectations

The Ontario science and technology curriculum for all grade levels is organized into five strands:

A. STEM Skills and Connections
B. Life Systems
C. Matter and Energy
D. Structures and Mechanisms
E. Earth and Space Systems

Two sets of expectations are listed for each grade in each strand: (1) overall expectations and (2) specific expectations.

The overall expectations describe, in general terms, the knowledge and skills students are expected to demonstrate by the end of each grade.

The specific expectations describe the expected knowledge and skills in greater detail.

The overall and specific expectations for each strand are presented in the Curriculum Correlation Chart in the introduction to each unit of ***Hands-On Science and Technology***. The chart also identifies the lessons within the unit that correspond to each specific expectation.

Hands-On Science and Technology Principles

Hands-On Science and Technology is grounded in a research-based approach that puts students at the centre of the teaching and learning process. The following principles reflect this approach:

- Effective science and technology education involves hands-on inquiry, problem solving, and decision making.

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- The development of students' understanding of science and technology concepts and science, technology, engineering, and mathematics (STEM) skills forms the foundation of science and technology education.
- Children have a natural curiosity about science and the world around them. This curiosity must be maintained, fostered, and enhanced through active learning.
- Science and technology activities must be meaningful and worthwhile and relate to real-life experiences.
- The teacher's role in science and technology education is to facilitate activities and encourage critical thinking and reflection. Children learn best by doing, rather than just listening. Instead of simply telling, the teacher should focus on formulating and asking questions, setting the conditions for students to ask their own questions, and helping students make sense of the events and phenomena they have experienced.
- Science and technology should be taught in conjunction with other school subjects. Themes and topics of study should integrate ideas and skills from several core areas whenever possible.
- Science and technology education should encompass, and draw on, a wide range of educational resources, including literature, nonfiction research material, audio-visual resources, and technology, as well as people and places in the local community.
- Science and technology education should be infused with knowledge and perspectives of Indigenous Peoples, as well as other diverse multicultural perspectives.
- Assessment of student learning in science and technology should be designed to focus on performance and understanding and should be conducted through meaningful assessment techniques used throughout each unit. See the detailed overview of the ***Hands-On Science and Technology*** **Assessment Plan** on page 31.
- Science and technology education is inclusive in nature. Learning opportunities should meet the diverse needs of all students through differentiated instruction and individualized learning experiences.

The Importance of STEM Education

The study of science, technology, engineering, and mathematics (STEM) helps students become scientifically and technologically literate citizens. STEM learning integrates and applies concepts and processes related to these subject areas through problem solving and design challenges. The skills that students develop through STEM learning include coding, innovation, computational thinking, and engineering and scientific design. STEM skills and concepts are infused throughout the units and lessons included in ***Hands-On Science and Technology***. Most lessons offer a suggestion for a STEM Makerspace project, which is designed to develop students' STEM skills in direct relation to the lesson. (See page 19 for a detailed overview of STEM Makerspaces.)

In addition, most lessons include coding activities. (See page 4 for more detailed information on coding.) ***Hands-On Science and Technology*** emphasizes the creative coding approach, which focuses on the key skills of creativity, agency, and computing, described in the Harvard Graduate School of Education's *Creative Computing Curriculum* as follows:

Creativity: Computer science and computing-related fields are often introduced to young people in a way that is disconnected from their interests and values—emphasizing technical detail over creative potential. Creative computing supports the development of personal

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connections to computing by drawing upon creativity, imagination, and interests.

Agency: Many young people with access to computers participate as consumers, rather than designers or creators. Creative computing emphasizes the knowledge, practices, and fundamental literacies that young people need to create the types of dynamic and interactive computational media they enjoy in their daily lives.

Computing: Creating computational artifacts prepares young people for more than careers as computer scientists or programmers. It supports young people's development as computational thinkers—individuals who can draw on computational concepts, practices, and perspectives in all aspects of their lives, across disciplines and contexts.

What Does STEM Look Like in a Classroom Setting?

When students engage in STEM learning they actively work in teams, collaborating to find solutions to real-world problems using science, technology, engineering, and mathematics. They use a variety of materials and technologies to innovate and create. They draw plans, gather materials, build prototypes, and test what they have built. They conduct experiments, take measurements, and record their observations. Students use digital technology to create new content such as photos, videos, digital presentations, animations, and games. They engage in programming activities using coding and robotics. Students reflect on their work and understand that there are many possible solutions to a problem. STEM in the classroom is student centred, with the teacher acting as facilitator of the learning. The classroom is humming with excitement as students discuss their ideas and share their work.

What Is Coding?

Coding, also called computer programming, refers to giving a computer a set of specific step-by-step instructions that tell it what to do. These instructions need to be written in a language the computer understands, referred to as a *programming language*. There are many programming languages. They use letters, numbers, and symbols in their instructions. Children first learn to code with easy-to-learn, user-friendly languages that use visual symbols like blocks. Scratch is an example of a programming language made for young people. Familiarize yourself with some coding resources that can be used in the classroom, such as Scratch <https://scratch.mit.edu/>, a free block-based programming language designed for student use, and Code.org, a website that offers free coding courses and activities.

No previous coding experience is necessary to engage students in the Coding Connections activities provided throughout ***Hands-On Science and Technology, Grade 6***. Use the suggested coding activities as an opportunity to learn alongside students. Making mistakes and using logical reasoning to fix them (*debugging*) are key parts of learning to code. Provide students with plenty of free exploration time when introducing a new program, so they can discover its features before working on a specific task.

The key ideas and coding concepts for students to learn in grade 6 are as follows:

- Computer code is written in a specific order (called a *sequence* or *algorithm*), so the computer knows which step to complete first, next, and so on.
- Code can be written and executed so that multiple things happen at the same time (referred to as *concurrent events*).

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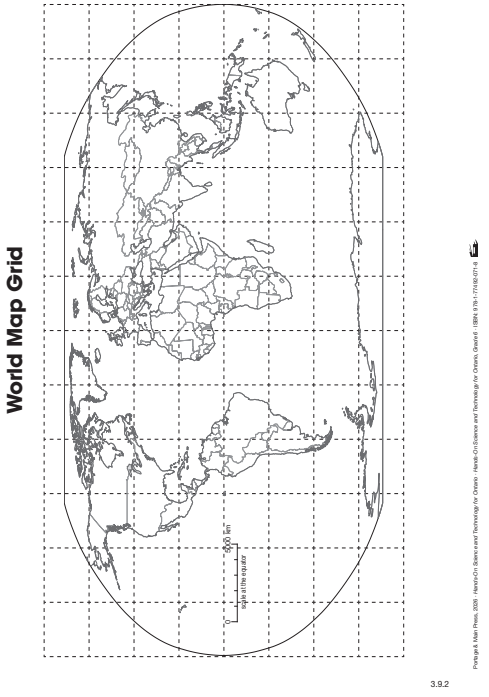
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- Code can be written and executed so instructions can be repeated over and over again (referred to as *repeating events* or *loops*).
- Code can be written and executed so that control structures (such as loops) can be placed inside other control structures (referred to as *nested events*).
- Code can be written and executed to include control structures that complete an action based on whether a condition is true or false (referred to as *conditional statements*).
- Code can be written more *efficiently* (using the fewest instructions possible).
- Making mistakes and figuring out how to fix them (*debugging*) is an important part of learning to code.
- Existing code can be altered to change the outcomes (referred to as *remixing code*).
- Code can be written and executed to model concepts by producing a variety of different outputs (what the program produces, such as sounds, lights, images, motion, and text).
- Code can be written and executed to store and process data for a variety of purposes.
- Code can be written and executed to model concepts based on data from various inputs—the information that tells a program what do to (e.g., user input with a keyboard or mouse, sensors such as cameras or microphones).
- *Pseudocode* is an informal way of expressing a program (a set of instructions for the computer) without having to follow any rules, and may include a combination of words, numbers, and symbols.

Coding concepts can be taught to students with or without the use of digital technology. ***Hands-On Science and Technology*** includes coding activities for both *plugged* and *unplugged* learning environments.

- *Plugged coding* uses the programming languages that a computer understands, therefore requiring the use of digital technology. A typical plugged coding activity for grade 6 is to connect a series of code blocks together, including conditional statements, to model scientific concepts in Scratch. For example, students may write a program that classifies living things based on user input.
- *Unplugged coding* introduces coding and programming through hands-on activities and games. A typical unplugged coding activity for grade 6 is to provide students with a labelled grid (letters along the x-axis and numbers along the y-axis), loose parts, a set of coding cards with directional arrows (including turns and loops), and If/Then/Else cards. Students use the cards to write a program that models real-world concepts (e.g., program an efficient flight path using data such as distance, wind speed and direction, cost of fuel, cost of over-flight permits, and air traffic on the World Map Grid on the next page). A labelled grid and a set of coding cards are provided on page 13. Print the labelled grid and the coding cards on 11 x 17 paper. A set of If/Then/Else cards are provided on page 14.

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Students can also describe their program using pseudocode, an informal way of expressing the steps in their program (a set of instructions for the computer) without having to follow any rules. Pseudocode is different from programming languages, which have very specific rules and formatting. Although there are no rules when writing pseudocode, computer programmers often follow some conventions when creating it. For students learning to express their own programs using pseudocode, the most important thing to note is that it should be easily understood by other people. For students in grade 6, pseudocode may include a combination of words, numbers, and symbols.

The following resources can be used to help introduce coding into your classroom:

- Canada Learning Code: <http://www.canadalearningcode.ca/>
- Code.org: <https://code.org/>
- Hello Ruby for educators: Love Letters for Computers: <https://www.helloruby.com/loveletters>

NOTE: Check with your board or school to learn which coding apps are available to you and are recommended for use in your classroom.

Unplugged Coding Kits

Prepare unplugged coding kits for students to use with the Coding Connections activities throughout ***Hands-On Science and Technology, Grade 6***. Unplugged coding kits are easy to make using common classroom materials. Include some of the following items in your kits:

- **Loose Parts:** In unplugged coding, students use loose parts as obstacles or goals. Consider including items such as coloured tiles or chips, two-sided counters, multicoloured linking cubes or centimetre cubes, LEGO pieces, game pawns and pieces, small toys, stickers, natural materials (e.g., pebbles, polished stones, shells, pine cones, wood chips), printable images related to the unit's theme, paper, pencils, crayons, markers, and scissors (so students can draw and cut out their own images). Be creative and use what is available.

  Printable Image Cards are included with lessons as needed. Students can also draw additional images on the Blank Cards (see page 13). Print the Blank Cards on 11 x 17 paper.
- **Grids:** Students use grids to design challenges and execute code. In the unplugged coding kits, consider including chart paper with gridlines, printable grids of various sizes, game boards with squares (e.g., checkers, chess), and hundreds charts. Create larger grids on tabletops or floors

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using masking tape. To create a foldable grid, paint or tape a grid onto a blanket, sheet, tablecloth, or drop cloth. Use sidewalk chalk or paint to create grids in outdoor learning spaces.

A Labelled Grid template is included (see page 13). Print the Labelled Grid template on 11 x 17 paper.

NOTE: The labelled grid uses letters (x-axis) and numbers (y-axis) to refer to specific locations on the grid. Students may initially need support to understand how the labels on the grid (e.g., A1) relate to locations on the grid. With practice, students will begin to understand how the labels make it easier to describe a location.

- **Coding Cards:** Students use coding cards to create algorithms (sequences of actions) that direct the movements of objects or people along the grid. Print the provided Coding Cards (see page 13) on 11 x 17 paper. Students can also draw their own coding cards. Ensure student cards include directional arrows (left, right, up, down), arrows with elbows for right turns and left turns, and stop and go cards (e.g., a red stop sign, a green go sign). As students become more familiar with coding, allow them to add cards to the deck. Ask them to explain their reasons for including the new cards. To help students organize their coding cards when initially creating sequences, provide 5 frames or 10 frames to use as a graphic organizer.

The Inquiry Approach to Science and Technology

As students explore science and technology concepts, they are encouraged to ask questions to guide their own learning. The inquiry approach is based on five components:

1. formulating questions
2. gathering and organizing information, evidence, or data
3. interpreting and analyzing information, evidence, or data
4. evaluating information, evidence, or data, and drawing conclusions
5. communicating findings

Using this approach, teachers facilitate the learning process. Students initiate questions; gather, organize, interpret, and analyze information; evaluate findings and draw conclusions; and communicate their learning. The process focuses on students' self-reflections as they ask questions, discover answers, and communicate their understanding.

An inquiry approach begins with more structured inquiry, moves to guided inquiry, and, finally, leads to open inquiry:

Structured Inquiry	■ The teacher provides the initial question and structures the procedures to answer it. ■ Students follow the procedures and draw conclusions to answer the question.
Guided Inquiry	■ The teacher provides the initial question. ■ Students are involved in designing ways to answer the question and communicate their findings.
Open Inquiry	■ Students formulate their own question(s), design and follow through with a developed procedure, and communicate their findings and results.

NOTE: According to Banchi and Bell (2008), open inquiry "requires the most scientific reasoning and greatest cognitive demand from students. … It is only appropriate to have students conducting open inquiries" when they have developed the necessary skills through "ample experience at the first three levels of inquiry" (p. 27). This requires careful observation and assessment by teachers to ensure that students are ready for open inquiry.

In an inquiry approach to science and technology, questions and ideas form the foundation of the teaching and learning process. The following quotation, included in the Ontario

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Literacy and Numeracy Secretariat's overview of inquiry-based learning, speaks clearly to this approach:

> While all students ask questions and express interests in world phenomena, it takes creative and responsive teaching to transform wonder into knowledge. To begin, inquiry works best in a classroom in which ideas are placed at the centre. Establishing a culture in which students are encouraged to express ideas but also to respectfully challenge and test one another's ideas is an important first step in the inquiry process. This spirit of inquiry is achieved by welcoming ideas and trusting that even the simplest questions can lead to something greater and not yet evident. Like any good growing system, these questions need time to germinate. Students' ideas can be expressed in many forms (questions, comments, diagrams, pictures, dance, etc.) and serve the important purpose of advancing student understanding of a topic. When the classroom culture is one that views ideas as improvable, students work hard to continuously improve the quality, coherence and utility of ideas—both individually and collectively. (Scardamalia, 2002, quoted in Ontario Literacy and Numeracy Secretariat, 2013, p. 4)

Cultural Connections

To acknowledge and celebrate the cultural diversity represented in Canadian schools, 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 students' diverse cultures by making connections to curricular expectations. It is also important to explore other cultures represented in the community and beyond to encourage intercultural understanding and harmony.

Throughout ***Hands-On Science and Technology***, suggestions are made for connecting science and technology topics to cultural explorations and activities.

Indigenous Perspectives and Knowledge

Indigenous Peoples are central to the Canadian context, and it is important to infuse Indigenous knowledge into the learning experiences of all students. The worldviews of Indigenous Peoples and their approaches and contributions to science are now being acknowledged and incorporated into science and technology education. The intentional integration of Indigenous knowledge in ***Hands-On Science and Technology*** helps to address the Calls to Action of the Truth and Reconciliation Commission of Canada (2015), particularly the calls to "integrate Indigenous knowledge and teaching methods into classrooms" (Action 62) and "build student capacity for intercultural understanding, empathy and mutual respect" (Action 63).

NOTE: The book *Braiding Sweetgrass for Young Adults: Indigenous Wisdom, Scientific Knowledge, and the Teachings of Plants* by Indigenous scientist Robin Wall Kimmerer (Zest Books, 2022) is an excellent resource for teachers and students. It focuses on how all living things provide us with gifts and lessons.

The traditional territories of Indigenous Peoples cover the entirety of what is now known as Ontario. It is important to recognize the diversity of Indigenous Peoples in Ontario and to focus on both the traditions and contemporary lives of the Indigenous communities in your area. Contact personnel in your school board—Indigenous education leads and consultants and Indigenous Education Councils—to find out what resources (e.g., people, books, videos) are available. Many such resources are featured in ***Hands-On Science and Technology***.

Indigenous Peoples have depended on and shared reciprocal relationships with the land since time immemorial. The environment—including geography, land and waters,

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vegetation, and climate—shapes their way of life. Since Indigenous Peoples observe the land and its inhabitants, the environment teaches them to survive and determines the methods they use to do so. The land continues to shape Indigenous Peoples' way of life today because of their ongoing, deep connection to it. Cultural practices, stories, languages, and knowledge originate from the land and water.

NOTE: When implementing land-based learning, opportunities abound to consider Indigenous knowledge and perspectives. (See page 21 for more information about land-based learning.) Outdoor learning provides an excellent opportunity to identify the importance of place. For example, use a map of the local area to have students identify the location of the land-based learning activity in relation to the school. This will help students develop a stronger image of their community and surrounding area.

It is also important to identify on whose traditional territory the school is located and where any land-based learning occurs, as well as the traditional names for these locations. The following sites provide maps of Ontario's First Nations that can be used for this purpose:

- Ontario First Nations Maps: <https://www.ontario.ca/page/ontario-first-nations-maps>
- Maps of Indigenous Communities in Ontario: <https://www.sac-isc.gc.ca/eng/1635957754306/1635957787562>
- First Nation Profiles Interactive Map: <https://geo.sac-isc.gc.ca/cippn-fnpim/index-eng.html>

In addition, the educator's guide *The First Nations and Treaties Map of Ontario as an Instructional Resource* offers maps and information for teachers; it is available at <http://www.edu.gov.on.ca/eng/indigenous/the-first-nations-and-treaties-map-of-ontario.pdf>.

Incorporate a land acknowledgment once students have learned whose territory the school and land-based learning location is on. The following example can be used for guidance:

- <location of school, e.g., city or town> *is located on the traditional territory of the _____ and is within the boundaries set by the_____ treaty_____.*

NOTE: Many Ontario school boards have established protocols for land acknowledgments. Check with Indigenous education leads and consultants in your board to see if there are specific protocols to follow.

When incorporating Indigenous perspectives in the classroom, it is important to value Traditional Ecological Knowledge:

> Traditional Ecological Knowledge, or TEK, is the most popular term to denote the vast local knowledge First Peoples have about the natural world found in their traditional environment. […] TEK is, above all, local knowledge based in people's relationship to place. It is also holistic, not subject to the segmentation of Western science. Knowledge about a specific plant may include understanding its life cycle, its spiritual connections, its relationship to the seasons and with other plants and animals in its ecosystem, as well as its uses and its stories. (First Nations Education Steering Committee and First Nations Schools Association, 2019, p. 13)

Indigenous Peoples developed technologies and survived on this land for millennia because of their knowledge of and reciprocal relationships with the land. Indigenous Peoples used observation and experimentation to refine technologies, such as building canoes and longhouses and discovering food-preservation techniques. Accordingly, TEK serves as an invaluable resource for science students and teachers.

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Indigenous Peoples do not view their knowledges as "science," as is reflected in this quote from the president of the Science Museum of Minnesota, Dr. Eric J. Jolly (Cherokee):

> When I weave a basket, I talk about the different dyes and how you make them and how the Oklahoma clay that we put on our baskets doesn't permeate the cell walls, it deposits on the outside. It makes a very nice dye but if you cut through the reed you'll see white still on the inside of the reed, whereas if I make a walnut dye and if I use as my mordent, alum and I use as my acid cider, that walnut dye will permeate the cell walls. You cut through the reed and it's brown through and through. Now what I've just described is the difference between osmosis and dialysis. That Western science calls those scientific terms is really wonderful, but it's not scientific terms if you are a basket weaver. Our culture incorporates so much of what people would call scientific knowledge and ways of thinking so naturally that we haven't parsed it out and put it in a book and said this is our science knowledge versus our weaver's knowledge. When I weave a basket I also tell the stories of the spirituality and not just the ways of which I dyed it. A basket weaver is as much a scientist, as an artist, and a spiritual teacher. We'd never think that you'd separate out just the science part, but you can't weave a basket without knowing the science. (Cited in Mack et al., 2012, pp. 50–51)

Throughout ***Hands-On Science and Technology***, there are many opportunities to incorporate culturally appropriate teaching methodologies from an Indigenous worldview. Making connections to the local community is essential to learning about Indigenous knowledge and ways of knowing. As one example, Elders and Knowledge Keepers offer a wealth of knowledge that can be shared with students. Consider inviting a local Elder or Knowledge Keeper as a guest into the classroom in connection with specific topics being studied (as identified within the given lessons throughout the unit). An Elder or Knowledge Keeper can guide a nature walk, share stories and experiences, describe traditional technologies, and help students understand Indigenous Peoples' perspectives of the natural world. Elders and Knowledge Keepers will provide guidance for learners and opportunities to build bridges between the school and the community.

NOTE: In ***Hands-On Science and Technology***, the term *Knowledge Keeper* refers to individuals who may or may not be recognized as Elders, but who carry the teachings of their community and can be called upon for that expertise. The term *Knowledge Holder* is used interchangeably with *Knowledge Keeper* in some communities (Government of Ontario, 2020–2023).

It is especially important to connect with Indigenous communities, Elders, and Knowledge Keepers in your local area, and to study local issues related to Indigenous Peoples in Ontario. Consider contacting the Indigenous education lead or consultant in your school board, your local Indigenous Education Council, or the Ontario Ministry of Education to access referrals. You may also consider contacting local Indigenous organizations for referrals to Elders and Knowledge Keepers. Such organizations may also be able to offer resources and opportunities for field trips and land-based learning.

Here are a few suggestions for working with Elders and Knowledge Keepers:

- Elders and Knowledge Keepers have a deep spirituality that influences every aspect of their lives and teachings. They are recognized because they have earned the respect of their community through wisdom, harmony, and balance in their actions and teachings (see Indigenous Corporate Training, 2019).

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- Some Indigenous keepers of knowledge are more comfortable being called "Knowledge Keepers" than "Elders." Be sensitive to their preference. In many communities, there are also "Junior Elders" who may also be invited to share their knowledge with students and school staff.
- Elders and Knowledge Keepers may wish to speak about what seems appropriate to them, instead of being directed to talk about something specific. It is important to respect this choice and not be directive about what an Elder or Knowledge Keeper will talk about during their visit.
- It is important to properly acknowledge any visiting Elders or Knowledge Keepers and their knowledge, as they have traditionally been and are recognized within Indigenous communities as highly esteemed individuals.

NOTE: It is important to understand the significant contribution that Elders, Knowledge Keepers, and Indigenous communities make when they share their traditional knowledge. In their culture of reciprocity, this understanding should extend past giving a gift or honorarium to an Elder or Knowledge Keeper for sharing knowledge. Think deeply about reciprocity and how you can go beyond inviting Indigenous guests to your classroom. Expand your own learning and become connected to Indigenous people by, for example, engaging in Indigenous community events, working with the education department of the local Nations, or exploring ways to continue developing the relationship between the local Nations and teachers in your board.

NOTE: Indigenous resources recommended in ***Hands-On Science and Technology*** are considered to be authentic resources, meaning that they reference the Indigenous community they came from, they state the individual who shared the story and gave permission for the story to be used publicly, and the person who originally shared the story is Indigenous. Stories that are works of fiction were written by an Indigenous author; for stories with more than one author, at least one of the authors is Indigenous. For more information, see the First Nations Education Steering Committee's *Authentic First Peoples Resources* guides at <http://www.fnesc.ca/authenticresources/>.

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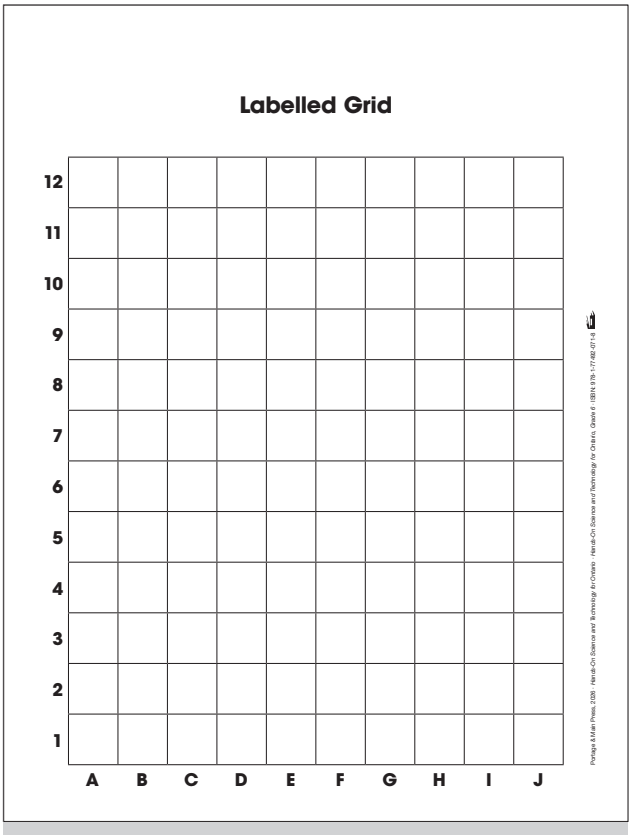
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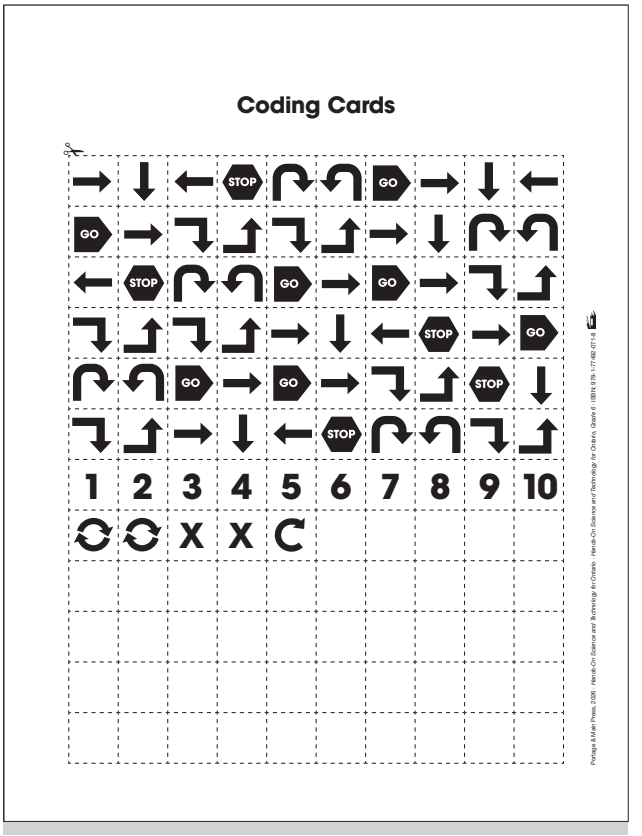
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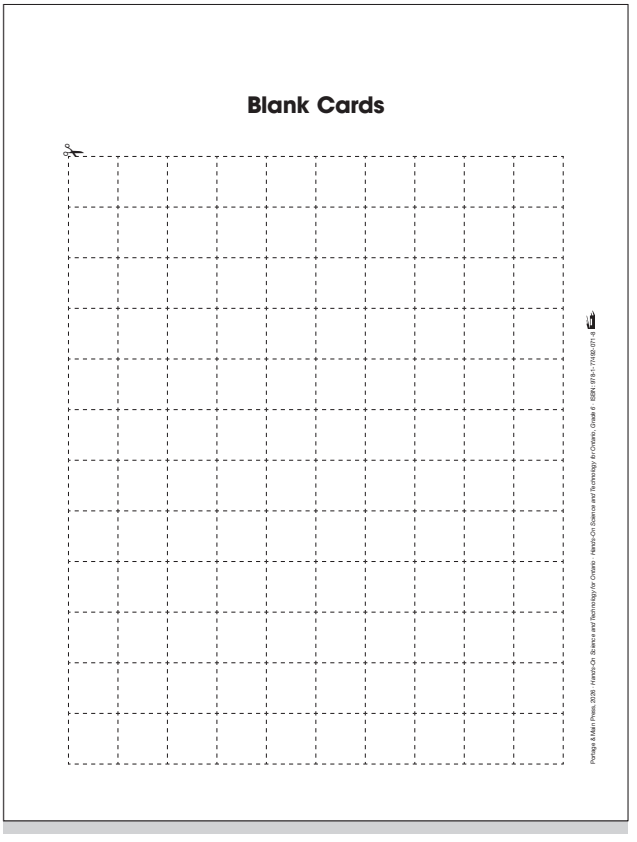
Labelled Grid



Coding Cards



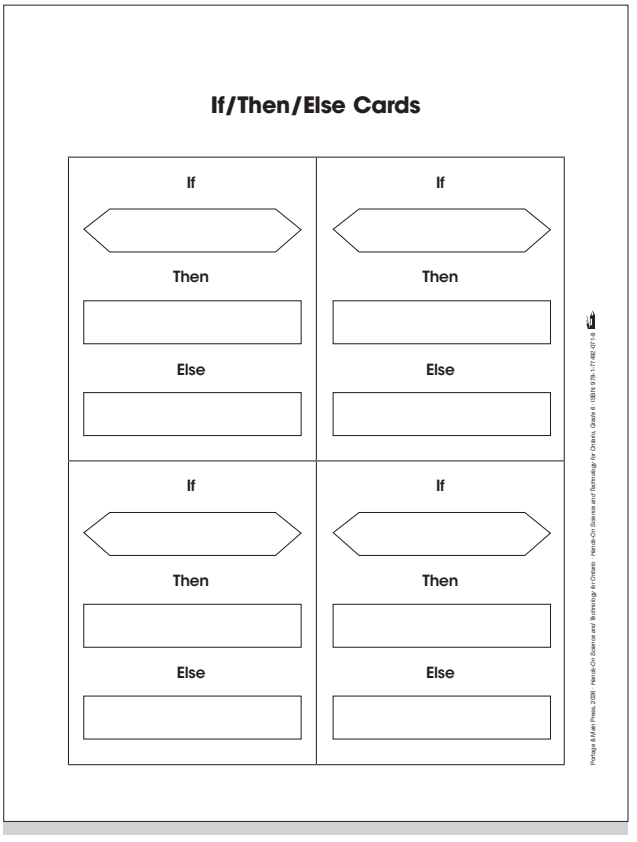
Blank Cards



NOTE: Print these templates on 11 x 17 paper.

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If/Then/Else Cards



If/Then/Else Cards

If
Then
Else

If
Then
Else

If
Then
Else

If
Then
Else

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How to Use *Hands-On Science and Technology* in Your Classroom

Unit Overview

Hands-On Science and Technology for Ontario is organized in a format that makes it easy to plan and implement. The book opens with an introduction (which includes assessment reproducibles) and is divided into four units that cover the selected topics of study for the grade level:

- Life Systems: Biodiversity
- Matter and Energy: Electrical Phenomena, Energy, and Devices
- Structures and Mechanisms: Flight
- Earth and Space Systems: Space

The units relate directly to the strands, expectations, fundamental concepts, and big ideas outlined in *The Ontario Curriculum, Grades 1–8: Science and Technology* (2022) document. Each unit opens with About This Unit, an introduction to the unit that summarizes the general goals for the unit. It provides background information for teachers, planning tips, and lists of vocabulary related to the unit, as well as other pertinent information such as how to embed Indigenous perspectives into student learning.

Additionally, About This Unit includes lists of related resources (books and online videos), annotated websites suitable for students, and coding and STEM resources.

Each unit is organized into numbered lessons composed of topics and activities based on the overall and specific expectations. Lessons are arranged in the following format:

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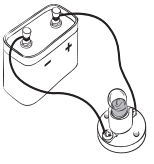
Lesson Title
- posed as a guided inquiry question related to the expectations addressed in the lesson

Information for Teachers
- provides basic scientific and technological knowledge needed for the activities

5 How Do Electric Circuits Work?

Information for Teachers

An *electric circuit* is a complete path through which electricity flows. Below, a dry-cell battery (the source of electricity), a socket and bulb, and the connecting wires form the complete path or circuit through which an electrical current flows.



SAFETY NOTE: Supervise students closely for all activities that involve electricity. Instruct students to never hook a wire to the two poles on a cell without also attaching a device to draw power (e.g., bulb and socket, doorbell, motor). If no device is drawing power, the wire can heat up and melt.

Materials
- 6 or 9 volt dry-cell batteries
- insulated copper wire
- miniature light bulbs and sockets
- scrap paper
- small screwdrivers
- chart paper
- markers
- student dictionaries
- Video Viewing Guide (2.5.1) (two copies for each student)
- sticky notes
- herringbone chart (from lesson 1)
- Science and Technology Glossary (1.1.1)

Activate

Organize the class into working groups, and provide each group with a 6 or 9 volt dry-cell battery, two pieces of insulated copper wire, a miniature light bulb and socket, a small screwdriver, and scrap paper. Challenge students to use the materials provided to make the bulb light up. Give groups plenty of time to discuss the challenge and write down their ideas and plans before they use the equipment. Planning should be verbal, collaborative, and written.

Once groups have discussed and recorded their plans, have them put the plans into action by experimenting with the materials.

Following the activity, discuss the investigation. Ask:
- How did you make the bulb light up?
- What did you learn about wiring a light bulb to a dry-cell battery?

Batteries and circuits are fun, so provide ample time for students to play and explore.

Introduce the guided inquiry question: **How do electric circuits work?**

Action: Part One

In their groups, have students examine the dry-cell batteries. Focus on the positive and negative poles of each battery. Ask:
- What do the positive (+) and negative (–) symbols on the battery mean?
- Do you think the bulb would light up if both wires were connected to the positive pole?
- Do you think the bulb would light up if both wires were connected to the negative pole?

Have groups test their predictions and discuss results. Stress that the wires must be connected to both poles to make the bulb light up.

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Activate
- activates prior knowledge, piques students' curiosity about related concepts, and introduces the lesson's guided inquiry question
- teachers may choose to record the guided inquiry question for display (e.g., on a sentence strip) so students can refer to it during activities and discussion

Action
- details a step-by-step procedure, including higher-level questioning techniques, and suggestions for encouraging the development of new knowledge and skills
- identified as Action: Part One, Action: Part Two, and so on (when there is more than one Action activity in a lesson)

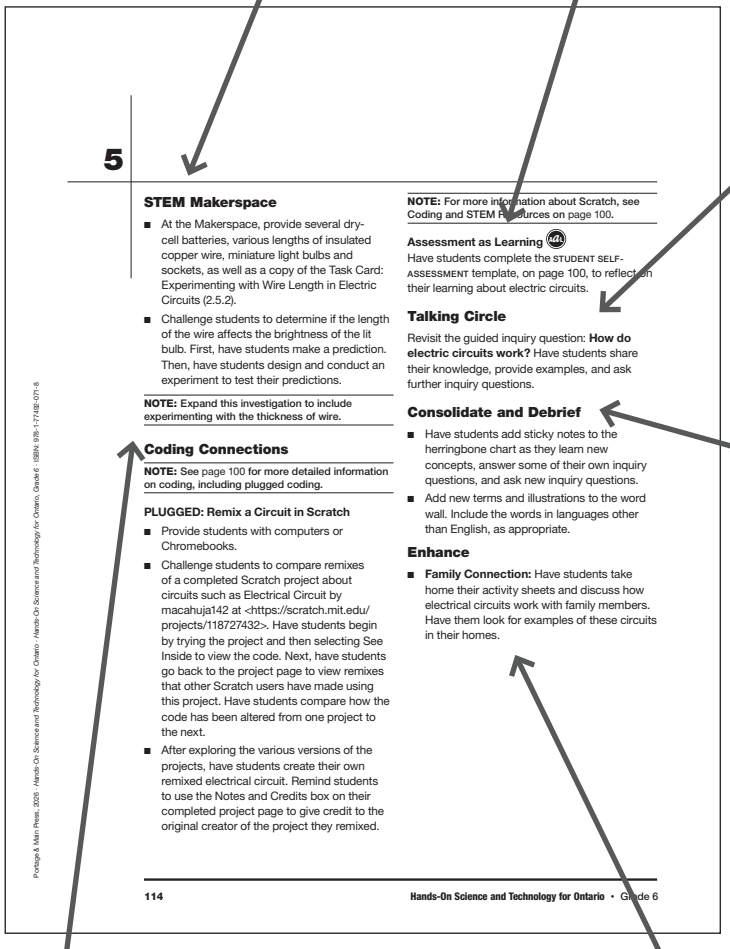
Materials
- lists all materials required to conduct the main activities
- includes items for display purposes or for recording students' ideas
- suggests visual materials (e.g., large pictures, sample charts, diagrams) to assist in presenting ideas and questions and to encourage discussion
- connects to Image Bank visuals, which may be printed or projected for specific activities (see Appendix on page 319 for thumbnails and free access)

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STEM Makerspace
- addresses STEM concepts and skills and promotes personalized learning, open inquiry, discovery, creation, and innovation related to the unit expectations
- suggests materials, equipment, and challenges related to the specific science and technology topics of study, while correlating with other subject areas

Assessment for, as, and of Learning
- provides suggestions for authentic assessment, which includes assessment *for* learning, assessment *as* learning, and assessment *of* learning
- focuses on the specific expectations related to the particular lesson (assessment strategies are outlined in the ***Hands-On Science and Technology*** Assessment Plan on page 31)



5

STEM Makerspace
- At the Makerspace, provide several dry-cell batteries, various lengths of insulated copper wire, miniature light bulbs and sockets, as well as a copy of the Task Card: Experimenting with Wire Length in Electric Circuits (2.5.2).
- Challenge students to determine if the length of the wire affects the brightness of the lit bulb. First, have students make a prediction. Then, have students design and conduct an experiment to test their predictions.

NOTE: Expand this investigation to include experimenting with the thickness of wire.

Coding Connections

NOTE: See page 100 for more detailed information on coding, including plugged coding.

PLUGGED: Remix a Circuit in Scratch
- Provide students with computers or Chromebooks.
- Challenge students to compare remixes of a completed Scratch project about circuits such as Electrical Circuit by macahuja142 at <https://scratch.mit.edu/projects/118727432>. Have students begin by trying the project and then selecting See Inside to view the code. Next, have students go back to the project page to view remixes that other Scratch users have made using this project. Have students compare how the code has been altered from one project to the next.
- After exploring the various versions of the projects, have students create their own remixed electrical circuit. Remind students to use the Notes and Credits box on their completed project page to give credit to the original creator of the project they remixed.

NOTE: For more information about Scratch, see Coding and STEM Resources on page 100.

Assessment as Learning AAL
Have students complete the STUDENT SELF-ASSESSMENT template, on page 100, to reflect on their learning about electric circuits.

Talking Circle

Revisit the guided inquiry question: **How do electric circuits work?** Have students share their knowledge, provide examples, and ask further inquiry questions.

Consolidate and Debrief
- Have students add sticky notes to the herringbone chart as they learn new concepts, answer some of their own inquiry questions, and ask new inquiry questions.
- Add new terms and illustrations to the word wall. Include the words in languages other than English, as appropriate.

Enhance
- **Family Connection:** Have students take home their activity sheets and discuss how electrical circuits work with family members. Have them look for examples of these circuits in their homes.

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Talking Circles
- provides students with opportunities to participate in a Talking Circle (see page 19 for more information) to demonstrate their learning through consolidation and to debrief on guided inquiry questions

Consolidate and Debrief
- suggests activities that review the main ideas of the lesson, focusing on fundamental concepts, big ideas, and overall and specific expectations
- offers ways for students to demonstrate what they have learned through consolidation and reflection, allowing for synthesis and application of inquiry and new ideas
- embeds learning by adding to graphic organizers; having students record, describe, and illustrate new vocabulary and communicate investigations and ideas in a science and technology glossary; and adding new science and technology vocabulary to the classroom word wall
- provides opportunities to reflect the cultural diversity of the classroom and the community by including new terminology in languages other than English, including Indigenous languages

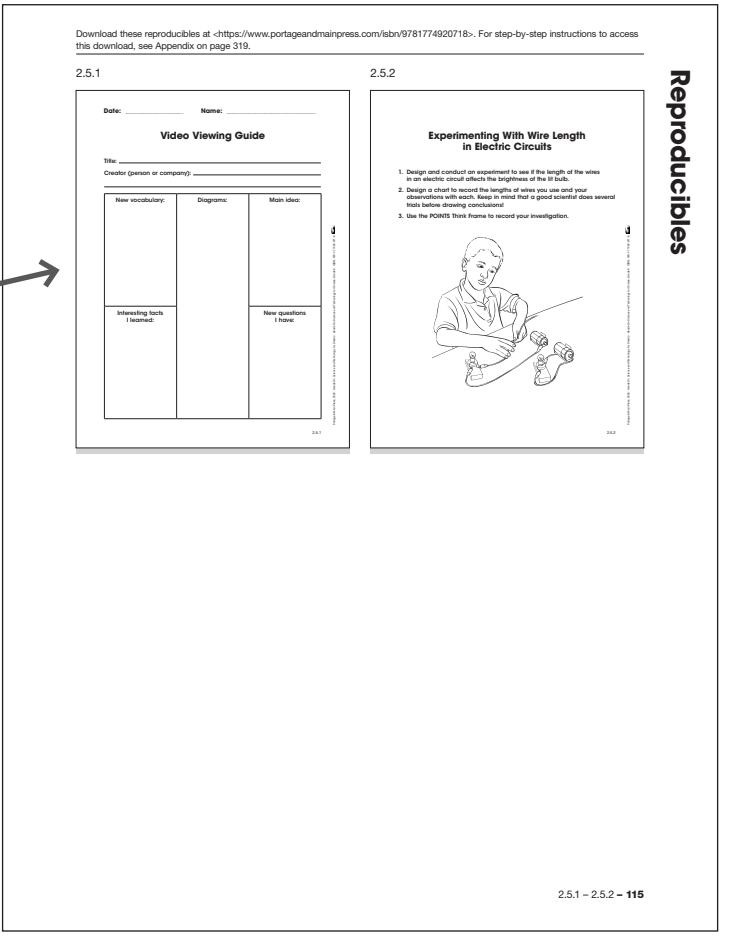
Coding Connections
- provides suggestions for plugged and unplugged coding activities; see page 5 for an explanation of plugged and unplugged coding

Enhance
- encourages active participation and learning through Family Connections, tasks that students complete at home with their family members, then bring back to school to share
- suggests additional optional activities to extend, enrich, and reinforce the expectations

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Reproducibles
- are included as thumbnails following the lesson
- may be used to guide activities or record data
- may also serve as a template for designing and constructing graphic organizers
- can be downloaded by going to the Portage & Main Press website at <https://www.portageandmainpress.com/isbn/9781774920718>. Use the password SPACE6 for access.


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2.5.1

Date: _____ Name: _____

Video Viewing Guide

Title: _____

Creator (person or company): _____

New vocabulary:	Diagrams:	Main idea:
Interesting facts I learned:		New questions I have:

2.5.2

Experimenting With Wire Length in Electric Circuits

1. Design and conduct an experiment to see if the length of the wires in an electric circuit affects the brightness of the lit bulb.
2. Design a chart to record the lengths of wires you use and your observations with each. Keep in mind that a good scientist does several trials before drawing conclusions!
3. Use the POINTS Think frame to record your investigation.

Reproducibles

2.5.1 – 2.5.2 – **115**

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 and technology lesson in itself or the sole assessment for the lesson.

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Talking Circles

Each lesson encourages the class to participate in a Talking Circle to consolidate learning and debrief on guided inquiry questions. Talking Circles originated with First Nations leaders as a process to encourage dialogue, respect, and the co-construction of ideas. The following process is generally used in a Talking Circle:

- the group forms a complete circle
- one person holds an object such as a stick, feather, shell, or stone
- only the person holding the stick talks, while others listen
- the stick is passed around in a clockwise direction
- each person talks until they are finished, being respectful of time
- the Talking Circle is complete when everyone has had a chance to speak
- a person may pass the stick without speaking if they choose (for more information, see First Nations Pedagogy Online, "Talking Circles," at <www.firstnationspedagogy.ca/circletalks.html>)

Consider inviting a local Elder or Knowledge Keeper to share with the class the process of a Talking Circle.

STEM Makerspaces

To address STEM concepts and skills and promote personalized learning, each unit of ***Hands-On Science and Technology*** includes a variety of suggestions for STEM Makerspace materials, equipment, and challenges related to the specific science and technology topics of study, while correlating with other subject areas. Suggested materials and challenges are intended to support open inquiry, discovery, creation, and innovation related to the unit expectations.

A Makerspace is a creative do-it-yourself environment, where students pose questions, share ideas, and explore hands-on projects. In the school setting, a STEM Makerspace is usually cross-curricular and allows for inquiry, discovery, and innovation. Sometimes, the STEM Makerspace is housed in a common area, such as the library, which means it can be used by the whole school community. A classroom STEM Makerspace is usually designed as a centre where students use knowledge, concepts, and skills acquired in a particular lesson and apply them to STEM challenges. Students often create do-it-yourself projects, learning together and collaborating on cross-curricular ideas or classroom themes. It is important to remember that learning is not directed here. Rather, the goal is simply to create conditions for learning to happen and give students the opportunity to work with a variety of age-appropriate tools. The centre may evolve to foster inquiry within a specific topic.

There is no list of required equipment that defines a STEM Makerspace; however, there are some items that should be included such as paper, cardboard, everyday recycled materials, tape, and glue. You may wish to include reusable building materials such as interlocking plastic building blocks, snap cubes, pattern blocks, and straws and connectors. Additionally, arts-and-crafts materials such as construction paper, modelling clay, fabric, buttons, and pipe cleaners are often integrated into Makerspace offerings.

Consider the following when planning and developing a STEM Makerspace centre:

- Always address safety concerns, ensuring materials, equipment, and tools are safe for student use. Include safety gloves and goggles, as appropriate.

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- Consider space and storage needs. Mobile carts and/or bins are handy for storing raw materials and tools.
- Work with students to write a letter to parents/guardians to explain the purpose of the Makerspace and ask for donations of materials.

The following resources provide information about including STEM in the classroom:

- Ontario Science Centre STEM Education Toolkit: <https://www.ontariosciencecentre.ca/teachers-plus-students/teacher-resources/stem-education-toolkit>
- Ontario Council for Technology Education: <https://octe.ca/resources/elementary>
- Let's Talk Science: <https://letstalkscience.ca/>

Classroom Environment

The classroom setting is an important component of the learning process. An effective classroom environment is inclusive of the diverse backgrounds and learning needs of all students. The strengths students bring to school are identified and nurtured. At the same time, every student is supported so they can succeed. The classroom must also be a space that encourages inquiry and discussion. The following are suggestions that can be used to promote inquiry in the classroom:

- Encourage students to ask questions and to appreciate different perspectives.
- Foster a nonthreatening atmosphere in which all students are comfortable sharing.
- Provide lots of opportunities for students to reflect on questions, share ideas, and generate further questions for inquiry.
- Promote discussion with and between students, as they need to talk about ideas with each other and with the teacher to help make meaning.
- Model for students how to gather the information they need so they have an adequate foundation for discussion.
- Ensure questions are clear and vocabulary is appropriate to learners.
- Avoid dominating discussion.
- Provide equal opportunities for all learners to participate.
- Model good questions and questioning strategies.
- Guide students in discovering answers to questions.

An active environment—one that gently hums with students' purposeful conversations and activities—indicates that meaningful learning is taking place. When your class is studying a specific topic, display related objects and materials in the room, including student work; pictures and posters, maps, graphs, and charts made during activities; and anchor charts of important concepts, procedures, skills, or strategies that are co-constructed with students. Visuals serve as a source of information, reinforce concepts and skills that have been stressed during lesson activities, and support students who are visual learners. As a support throughout the unit, display charts outlining success criteria so that vocabulary and concepts are visible to students at all times.

Planning Units

Timelines

No two groups of students explore topics and materials at the same rate, and so planning the duration of lessons and units is an important responsibility of the teacher. In some cases, students will not complete a lesson's activities during one block of time. In addition, students may be especially interested in one topic and want to expand on it. Consider the individual needs of your class; there are no strict timelines for ***Hands-On Science and Technology***.

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It is important, however, to spend time on every unit in the book so that students focus on all the curriculum expectations established for this grade level.

Classroom Management

Hands-On Science and Technology provides students with many opportunities to participate in hands-on activities; they will benefit more from this type of primary experience than if you merely demonstrate the activities. Although hands-on activities are emphasized throughout this book, how these experiences are managed is up to the teacher, since it is you who ultimately determines how your students function best in the learning environment. In some cases, you may have all students manipulating materials individually; in others, you may choose to organize the class into small groups.

Organizing the class into small working groups of three or four students is the most productive and beneficial way to manage the activities. Group work encourages the development of social skills, enables all students to be active in the learning process, and can reduce the cost of materials and equipment. Students learn from their classmates while working in collaborative groups.

When your class is working in collaborative groups, it may be helpful to assign each student a role, as follows:

- **leader**: makes sure everyone in the group has an opportunity to share their ideas and opinions
- **recorder**: records the group's data, research, questions, and any other information on the lesson's sheets or charts
- **reporter**: reports the group's ideas, findings, or answers back to the class
- **materials manager**: collects and returns all materials needed for each activity

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.

Classroom Safety

The nature of science and technology, and of scientific and technological experimentation, means that safety concerns do arise from time to time. In these instances, teachers may decide to demonstrate an activity themselves, while still encouraging as much student interaction as possible. Throughout ***Hands-On Science and Technology***, whenever there is a potential safety issue to be aware of, the following safety icon appears:



Land-Based Learning

Land-based learning replaces the classroom walls with the natural environment. Land-based learning offers all students first-hand opportunities to observe, explore, and investigate the land, waters, and atmosphere of the natural world. Land-based learning promotes a healthy interplay between society and nature and helps students envision a world where there is meaningful appreciation and respect for our natural environment—an environment that sustains all life forms. Many lessons in ***Hands-On Science and Technology*** incorporate land-based learning activities, ranging from a casual walk around the neighbourhood to examine trees to a more involved exploration of local waterways. When land-based learning connections are made in ***Hands-On Science and Technology***, the following icon appears:



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Scientific and Engineering Design Processes

Scientific Inquiry Skills: Guidelines for Teachers

Hands-On Science and Technology is based on a scientific inquiry approach. While involved in the lessons, students use a variety of inquiry skills as they answer questions, solve problems, and make decisions. These skills are not unique to science and technology, but are integral to students' acquisition of scientific and technological literacy. They include initiating and planning, performing and recording, analyzing and interpreting, and communicating and working in teams. At the grade 6 level, basic skills should focus on scientific inquiry and problem solving.

Use the following guidelines to encourage students' development of inquiry skills in specific areas.

Observing

Students learn to perceive characteristics and changes using all five senses. Encourage students to safely use sight, smell, touch, hearing, and taste to gain information about objects and events. Observations may be qualitative (e.g., texture, colour), quantitative (e.g., size, number), or both.

Observing includes:

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

Encourage students to communicate their observations in a variety of ways, including orally, in writing, by sketching labelled diagrams, and by capturing evidence digitally (e.g., using a camera or tablet).

Questioning

Generating thoughtful inquiry questions is an essential skill for students when participating in inquiry-based learning. Encourage students to be curious and to extend their questions beyond those posed to them.

Students should learn to formulate specific questions to investigate, then create, from a variety of possible methods, a plan to find answers to those questions.

Exploring

Students need ample opportunities to manipulate materials and equipment in order to discover and learn new ideas and concepts. During exploration, encourage students 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. At a deeper level, discussion allows students to make meaning by discussing inconsistencies/misconceptions and comparing/contrasting their observations with others. This is the constructivist model of learning, which is essential in inquiry-based learning.

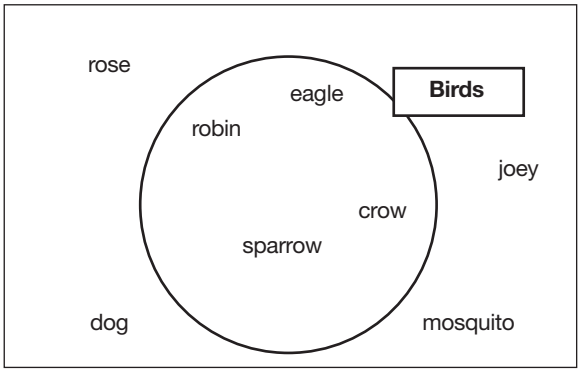
Classifying

Classification is used to group or sort objects and events and is based on observable properties. For example, objects can be classified into groups according to colour, shape, or size. Two strategies for sorting are the use of sorting mats and Venn diagrams. Sorting mats show distinct groups, while Venn diagrams intersect to show similar characteristics among sets.

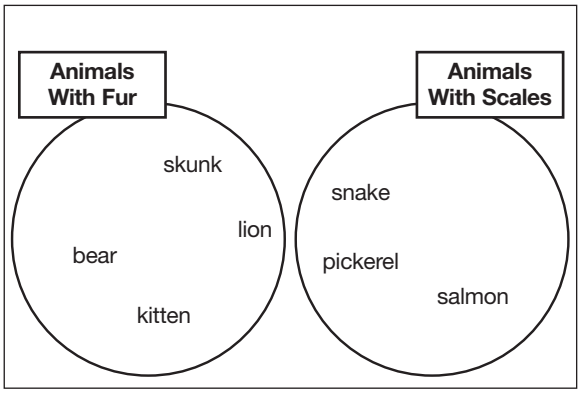
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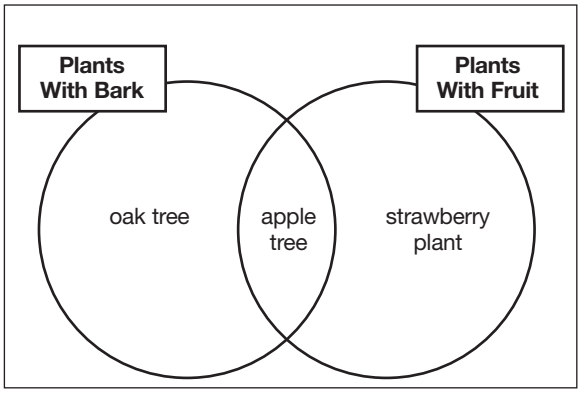
Single Sorting Mat



Double Sorting Mat



Double Venn



Measuring

Measuring is the process of discovering the dimensions or quantity of objects or events and, at the grade 6 level, usually involves comparing, ordering, and measuring objects by length, area, volume, and mass. By grade 6, students will measure the passage of time using seconds, minutes, and hours, and use protractors to measure angles in degrees.

An essential skill of measurement is estimating. Encourage students to estimate before they measure, whether in nonstandard or standard units. Estimation provides opportunities for students to take risks, use prior knowledge, and enhance their measuring skills by comparing estimates and actual results.

Communicating, Analyzing, and Interpreting

In science and technology, communication is achieved through diagrams, graphs, charts, maps, models, and symbols, as well as written and spoken language. Communicating includes:

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

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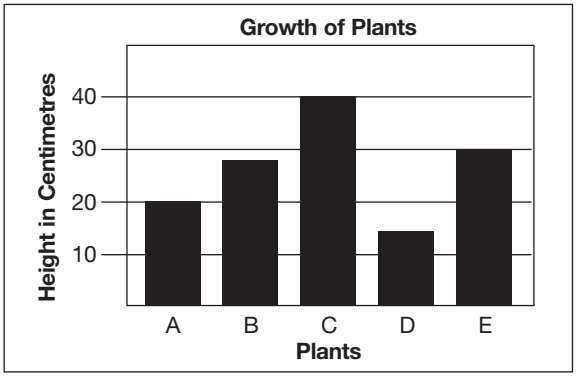
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When presenting students with charts and graphs, or when students make their own charts and graphs as part of a specific activity, the following guidelines should be followed:

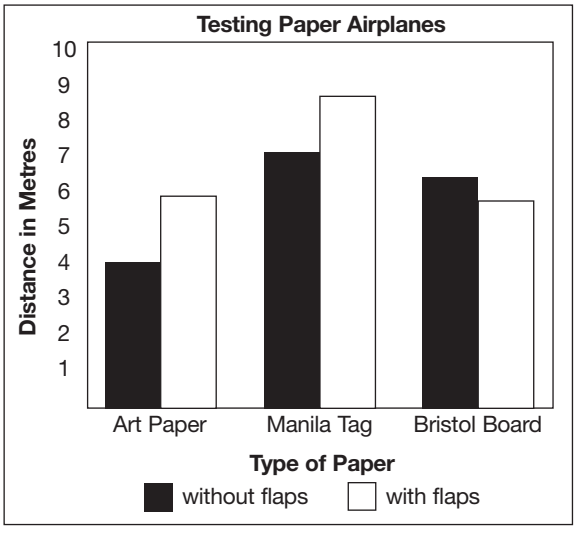
- A **pictograph** has a title and information on one axis that denotes the items being compared. (Note that the first letter of each word of both the title and the axis text is capitalized.) There is generally no graduated scale or heading for the axis representing numerical values.

Favourite Dessert				
				
				
				
				
Cake	Pie	Ice Cream		

- A **bar graph** is another common form of scientific communication that students use in grade 6. 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 labelled and capitalized 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.



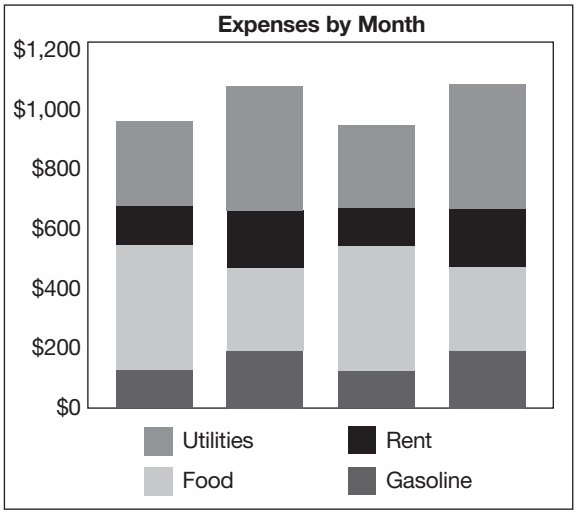
- A **double bar graph** can also be used to communicate scientific results. This type of graph is commonly used when comparing similar attributes in different objects. For example, an investigation into flight may have students constructing model airplanes with and without flaps, from different types of paper. The resulting double bar graph may look as follows:



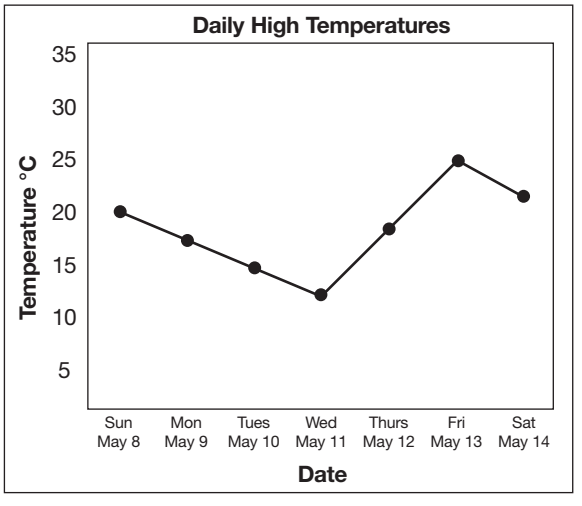
- **Stacked-bar graphs** display the data values proportionally. Stacked-bar graphs can be used to display percent or relative frequency. Each bar in the graph represents a whole, and each of the segments in a bar represents a different category. Different colours are

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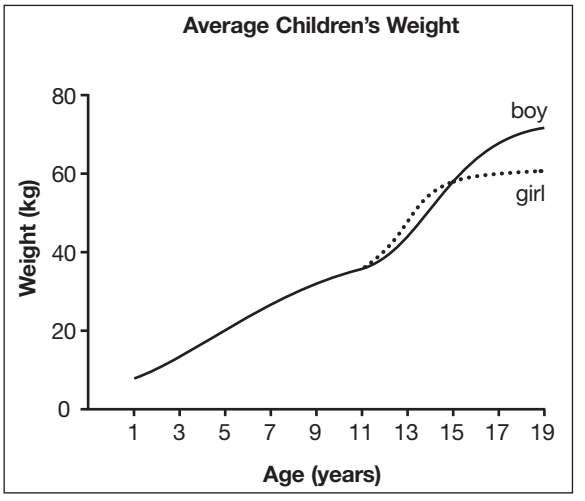
used within each bar to easily distinguish between categories. The example below demonstrates how bars are stacked.



- A **broken line graph** communicates data measured over a period of time. For example, a broken line graph may be used to present daily outdoor temperature highs over a period of one week.



- A **continuous line graph** shows trends in data over time using an unbroken line in which both axes represent continuous quantities. The slope of the line tells the reader at a glance the direction of the trends.



- A **stem-and-leaf plot** displays data that is organized by place value. The plot clearly shows the greatest, least, and median values in a set of data. The following stem-and-leaf plot shows books read over the summer by 10 students with these results: 6, 7, 10, 12, 12, 15, 19, 21, 23, 25.

Stem	Leaf
0	6 7
1	0 2 2 5 9
2	1 3 5

- A **chart (table)** has an appropriate title, and both columns and rows need specific headings. (Note that the first letter of each word in all titles and headings is capitalized.) In some cases, pictures can be used alongside or in place of words 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.

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Checklist Chart

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

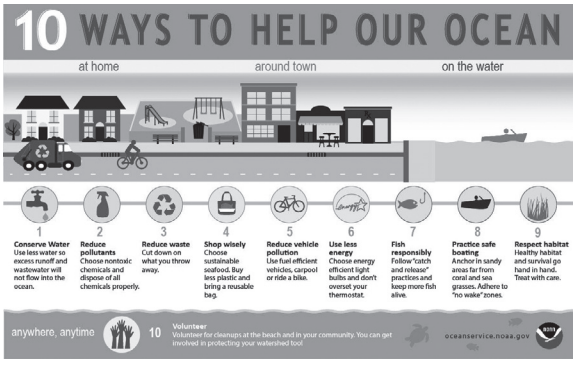
Data Chart

Local Snowfall		
Month	**2023/2024 Snowfall (cm)**	**Average Snowfall (cm)**
October	7	5
November	9	8
December	23	20
January	29	25
February	16	18
March	11	10

- A **frequency table** is a means of recording the frequency of occurrence. A tally chart is one type of frequency table commonly used in grade 6. In this kind of chart, data is recorded as an organized count. The count is grouped in fives so the total can be easily determined by counting by fives.

Favourite Sport		
Sport	**Tally**	**Total**
baseball	𝍸 |	6
hockey	𝍸 𝍸	10
soccer	𝍸 𝍸 ||	12

- In grade 6, students also learn to make **infographics** to display data in various ways, such as using tables, plots, graphs, and images. For example:



"Print" by Flickr User NOAA's National Ocean Service. Used under Public Domain licence.

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.

NOTE: Teachers are encouraged to look for connections to Indigenous perspectives and knowledge whenever possible. For example, similar to a balloon, in many Indigenous cultures, fish stomachs and sealskins were traditionally used as flotation devices. The scientific concept is the same.

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 in a basin of water. Again, it is important to encourage students to take risks when making inferences. Instead of explaining scientific phenomena to them, give students opportunities to infer for themselves using a variety of perspectives, and then build their knowledge base through inquiry and investigation.

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Inquiry Through Investigation and Experimentation

When investigations and experiments are conducted in the classroom, it is essential to plan and record both the process and the results. The traditional scientific method uses the following format:

- 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

This method of recording results is appropriate at the grade 6 level. However, in some cases, it may be more appropriate to focus on a narrative style of reporting that includes the following:

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

A simpler four-question narrative that includes the following questions may also be used with any age group.

1. What was I looking for? (Describe the question you were trying to answer or the hypothesis/prediction you were testing.)
2. How did I look for it? (Tell what you did. Include materials and method.)
3. What did I find? (Describe observations and data.)
4. What does this mean? (Draw conclusions and consider applications to real life.)

This narrative may be completed in a variety of ways: oral discussion as a class, recording findings as a class, having students use drawings and writing to communicate independently, or a combination of these.

Throughout ***Hands-On Science and Technology***, a variety of methods are used to encourage students to communicate the inquiry process, including those listed above. Formats such as concept maps and other graphic organizers are also used.

Engineering Design Process

Throughout ***Hands-On Science and Technology***, students have opportunities to use technological problem-solving skills to design and construct objects. For example, in unit 2, lesson 9, students can design and construct an electrical device to perform a useful function.

The engineering design process involves having students seek solutions to practical problems. The process includes the following steps:

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 or prototype**. 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 engineering design process also involves research and experimentation.

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



Inquiry Through Research

In addition to hands-on inquiry, research is another aspect of inquiry that involves finding, organizing, and presenting information related to a specific topic or question. Even at a young age, students can begin to research topics studied in class if they are provided with support and guidelines. This is also an effective way to integrate oral communication, reading, writing, and media literacy expectations from the Ontario language curriculum for grades 1–8 (2023).

Guided research is a teaching and learning strategy that is encouraged throughout ***Hands-On Science and Technology***. Guided research provides an opportunity for students to seek further information about subjects of inquiry, personal interests, or topics of their choice. Accordingly, students are empowered and engaged in the process. Guided research encourages students and teachers to do the following:

Students	Teachers
■ 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	■ provide opportunities for students to ask questions of personal interest ■ provide access 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 and Technology***, the approach to scientific inquiry and research is one of gradual release, where 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 and Technology***.

Online Considerations

As our technological world continues to expand at an accelerating rate and information is increasingly available online, students will turn to the internet more and more. Accordingly, ***Hands-On Science and Technology*** is replete with opportunities for students to use online resources for research and investigation. Discuss online safety protocols with students and be vigilant in supervising their internet use. Review websites and bookmark those that are appropriate for student use.

Discuss plagiarism with students; explain that copying information word for word—from a book, the internet, AI online sources, or any other resource—is wrong. Such information should usually be paraphrased in the student's own words (sometimes including short direct quotations marked as such), and the source of the information cited. Photos, drawings, figures, and other images found online should also only be used with permission and citation of the source. Alternatively, students can source images for which permission has already been granted for use, such as through Creative Commons Canada, a nonprofit organization that "promotes and enables the sharing of knowledge and creativity…[and] produces and maintains a free suite of licensing tools to allow anyone to easily share, reuse, and remix materials with a fair 'some rights reserved' approach to copyright." See <http://ca.creativecommons.org>.

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Addressing Students' Literacy Needs

The inquiry process involves having students ask questions and conduct investigations and research to answer these questions. At the grade 6 level, students may benefit from support for research, reading, and writing. Consider having volunteers, student mentors, or educational assistants help students during these processes. In some cases, such helpers may also scribe for students to communicate their findings.

References

Creative Commons Canada. http://ca.creativecommons.org.

Ontario Ministry of Education. *The Ontario Curriculum, Grades 1–8: Language,* 2023. https://www.dcp.edu.gov.on.ca/en/curriculum/elementary-language/downloads.

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The *Hands-On Science and Technology* Assessment Plan

Hands-On Science and Technology provides a variety of assessment tools that enable teachers to build a comprehensive and authentic daily assessment plan for students. Based on research about the value of quality classroom assessment (Davies, 2020), lessons include suggestions for authentic assessment, which includes assessment *for* learning, assessment *as* learning, and assessment *of* learning.

Ontario's policy on assessment is outlined in the document *Growing Success: Assessment, Evaluation, and Reporting in Ontario Schools* (2010). The document describes the roles of teachers and students in the learning and assessment process:

> In a traditional assessment paradigm, the teacher is perceived as the active agent in the process, determining goals and criteria for successful achievement, delivering instruction, and evaluating student achievement at the end of a period of learning. The use of assessment for the purpose of improving learning and helping students become independent learners requires a culture in which student and teacher learn together in a collaborative relationship, each playing an active role in setting learning goals, developing success criteria, giving and receiving feedback, monitoring progress, and adjusting learning strategies. The teacher acts as a "lead learner," providing support while gradually releasing more and more responsibility to the student, as the student develops the knowledge and skills needed to become an independent learner. (p. 30)

Hands-On Science and Technology supports Ontario's *Growing Success* policy by focusing assessment suggestions on the learning process during performance-based activities. Although many of the suggestions involve student writing, there are no tests or quizzes included with the units. This is because each lesson includes such a wide variety of suggested activities for teachers to choose from that tests and quizzes could not possibly reflect the specific tasks in which students participated. Since assessment needs to be directly connected to learning, ***Hands-On Science and Technology*** suggests assessment strategies that can be used in a variety of ways, and that can be modified for use with individual students or groups of students.

The primary purpose of assessment is to improve student learning. Assessment *for* learning provides students with descriptive feedback and coaching for improvement. Assessment *as* learning helps students self-assess by developing their capacity to set their own goals, monitor their own progress, determine next steps, and reflect on their learning. Assessment *of* learning is summative in nature and is conducted by teachers to identify student progress in relation to learning expectations. The challenge for teachers is to integrate assessment seamlessly with other learning goals. The Ontario assessment model, described in *Growing Success*, uses the following process:

- **Establish learning goals from curriculum expectations**. Develop learning goals from curriculum expectations and include them in lessons, using student-friendly language. Share them with students and use them to guide instruction.
- **Develop success criteria**. Establish success criteria, using assessment task exemplars of student work or the Achievement Chart for Science and Technology (provided on page 40) from *The Ontario Curriculum, Grades 1–8: Science and Technology* (2022), or in collaboration with students. Write these descriptors in student-friendly language to help students understand what successful learning looks like.
- **Provide descriptive feedback**. In conversations with students, identify what criteria they have and have not met, and provide any needed instruction.

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Work with students to determine next steps and how they can improve. This may include differentiating instruction.

- **Use information for peer and self-assessment**. Have students assess their own work and the work of their peers to determine what still needs to be done.
- **Establish individual goals**. Encourage students to determine what they need to learn next and how to get there.

Hands-On Science and Technology encourages assessment strategies that infuse these five elements of the Ontario assessment model, providing assessment suggestions, rubrics, and templates that can be used during the teaching/learning process. Assessment suggestions include tasks related to assessment for learning, assessment as learning, and assessment of learning.

Assessment *for* Learning

It is important to assess students' understanding before, during, and after a lesson. This information will help you determine students' needs and plan next steps in instruction.

Begin by finding out what students already know. This will allow you to identify misconceptions students may have about science and technology concepts and can help when making connections to new learning.

To assess students as they work, use the assessment *for* learning suggestions provided with many activities. While observing and conversing with students, consider using one or both of the following templates to record assessment *for* learning data:

- **Anecdotal Record:** To gain an authentic view of student progress, it is critical to record observations *during* lessons. The ANECDOTAL RECORD template (page 36) provides a format for recording observations about individuals or groups.
- **Individual Student Observations**: To focus more on individual students over a longer period of time, consider using the INDIVIDUAL STUDENT OBSERVATIONS template (page 36). This template provides more space for comments and is especially useful during conferences, interviews, or individual student performance tasks.

Assessment *as* Learning

It is important for students to reflect on their own learning in relation to science and technology. For this purpose, a STUDENT SELF-ASSESSMENT template is provided (page 36), as well as a STUDENT REFLECTIONS template (page 36).

In addition, the SCIENCE AND TECHNOLOGY JOURNAL (page 37) can be used to encourage students to reflect on their own learning. Print several copies for each student, cut the pages in half, add a cover, and bind the pages together. Students can create their own title pages for their journals. For variety, have students use the blank reverse side of each page for other reflections, such as drawing or writing about:

- new science and technology challenges
- favourite science and technology activities
- real-life experiences with science and technology
- new terminology
- new places explored during investigations

Students may also journal in other ways, such as by adding notes to their portfolios, or by keeping online science and technology blogs or journals to record successes, challenges, and next steps relating to the learning goals.

NOTE: The SCIENCE AND TECHNOLOGY JOURNAL **template is provided as a suggestion, but journals can also be made from simple notebooks or recycled paper.**

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When working in groups, students will benefit from reflecting on their ability to listen to others respectfully, share ideas, and participate actively in the inquiry process. For this purpose, use the COLLABORATION SKILLS SELF-ASSESSMENT template (page 37).

Assessment *of* Learning AOL

Assessment *of* learning provides a summary of student progress related to accomplishing the learning goals at a particular point in time. To draw conclusions about what a student knows and can do, it is important to gather a variety of assessment data. Consider collecting student products, observing processes, and having conversations with students. Determine which student work is formative and which is summative, and use only the most recent and consistent evidence.

Assessment *of* learning suggestions are provided throughout units of study and in the culminating lesson of each unit of ***Hands-On Science and Technology***. To record student results, use the ANECDOTAL RECORD template (page 36), the INDIVIDUAL STUDENT OBSERVATIONS template (page 36), and the RUBRIC (page 38).

Always assess a student's individual accomplishments, rather than the work they do in a group. However, you may assess *how* an individual student works within a group. Such skill development includes the ability to listen to others respectfully, share ideas, and participate actively in the inquiry process. For this purpose, use the COLLABORATION SKILLS TEACHER ASSESSMENT template (page 37).

As mentioned on page 31, ***Hands-On Science and Technology*** does not provide tests and quizzes for units of study. Any formal assessment of students needs to be connected to the specific skills and concepts focused on during lessons, and since each teacher will select different activities from those provided within each lesson, assessment tasks will look different in each classroom. Consider focusing on the various assessment suggestions provided and using the Achievement Chart for Science and Technology on page 40 as your guide.

Performance Assessment

Both assessment *for* learning and assessment *of* learning include performance assessment. Performance assessment is planned, systematic observation and assessment based on students actually doing a specific science and technology activity. Teacher- or teacher/student-created rubrics can be used to assess student performance.

Use the SAMPLE RUBRIC and the RUBRIC template (page 38) for this assessment. For any specific activity, before the work begins, discuss with students success criteria for completing the task. This will ensure that the success criteria relate to the lesson's learning goals. Record these criteria on the rubric.

When conducting assessment *for* learning, review the rubric with students to determine strengths, challenges, and next steps related to learning goals.

When conducting assessment *of* learning, use the rubric to determine summative data. For example, use the rubric criteria to assess student performance, and students can receive a check mark 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 template (page 38).

When using the rubric for assessment *of* learning, consider using four levels of achievement to correlate with the Achievement Chart for Science and Technology (page 40).

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For example:

1. achievement that falls much below the provincial standard
2. achievement that approaches the provincial standard
3. achievement that meets the provincial standard
4. achievement that surpasses the provincial standard

Hands-On Science and Technology provides numerous opportunities for students to apply their skills. Consider using the same levels of achievement throughout the year to track student learning and determine when students have a thorough understanding and demonstrate 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 students' work, with students involved in selecting pieces and justifying their choices. *Progress portfolios* reflect students' progress as their work improves and aim to demonstrate in-depth understanding of the materials over time.

Select, with student input, work to include in a science and technology portfolio or in a science and technology section of a multi-subject portfolio. Selections should include representative samples of student work in all types of science and technology activities.

Use the PORTFOLIO TABLE OF CONTENTS template (page 38) and PORTFOLIO ENTRY RECORD (page 39) to organize the portfolio.

Indigenous Perspectives on Assessment

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, Knowledge Keepers, community members, and teachers. An assessment that includes all these perspectives provides a balanced understanding of what represents success for Indigenous students and their family/community. A strong partnership between parents/guardians/community and school improves student achievement. 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 worldview. In ***Hands-On Science and Technology***, consideration has been given to assessment from an Indigenous perspective. The following suggestions support this perspective:

- Consider learning and assessment in a holistic way, acknowledging that each student will find identity, meaning, and purpose through connections to the community, the natural world, and values such as respect and gratitude.
- Directly questioning the information being taught is not necessarily common to the process of gaining knowledge within an Indigenous perspective; instead, observation and waiting to gain understanding may be more familiar. Acknowledge this cultural difference and reassure students that the observations they make and their ability to demonstrate their understanding are valid.
- Incorporate family and community in learning and assessment. Include parents/caregivers, siblings, grandparents, aunts and uncles, cousins, and community members such as Elders, Knowledge Keepers, daycare

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staff, babysitters, and coaches. For this purpose, consider using the FAMILY AND COMMUNITY CONNECTIONS: ASSESSING TOGETHER template (page 37). After any lesson or module, students can take home a copy of this template to complete with family or community members (with permission). This template can also be completed by students in pairs, to enhance the sense of community in the classroom.

- Have students take home one of their self-assessment templates (STUDENT SELF-ASSESSMENT, STUDENT REFLECTIONS, SCIENCE AND TECHNOLOGY JOURNAL, or COLLABORATION SKILLS SELF-ASSESSMENT) to explain it to a family or community member. These templates can also be shared with a peer to enhance the sense of community within the school.

Evidence of Student Achievement Levels for Evaluation

At the end of each unit, determine achievement levels for each student. Assessment *of* learning information gathered throughout the unit can be used to identify these levels, according to the Ontario Achievement Chart for Science and Technology. The most recent and consistent assessment information should be used to determine achievement levels. The Achievement Chart for Science and Technology is provided on page 40.

Important Note to Teachers

Throughout ***Hands-On Science and Technology***, suggestions are provided for assessment *for* learning, assessment *as* learning, and assessment *of* learning. Keep in mind that these are merely suggestions. Use the assessment strategies presented in a wide variety of ways, and build an effective assessment plan using these assessment ideas, as well as your own valuable experiences as a teacher.

References

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Achievement Chart for Science and Technology

The achievement chart identifies four categories of knowledge and skills and four levels of achievement in science and technology.

1. Knowledge and Understanding – Subject-specific content acquired in each grade (knowledge), and the comprehension of its meaning and significance (understanding)				
Categories	**Level 1**	**Level 2**	**Level 3**	**Level 4**
	The student:			
Knowledge of content (e.g., facts, terminology, definitions)	demonstrates limited knowledge of content	demonstrates some knowledge of content	demonstrates considerable knowledge of content	demonstrates thorough knowledge of content
Understanding of content (e.g., concepts, ideas, theories, principles, procedures, processes)	demonstrates limited understanding of content	demonstrates some understanding of content	demonstrates considerable understanding of content	demonstrates thorough understanding of content
2. Thinking and Investigation – The use of critical and creative thinking skills and inquiry and problem-solving skills and/or processes				
Categories	**Level 1**	**Level 2**	**Level 3**	**Level 4**
	The student:			
Use of initiating and planning skills and strategies (e.g., formulating questions, identifying the problem, developing hypotheses, scheduling, selecting strategies and resources, developing plans)	uses initiating and planning skills and strategies with limited effectiveness	uses initiating and planning skills and strategies with some effectiveness	uses initiating and planning skills and strategies with considerable effectiveness	uses initiating and planning skills and strategies with a high degree of effectiveness
Use of processing skills and strategies (e.g., performing and recording; gathering evidence and data; examining different points of view; selecting tools, equipment, materials, and technology; observing; manipulating materials; proving)	uses processing skills and strategies with limited effectiveness	uses processing skills and strategies with some effectiveness	uses processing skills and strategies with considerable effectiveness	uses processing skills and strategies with a high degree of effectiveness
Use of critical/creative thinking processes, skills, and strategies (e.g., analysing, interpreting, problem solving, evaluating, forming and justifying conclusions on the basis of evidence, developing solutions, considering diverse perspectives)	uses critical/ creative thinking processes, skills, and strategies with limited effectiveness	uses critical/ creative thinking processes, skills, and strategies with some effectiveness	uses critical/ creative thinking processes, skills, and strategies with considerable effectiveness	uses critical/ creative thinking processes, skills, and strategies with a high degree of effectiveness

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3. Communication – The conveying of meaning through various forms				
Categories	**Level 1**	**Level 2**	**Level 3**	**Level 4**
	The student:			
Expression and organization of ideas and information in oral, visual, and/or written forms (e.g., diagrams, models, articles, project journals, reports)	expresses and organizes ideas and information with limited effectiveness	expresses and organizes ideas and information with some effectiveness	expresses and organizes ideas and information with considerable effectiveness	expresses and organizes ideas and information with a high degree of effectiveness
Communication for different audiences (e.g., peers, adults, community members) **and purposes** (e.g., to inform, to persuade) **in oral, visual, and/or written forms**	communicates for different audiences and purposes with limited effectiveness	communicates for different audiences and purposes with some effectiveness	communicates for different audiences and purposes with considerable effectiveness	communicates for different audiences and purposes with a high degree of effectiveness
Use of conventions, vocabulary, and terminology of the discipline in oral, visual, and/or written forms (e.g., symbols, formulae, International System of Units)	uses conventions, vocabulary, and terminology of the discipline with limited effectiveness	uses conventions, vocabulary, and terminology of the discipline with some effectiveness	uses conventions, vocabulary, and terminology of the discipline with considerable effectiveness	uses conventions, vocabulary, and terminology of the discipline with a high degree of effectiveness
4. Application – The use of knowledge and skills to make connections within and between various contexts				
Categories	**Level 1**	**Level 2**	**Level 3**	**Level 4**
	The student:			
Application of knowledge and skills (e.g., concepts and processes; procedures related to the safe use of tools, equipment, materials, and technology; investigation skills) **in familiar contexts**	applies knowledge and skills in familiar contexts with limited effectiveness	applies knowledge and skills in familiar contexts with some effectiveness	applies knowledge and skills in familiar contexts with considerable effectiveness	applies knowledge and skills in familiar contexts with a high degree of effectiveness
Transfer of knowledge and skills (e.g., concepts and processes, safe use of equipment and technology, investigation skills) **to new contexts**	transfers knowledge and skills to new contexts with limited effectiveness	transfers knowledge and skills to new contexts with some effectiveness	transfers knowledge and skills to new contexts with considerable effectiveness	transfers knowledge and skills to new contexts with a high degree of effectiveness

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Making connections within and between various contexts (e.g., connections between sciences; connections to everyday and real-life situations; connections among concepts within science and technology; connections involving use of prior knowledge and experience; connections among science and technology and other disciplines, including other STEM [science, technology, engineering, and mathematics] subjects)	makes connections within and between various contexts with limited effectiveness	makes connections within and between various contexts with some effectiveness	makes connections within and between various contexts with considerable effectiveness	makes connections within and between various contexts with a high degree of effectiveness
Proposing courses of practical action to deal with problems relating to our changing world	proposes courses of practical action of limited effectiveness	proposes courses of practical action of some effectiveness	proposes courses of practical action of considerable effectiveness	proposes highly effective courses of practical action

Source: Ontario Ministry of Education. "Assessment and Evaluation of Student Achievement." Elementary Science and Technology (2022). https://www.dcp.edu.gov.on.ca/en/curriculum/science-technology/context/evaluation.

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Unit 1

Biodiversity

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About This Unit

In this unit of ***Hands-On Science and Technology for Ontario, Grade 6***, students explore the diversity of living things and the classification of species into kingdoms. The focus is on plants and animals, with additional lessons related to protists, bacteria, and fungi. Students will begin to understand how these kingdoms are organized according to structural characteristics of living things, with a focus on the phyla (branches) of the various kingdoms. Being able to classify animals helps us to recognize, appreciate, and explain biodiversity.

Before the invention of the microscope, organisms were classified only as plant or animal. With the discovery of microscopic forms of life, it became apparent that many of these microorganisms (e.g., fungi, bacteria, algae, viruses, and single-cell organisms like the paramecium and amoeba) have both animal and plant characteristics and could not be simply classified into either kingdom.

Scientists have not agreed upon one classification system for living things. With the study of taxonomy, several different possible kingdoms and domains become evident.

One of the most popular systems today is Linnaean taxonomy, the five-kingdom classification of living organisms conceived by Swedish scientist Carolus Linnaeus: animal, plant, fungus, protist, and monera (viruses have yet to be classified within this system).

It should not be a surprise to find reference materials with contradictory information. Discuss this classification debate with students. This can provide a venue for understanding that science is an ever-evolving field of study and does not always provide clear answers. New information about DNA continues to influence our understanding of how to classify organisms.

Indigenous Peoples also have systems for classifying living things. Though Indigenous classification systems use different criteria from Western science, they nevertheless contribute to a deep understanding of symbiotic relationships, ecological conservation, and sustainability. The Haudenosaunee and Iroquois creation story of Sky Woman delineates the four main classifications for life within their cultures: land walkers, water dwellers or divers, winged creatures, and flora or plant life. The Anishinaabe creation story of Turtle Island also delineates these four categories for life on Earth. The story of the Three Sisters is an example from the Six Nations and Ojibwe cultures that demonstrates another understanding of plant classification through the lens of symbiotic relationships and the dangers of monoculture.

Classifying objects is an important part of a scientist's work. They do this to better understand the classes, both as individual species and how they compare and contrast with other organisms. When teaching the content found in this unit, it is important to keep in mind that classifying is very much a scientific-process skill. Since the classification systems used to organize living things are quite complex, give students repeated opportunities to explore and extend their thinking. Encourage them to compare and contrast animals, plants, and even nonliving things; this will help students develop critical-thinking skills. This unit also provides a variety of suggestions for graphic organizers and strategies to aid students in their study.

Planning Tips for Teachers

- Collect a variety of pictures, books, and videos about living things including plants, animals, fungi, bacteria, and protists. Involve students in collecting resources. Good sources for images include old calendars; magazines (e.g., *Ranger Rick*, *Owl*, *Chickadee*, *Highlights for Children*, *Canadian Geographic*, *National Geographic*); gardening and farming magazines; websites

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(see Resources for Students, page 50); departments of agriculture and forestry; environmental associations; local zoological, wildlife, animal protection, and naturalist organizations; government conservation departments; and local water/wildlife conservation associations (e.g., Conservation Ontario, Toronto and Region Conservation Authority).

- Have at least one good-quality, high-powered microscope. Consider accessing other related materials, such as prepared slides or Microslide Viewers.
- Whenever possible, use reusable or recycled items for classroom experiments and demonstrations. For example, rather than single-use zipper-lock bags, use silicone or sturdy plastic bags that can be washed and reused.
- Collect a variety of fiction and nonfiction books about living things and biodiversity at a range of reading levels appropriate for your students. Keep these reading materials at the Diversity of Living Things Library (set up in lesson 1, Action: Part Four) for reference throughout the unit.
- Consider recording each lesson's guided inquiry question (e.g., on a sentence strip) for display throughout related investigations.
- Have students make land-based journals for use throughout the unit. Use notebooks with sturdy covers or drawing paper and clipboards. Provide a zipper-lock bag for each student to carry their journal and journal supplies (e.g., pencils, sharpeners, pencil crayons [rather than markers, which will bleed if wet], stretch gloves [for journaling on cooler days]).
- Lesson 5 includes a nature walk at a local park, forest, or nature preserve. Arrange this ahead of time.
- Lesson 7 includes a pond study. Note that spring is the best time to conduct this study, when shallow ditches and large puddles are rife with living organisms that can be investigated. To ensure students have appropriate apparel to wear on the day of the trip, including rubber boots, plan this activity well in advance.

STEM Makerspace

Add unit-specific materials to the Makerspace, in addition to the general materials listed in the introduction to ***Hands-On Science and Technology for Ontario, Grade 6*** (see page 19), that encourage learning about biodiversity. Include various samples of living things such as shells, seeds, leaves, fruits, vegetables, and grains. Include unique specimens such as birds' nests, starfish, shark's tooth (a house plant), and fur samples. Include field guides, identification keys, photographs of various organisms, and containers for collecting samples from the outdoors. Also include microscopes, relevant slides, and Microslide Viewers with relevant slide strips.

Coding

Coding is one of the STEM skills infused throughout the ***Hands-On Science and Technology*** lessons. See page 4 for more details on coding.

Indigenous Knowledge and Perspectives

Throughout this unit, continue to enhance students' science and technology education by infusing it with Indigenous perspectives as often as possible.

For Indigenous Peoples, all life—plant, animal, and human—is equal, and all living things are interdependent for survival. Traditionally, Indigenous Peoples lived off the land; they are keenly aware of their surroundings—including the wide range of plants and animals found

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in their ecosystem. This close relationship to the land helps foster Indigenous worldviews of connection to all living things. It is also believed that an animal gives up its spirit to provide humans with what we need for survival. Therefore, out of respect, no portion of a hunted animal should go to waste, with every part being used for food, clothing, tools, or shelter.

Animals are viewed as teachers, guides, and companions; moreover, they are viewed as integral to physical survival—traditionally, and for many Indigenous Peoples today, existence depends on animals and plants for everything from transportation to signalling seasonal changes to assisting with agricultural pursuits.

Examples of this occur in several lessons and activities, such as the following:

- Indigenous art depicting animals
- biodiversity from an Indigenous perspective
- Indigenous plants and animals of Ontario
- land acknowledgements
- inviting Elders and Knowledge Keepers to speak to students about the diversity of living things

Science and Technology Vocabulary

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

- *animal, arthropod, bacteria, biodiversity, classification key, classification system, community, endoskeleton, exoskeleton, fungus, habitat, interrelationship, invasive species, invertebrate, kingdom, mould, native species, naturalist, organism, plants, protist, species, structure, vertebrate*

Infuse vocabulary related to scientific and technological inquiry skills into daily lessons. Display this vocabulary in the classroom throughout the year, as it relates to all science and technology units. Have students determine which skills they are being asked to use as they work through particular lessons. Discuss what the 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, estimate, explain, explore, find, follow, graph, identify, improve, investigate, measure, observe, order, plan, predict, recognize, record, repeat, research, respond, select, sequence, test*

In lesson 1, have students begin a Science and Technology Glossary in which they will record new vocabulary introduced throughout the unit. Also in lesson 1, create a word wall for the unit on a bulletin board, poster paper, or chart paper. Record new vocabulary on the word wall as it is introduced. Ensure the word wall is located where all students can see it. Refer frequently to new words and encourage students to use them in both their writing and conversation.

NOTE: Include terminology in languages other than English on the class word wall. This is a way of acknowledging and respecting students' cultural backgrounds, while enhancing learning for all students. Use resources such as Google Translate and Microsoft Translator. To translate terms to Indigenous languages, there are a variety of online dictionaries available. For example:

- The Ojibwe People's Dictionary <ojibwe.lib.umn.edu/>
- Freelang Mohawk-English Dictionary <www.freelang.net/online/mohawk.php>
- Nishnaabemwin Dictionary <https://dictionary.nishnaabemwin.atlas-ling.ca/#/help>
- First Voices: Explore Languages <https://www.firstvoices.com/explore/FV/sections/Data>

Online dictionaries are also available for other languages that may be reflective of the class population.

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Promoting Scientific Inquiry

Throughout the inquiry process, it is essential for teachers and students to generate thoughtful questions about the scientific information and issues presented. Many questioning systems can be applied to the material within the unit. Simply changing a question can shift the focus from knowledge and understanding to scientific inquiry, which can lead to use of engineering and scientific design.

The chart below shows how questions related to topics of study in this unit, and which address specific curriculum outcomes, can focus on knowledge and understanding (as in column two) or encourage more in-depth inquiry and higher-level thinking (as in column three) and then lead to engineering and scientific design (column four). A questioning system such as this can be used by both teachers and students to reach beyond factual content toward rich, inquiry-based investigations.

Unit Topic	**Knowledge and Understanding** (content questions that range in complexity)	**Scientific Inquiry** (testable questions by students or by scientists)	**Engineering and Scientific Design** (prototype questions designed or critiqued by students)
Classification and identification	What are the branches of the Animal Kingdom?	What similarities and differences can you observe between plants and animals?	What are the limitations of a compound light microscope (found in high-school labs) in observing bacteria?
Invertebrates and vertebrates	Is there an advantage to having a backbone?	What diversity of invertebrates can be found in a rotting log?	What conditions are necessary to keep a terrarium healthy?

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Curriculum Correlation Chart

Overall Expectation	Specific Expectation	Lessons											
		1	2	3	4	5	6	7	8	9	10	11	12
B1. Relating Science and Technology to Our Changing World: assess the importance of biodiversity, and describe ways of protecting biodiversity	**B1.1** assess the benefits of biodiversity and the consequences of the diminishing of biodiversity							√	√	√	√	√	
	B1.2 analyse a local issue related to biodiversity while considering different perspectives; plan a course of action in response to the issue; and act on their plan							√	√	√		√	
B2. Exploring and Understanding Concepts: demonstrate an understanding of biodiversity, its contributions to the stability of natural systems, and its benefits to humans	**B2.1** describe the distinguishing characteristics of different groups of organisms, and use these characteristics to further classify these organisms using a classification system	√	√	√	√	√		√	√	√			√
	B2.2 demonstrate an understanding of biodiversity as the diversity of life on Earth, including the diversity of organisms within species, among species in a community, and among communities and the habitats that support them	√					√		√				
	B2.3 describe ways in which biodiversity within species is essential for their survival												√
	B2.4 describe ways in which biodiversity within and among communities is essential for maintaining the resilience of these communities								√	√			
	B2.5 describe interrelationships within species, between species, and between species and their natural environment, and explain how these interrelationships sustain biodiversity					√	√		√	√			

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Overall Expectation	Specific Expectation	Lessons											
		1	2	3	4	5	6	7	8	9	10	11	12
	B2.6 explain how invasive species reduce biodiversity in local environments								√				
	B2.7 explain how climate change contributes to a loss of biodiversity, and describe the impact of this loss										√		
	B2.8 describe the importance of biodiversity in supporting agriculture, including Indigenous agriculture around the world									√	√		

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Resources for Students

NOTE: Resources marked with an asterisk are considered authentic resources. This means that traditional stories reference the Indigenous community they came from, they state the individual that shared the story and gave permission for the story to be used publicly, and the person who originally shared the story is Indigenous. Stories that are works of fiction were written by an Indigenous author. For more information, please see Authentic First Peoples Resources at <http://www.fnesc.ca/>.

Books

*We Are All Connected series, Celestine Aleck, Brenda Boreham, Leah Marie Dorion, John Haugen, Michael Kusugak, Terri Mack, Charmaine Peal, Rod Peters, Kim Soo Goodtrack, and Joe Starr (Strong Nations, 2017).

The Crops We Grow, Georgia Amson-Bradshaw (Cavendish Square, 2020).

**Neekna and Chemai,* Jeannette C. Armstrong (Theytus Books, 2018).

**Mashkiki Road: The Seven Grandfather Teachings,* Elizabeth S. Barrett (Minnesota Historical Society, 2022).

Humongous Fungus: The Weird and Wonderful Kingdom of Fungi, Lynne Boddy (DK, 2021).

Darwin's Tree of Life, Michael Bright (Crocodile Books, 2019).

**A Day With Yayah,* Nicola I. Campbell (Tradewind Books, 2017).

**Stand Like a Cedar,* Nicola I. Campbell (HighWater, 2021).

**Creation Story: Sky Woman,* Michelle Corneau (Strong Nations, 2016).

**The Three Sisters,* Michelle Corneau (Strong Nations, 2016).

Desert Girl, Monsoon Boy, Tara Dairman (Putnam, 2020).

Many: The Diversity of Life on Earth, Nicola Davies (Candlewick, 2017).

**Wild Berries,* Julie Flett (Simply Read Books, 2025).

The Book of Brilliant Bugs, Jess French (DK, 2020).

The Mushroom Fan Club, Elise Gravel (Drawn & Quarterly, 2021).

**The Sockeye Mother,* Hetxw'ms Gyetxw (Brett D. Huson) (HighWater, 2017).

**A Walk on the Tundra,* Rebecca Hainnu (Inhabit Media, 2018).

**A Walk on the Shoreline,* Rebecca Hainnu (Inhabit Media, 2019).

Shell, Beak, Tusk: Shared Traits and the Wonders of Adaptation, Bridget Heos (Houghton Mifflin Harcourt, 2017).

Biodiversity Eco Facts, Izzi Howell (Crabtree, 2020).

**Can You Hear the Plants Speak?* Nicholas Hummingbird and Julia Wasson (HarperCollins Canada, 2024).

Unusual Life Cycles of Invertebrates, Jaclyn Jaycox (Capstone, 2022).

Tiny Monsters: The Strange Creatures That Live on Us, in Us, and Around Us, Steve Jenkins (Houghton Mifflin Harcourt, 2020).

Trees, Leaves, Flowers & Seeds: A Visual Encyclopedia of the Plant Kingdom, Sarah Jose (DK, 2019).

What Is the Impact of Declining Biodiversity? Stuart A. Kallen (ReferencePoint, 2021).

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How to Change Everything: The Young Human's Guide to Protecting the Planet and Each Other, Naomi Klein (Puffin, 2021).

Creepy Crawlies and the Scientific Method: More Than 100 Hands-On Science Experiments for Children, Sally Stenhouse Kneidel (Fulcrum, 2015).

Germs Up Close, Sara Levine (Millbrook, 2021).

Eye-Popping Plant Part Facts, Paul Mason (Gareth Stevens Classroom, 2023).

The Bacteria Book: The Big World of Really Tiny Microbes, Steve Mould (DK, 2018).

Canadian Biodiversity, Sheryl Normandeau (Coast2Coast2Coast, 2019).

**Âmî Osâwâpikones (Dear Dandelion),* S.J. Okemow (Annick, 2023).

My Wounded Island, Jacques Pasquet (Orca, 2017).

Avati: Discovering Arctic Ecology, Mia Pelletier (Inhabit Media, 2021).

**Be a Good Ancestor,* Leona Prince and Gabrielle Prince (Orca, 2022).

Science Infographics: Plants, Jon Richards (Wayland, 2022).

Karl, Get Out of the Garden! Carolus Linneaus and the Naming of Everything, Anita Sanchez (Charlesbridge, 2017).

**Muskgege—Carol's Traditional Medicines,* Caroline Sanoffsky (Manitoba First Nations Education Resource Centre, 2017).

Moth and Wasp, Soil and Ocean: Remembering Chinese Scientist Pu Zhelong's Work for Sustainable Farming, Sigrid Schmalzer (Tilbury House, 2020).

Tree of Life: The Incredible Biodiversity of Life on Earth, Rochelle Strauss (Kids Can, 2013).

Full of Life: Exploring Earth's Biodiversity, Isabel Thomas (Phaidon, 2022).

Animal Eyes: How Creatures See and How Their Eyes Have Adapted to Their World, Françoise Vulpé (Firefly Books, 2023).

Finding Wild, Megan Wagner Lloyd (Knopf Books for Young Readers, 2016).

Nature Out of Balance: How Invasive Species Are Changing the Planet, Merrie-Ellen Wilcox (Orca, 2021).

Websites

- **https://coolcosmos.ipac.caltech.edu/infrared_gallery/1**
  Infrared Zoo—Cool Cosmos: Includes infrared images of, and information about, various warm- and cold-blooded animals.
- **https://www.haudenosauneeconfederacy.com/historical-life-as-a-haudenosaunee/food-and-hunting/**
  Food and Hunting—Haudenosaunee Confederacy: Describes the traditional diet as well as the agricultural and hunting practices of the Haudenosaunee.
- **https://minwanjigewin.wordpress.com/**
  Minwanjigewin: Food and Tradition—Great Lakes Inter-Tribal Council Inc.: Information about the traditional diet of the Ojibwe.
- **https://www.torontozoo.com/pdfs/tic/ways-of-knowing.pdf**
  Ways of Knowing Partnership Turtle Island Conservation—Toronto Zoo: A partnership between the Toronto Zoo and First Nations communities for ecological conservation.

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- **https://www.canada.ca/en/environment-climate-change/services/biodiversity/2030-nature-strategy.html**
  Canada's 2030 Nature Strategy and the Nature Accountability Bill—Government of Canada: Information about the strategy and bill relating to halting and reversing biodiversity loss in Canada.
- **https://savethebee.org/common-fungi-threatening-honey-bee-health/**
  "Common Fungi Threatening Honey Bee Health." Save The Bee.
- **https://www.cbc.ca/news/canada/ottawa/parents-worried-mould-alta-vista-public-school-1.5368571**
  "Parents Worried Over Mould Exposure at Ottawa School." Kimberley Molina. CBC News. November 22, 2019.
- **https://www.aptnnews.ca/national-news/first-nation-students-sickened-forced-from-school-due-to-mould-crisis/**
  "First Nation Students Sickened, Forced From School Due to 'Mould Crisis.'" Kathleen Martens. APTN News. February 1, 2019.
- **www.savethefrogs.com/**
  Save the Frogs!: Information about frogs, the roles they play in different ecosystems, and how to get involved in frog conservation.
- **www.invadingspecies.com/invaders/**
  Invaders—Ontario's Invading Species Awareness Program: Information about different species of invasive plants and animals.
- **https://ontarionature.org/immediate-action-for-old-growth-forests-blog/**
  "Immediate Action Needed to Protect Ontario's Old-growth Forests." Jenna Cardoso. Ontario Nature. November 18, 2021.
- **https://davidsuzuki.org/take-action/act-locally/connecting-youth-with-nature/**
  Connecting Youth With Nature—David Suzuki Foundation: Take the Suzuki Superhero Challenge, a program to help youth get outside and engage with the natural world.
- **https://farmtario.com/crops/white-mould-troubling-for-some-regions/**
  "White Mould Troubling for Some Regions." Matt McIntosh. Farmtario. October 4, 2023.
- **https://kids.nationalgeographic.com/**
  National Geographic Kids: Articles, videos, and activities related to biodiversity, plastic pollution, climate change, and much more.
- **https://rangerrick.org/**
  Ranger Rick—National Wildlife Federation: Articles, videos, and games for kids related to wildlife. Includes a number of videos that feature various animal adaptations.
- **https://ontariotrees.com**
  Ontario Trees & Shrubs: An online field guide to trees and shrubs in Ontario.
- **https://www.ontario.ca/page/tree-atlas**
  The Tree Atlas—Province of Ontario: Learn which trees are native to Ontario and the best species to plant where you live.
- **https://www.canadaaction.ca/ontario-farming-facts**
  "Farming & Agri-Food in Ontario: 30 Facts." Canada Action. August 6, 2025. Information about farming in Ontario.

Videos

- **https://www.youtube.com/watch?v=WcF99s_umA8**
  "What are the advantages and disadvantages of having an exoskeleton?" rvssciencevideos2012 (1:48).

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- **https://www.youtube.com/watch?v=eym10GGidQU**
  "How This Town Produces No Trash." Seeker Stories (5:05).
- **https://www.youtube.com/watch?v=xFqecEtdGZ0**
  "Can we create the 'perfect' farm? – Brent Loken." TED-Ed (7:09).
- **https://www.youtube.com/watch?v=WhOrIUlrnPo**
  "What is organic farming? | Agriculture | Biology | FuseSchool." FuseSchool Global Education (3:50).
- **https://www.youtube.com/watch?v=WXvlP9Zyxss**
  "Climate change explained in 5 minutes." CBC Kids News (4:46).
- **https://royalsaskmuseum.ca/educate/learning-resources/gr-k-5-storytelling-with-elder-hazel**
  GR 5–K: Storytelling with Elder Hazel—Royal Saskatchewan Museum: Indigenous Storytelling with Elder Hazel Video Series.

Coding and STEM Resources

Plugged Coding Resources

- **https://climateclock.world/**
  Climate Clock: Tracking time left to limit global warming to 1.5°C.
- **https://climateclock.net/**
  The Climate Clock—Tracking Global Warming in Real Time: Climate Clock shows how long it will be until we emit enough to cause global temperatures to reach 1.5°C.

Scratch

- **https://scratch.mit.edu/**
  Scratch is a free block-based visual programming language that allows students to create animations, stories, and games through coding.
- **https://scratch.mit.edu/educators/**
  Find information about how to use Scratch in a classroom setting, including tutorials, educator guides, and other resources.
- **https://scratch.mit.edu/projects/editor/?tutorial=all**
  Tutorials for students to learn about the different ways they can use Scratch.
- **https://scratch.mit.edu/projects/685740293/editor/**
  Biodiversity invasive species – example remix: A sample of an invasive species game created by lalalark that students can remix in Scratch.
- **https://schools.sciencenorth.ca/grade-6**
  Science North—Invasive Species Game in Scratch: Scroll down to find a lesson plan and coding guide to design a game in Scratch to show how invasive species can damage the biodiversity of ecosystems.

Hour of Code

- **https://projects.raspberrypi.org/en/projects/tree-life-simulator**
  Tree Life Simulator: A tutorial by the Raspberry Pi Foundation to guide students in creating a simulation in Scratch that demonstrates the effects of land management and deforestation on trees, wildlife, and the environment.

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- **https://www.codespeaklabs.com/blog/code-a-pokemon-evolution-game-in-scratch**
  Code a Pokémon Evolution Game in Scratch: Students can use this tutorial by Code Speak Labs to create a Pokémon game in Scratch.
- **https://www.vidcode.com/project/climate-clock**
  Code a Climate Clock: In this tutorial by Vidcode students will learn how to build their own climate clock.

Unplugged Coding Resources

- **https://teachinglondoncomputing.org/algorithmic-doodle-art/**
  Algorithmic Doodle Art—Teaching London Computing: Guides students through creating simple algorithms involving fractions to draw nature pictures.

STEM Resources

- **https://kids.britannica.com/students/article/dichotomous-key/624999**
  Dichotomous Key—Britannica Kids: Student-friendly information about dichotomous keys—a tool used to identify organisms or objects by offering a series of two-part choices that lead the user through a process of elimination based on observable traits.
- **https://creately.com/guides/what-is-a-dichotomous-key/**
  What is a Dichotomous Key? How to Create One With Examples—Creately: Information about the classification tool known as a dichotomous key.
- **https://www.mindomo.com/**
  Collaborative Mind Map Maker—Mindomo: Mind mapping software to organize ideas.
- **https://kids.frontiersin.org/articles/10.3389/frym.2021.656168**
  "What Is Genetic Diversity and Why Does It Matter?" Melissa Minter, Erica S. Nielsen, Colette Blyth, et al. Frontiers for Young Minds. December 9, 2021. Explains how changes to DNA creates genetic diversity important to the survival of species.
- **https://www.amnh.org/explore/ology/biodiversity/around-the-world-with-dna**
  Around the World With DNA—American Museum of Natural History: Profiles the work of six different scientists who are using DNA science to help protect endangered animals.
- **https://biologycorner.com/worksheets/DNAcoloring.html**
  DNA – The Double Helix—Biology Corner: Information and downloadable resources about DNA.
- **https://www.amnh.org/explore/ology/genetics**
  Genetics—American Museum of Natural History: Information about genetics and the study of genes.
- **https://www.amnh.org/explore/ology/genetics/make-a-dna-model2**
  Make a DNA Model—American Museum of Natural History: Instructions for creating a model of a DNA molecule.
- **https://letstalkscience.ca/educational-resources/backgrounders/introduction-bacteria**
  Introduction to Bacteria Backgrounder—Let's Talk Science: Information about bacteria.
- **https://www.myctor.org/resources/education/sporeprints**
  Spore Prints—Mycological Society of Toronto: Printable spore print cards and instructions on how to use them.

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- **https://namyco.org/interests/education/how-to-make-a-spore-print/**
  How to Make a Spore Print—North American Mycological Association: Instructions on how to create and use a spore print card.
- **https://explore.beatymuseum.ubc.ca/mushroomsup/sporetype.html**
  Spore Type—Beaty Biodiversity Museum: Information on how to use spore prints to identify mushrooms.
- **https://www.un.org/sustainabledevelopment/cities/**
  United Nations Goals for Sustainable Development: Student-friendly information and resources about sustainable development.

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2 How Can We Show Classification Systems in Different Ways?

Materials

- various collections of objects for classifying*
- collections of pictures of living things (one for each working group)
- large zipper-lock bags
- recycled sheets of paper
- computer/tablet with internet access
- markers
- chart paper
- Activity Sheet: Classifying Objects (1.2.1) (one copy for each student)
- Activity Sheet: Using a Tree Diagram (1.2.2) (one copy for each working group)
- sticky notes
- KWHL chart (from lesson 1)
- Science and Technology Glossary (1.1.1)

***NOTE: This lesson requires various collections of objects for classification activities. Consider having students bring in collected objects from home. Place each collection inside a labelled zipper-lock bag. Collections may include stamps, buttons, beads, screws, coins, seashells, sports cards (or other collector cards), rocks and minerals, seeds, and lids (e.g., from food jars and household containers, pen caps).**

Activate

Gather students into a circle, and have each student remove a shoe and place it in the centre of the circle. Discuss the similarities and differences between the shoes. Then, have students brainstorm different ways they could classify, or sort, the shoes. Decide as a class which sorting rule or classification system is best. Have students sort the shoes and then explain why they liked that classification system.

Then, add your own shoe to the collection, and have students discuss how to classify it according to the criteria used to sort their shoes.

Introduce the guided inquiry question: **How can we show classification systems in different ways?**

Action: Part One

Display the various collections of objects in zipper-lock bags. Circulate the collections and give students an opportunity to examine and discuss each one. Ask:

- Why are the objects grouped in this way?
- What do the objects in each bag have in common with one another?
- How are they different?

Introduce the term *classification*. Grade 6 students should be familiar with the concept (they classified plants in grade 3 and matter in grade 5). Focus on the idea that classification is a system of sorting objects into groups according to the objects' characteristics.

Organize the class into working groups. Give each group one bag with a collection, and several recycled sheets of paper. Challenge the groups to examine the objects in their bags and find a way to sort the objects into two groups. For example, students working with buttons might sort the objects into buttons with shanks and buttons without shanks.

Next, distribute a copy of Activity Sheet: Classifying Objects (1.2.1) to each student. Have students record their classification systems on the sorting mat.

Have groups share their classification systems, identifying rules or other criteria for how they sorted the objects.

Use the collections to explore the topic of classification systems with students. Ask:

- What are the advantages and/or disadvantages of classifying into only two groups?

▶

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2

- Is it easier or better to classify objects into more than two groups?
- How is classifying helpful with these collections?
- Are there a variety of ways to classify any one collection?
- Is there a right or wrong way to classify?
- How could we sort each collection using a different classification system?

Have students share their ideas.

Action: Part Two

Introduce students to another way of recording classification—using a tree diagram. This system allows for more sophisticated and complex classifying. Use one of the collections to model this system on chart paper, similar to the example at the bottom of the page.

The example shows classification of a collection of lids from various containers. The diagram can extend further according to students' ideas.

As a class, sort and classify a set of objects, and develop a tree diagram on chart paper to record this classification system.

Distribute a copy of Activity Sheet: Using a Tree Diagram (1.2.2) to each group of students.

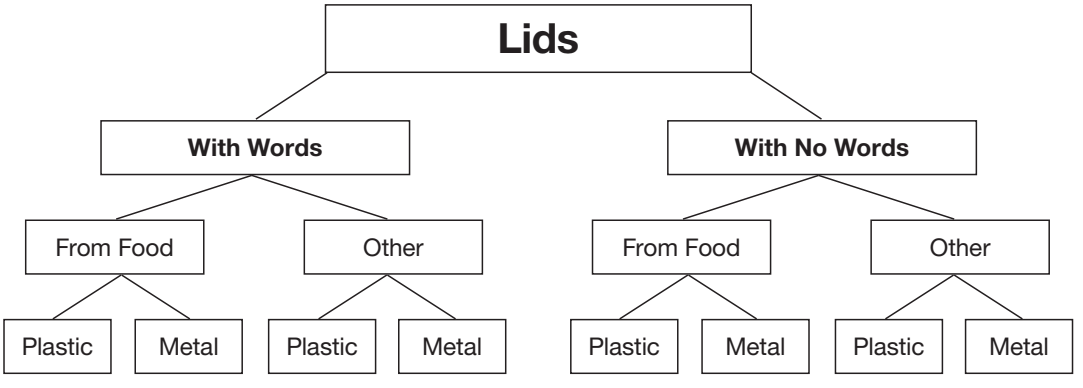
Have the groups re-sort their original collections using a tree diagram and record on their activity sheets. Students can add more lines and boxes on the back of the sheet if needed.

Discuss students' ideas about classification systems. Ask:

- What were some challenges your group experienced in deciding on a system for classifying your objects?
- What things in nature do scientists classify? (e.g., plants, animals, rocks)
- Why do scientists classify things?
- Do you think scientists would have had the same difficulties you had in deciding how to group these things?

Action: Part Three

Organize the class into working groups and provide each group with a collection of pictures of living things. Challenge the groups to classify their pictures according to their own rules. Encourage them to classify the living things into

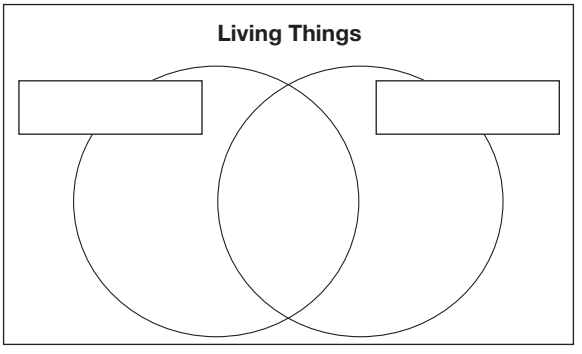


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more than two groups. Have students share their sorting and rules with the class and discuss other ways the pictures could be classified.

Next, review with students the Venn diagram as a means of recording intersecting classification systems. On chart paper, construct a double Venn diagram, as in the example below:



Ask students:

- How is this diagram different from the sorting mat or tree diagram?
- What do you think is the purpose of the overlapping or intersecting section?
- How might a living thing belong to two different groups?

Choose labels for the two groups, such as "Ocean Habitat" and "Mammals," and record these on the Venn diagram. Focus first on the intersecting section. Ask:

- Which living things belong to both groups?
- Which mammals live in the ocean? (e.g., seal, whale, dolphin, porpoise)

Record the names of these mammals in the intersecting part of the Venn diagram. Now, ask:

- Which organisms live in an ocean habitat but are not mammals?

As students brainstorm, record their suggestions in the appropriate circle. Include plants as well as various other sea life (e.g., sponge, urchin, conch, fish, shark, octopus). Ask:

- Which living things are mammals but do not live in an ocean habitat?

As students brainstorm, record their suggestions in the appropriate circle.

As a class, discuss other labels that might be used to sort living things on an intersecting Venn diagram, and record these on chart paper.

Now, have students work in pairs to create their own Venn diagrams. Provide each pair with a sheet of chart paper and markers to create their Venn diagrams. Then, have them either sort the pictures of living things onto their diagrams, or generate their own examples.

Assessment for Learning AfL
Observe students as they use the sorting mat (1.2.1), a tree diagram (1.2.2), and a Venn diagram to classify objects and pictures. Focus on students' abilities to identify criteria for classification. Use the ANECDOTAL RECORD template, on page 36, to record results.

Action: Part Four

Indigenous Peoples have used different systems of classification because their needs, traditions, and local environment were different from those of the Europeans. Explore with students Indigenous views on animate and inanimate objects and classification. For example, in the Anishinaabe language, the word for rock is included in the animate category because rocks are believed to have a spirit. Consider inviting a local Elder or Knowledge Keeper into the classroom to share knowledge about categorization, and related stories, with the class.

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Then, read one or more of the following resources with students:

- *Creation Story: Sky Woman* by Michelle Corneau
- "Haudenosaunee Opening Address" from *The Ways of Knowing Guide: Earth's Teachings* compiled by Toronto Zoo Turtle Island Conservation <https://www.torontozoo.com/pdfs/tic/ways-of-knowing.pdf>

NOTE: For further information about this topic, see the book *Braiding Sweetgrass: Indigenous Wisdom, Scientific Knowledge, and the Teachings of Plants* by Robin Wall Kimmerer (Milkweed, 2013).

Next, have students research online to create a large collection of pictures of animals found in Ontario (e.g., chipmunk, groundhog, rabbit, deer, wolf, fox, bear, chickadee, sparrow, trout, pike, moth, beetle, turtle, frog, snake).

Challenge students to find several different ways to classify the animals. Encourage them to consider Indigenous worldviews when sorting them. This could include classifying animals by how they are important to humans, why they are dangerous, or according to information like the season they are hunted, how they move (fly, swim, run, crawl), or where they are found.

STEM Makerspace

- Provide students with computers or tablets.
- Have students explore online examples of dichotomous keys—tools used to identify and classify living things. For example:
  - <https://kids.britannica.com/students/article/dichotomous-key/624999>
  - <https://creately.com/guides/what-is-a-dichotomous-key/>
- Challenge students to create a new system to classify living things with an accompanying dichotomous key using the materials available at the Makerspace. Alternatively, have students create their dichotomous keys using mind mapping software to represent their classification system digitally. For example:
  - Creately <https://creately.com/guides/what-is-a-dichotomous-key/>
  - Mindomo <https://www.mindomo.com/>
  - Google Slides

Coding Connections

NOTE: For more information about coding, see "What Is Coding?" in the Introduction on page 4.

PLUGGED: Classifying Living Things in Scratch

- Provide students with Chromebooks, laptops, or tablets.
- Challenge students to create a program that displays a living thing sprite based on the answers to a set of questions using Scratch: <https://scratch.mit.edu/>.
- Have students begin by viewing the Animate a Sprite Tutorial (select the Tutorials button to access) to learn how to change a sprite's costume. Students can then code their sprite to switch costumes depending upon the answer that the user inputs. For example: Ask "Does it have feathers?" If the answer is Yes, Then switch costume to toucan, Else ask "Does it have scales?" and so on.

NOTE: For more information about Scratch, see Coding and STEM Resources on page 4.

Talking Circle

Revisit the guided inquiry question: **How can we show classification systems in different ways?** Have students share their knowledge, provide examples, and ask further inquiry questions.

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Consolidate and Debrief

- Have students add to the KWHL chart as they learn new concepts, answer some of their own inquiry questions, and ask new questions.
- Add new vocabulary and corresponding illustrations to the word wall. Include the words in languages other than English, as appropriate.
- Have students add new vocabulary, illustrations, and sentences to their Science and Technology Glossaries (1.1.1). When possible, encourage students to add the words in languages other than English, including Indigenous languages, reflective of the classroom community.

Enhance

- **Family Connection:** Have students work with family members to create their own classification system using a sorting mat or Venn diagram. They can choose any topic related to biodiversity (e.g., animals, plants, insects, trees).
- Show students the video "How This Town Produces No Trash" at <https://www.youtube.com/watch?v=eym10GGidQU> (5:05). Then, have students research the rules for sorting recycling in their communities, and compare these rules to other communities around the world. Discuss with students the purpose of sorting recycling, and the pros and cons of doing so.
  - The video mentions that the town's goal is to be 100% zero waste by 2020. Have students conduct research to see if the town was able to reach this goal.
- Have students explore the classification system used for telephone numbers (country code, area code, and local number). Make a math connection by challenging students to explore possible combinations in their own phone numbers by varying only the last four digits.

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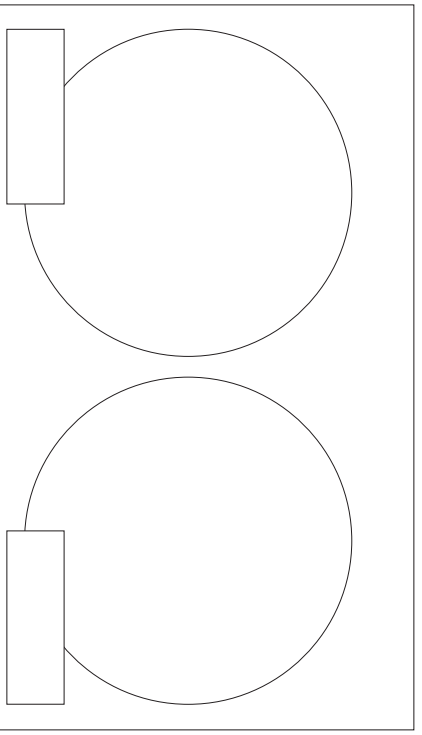
Download these reproducibles at <https://www.portageandmainpress.com/isbn/9781774920718>. For step-by-step instructions to access this download, see Appendix on page 319. SAMPLE PAGES www.portageandmainpress.com

1.2.1

Name: _____

Date: _____

Classifying Objects



1.2.1

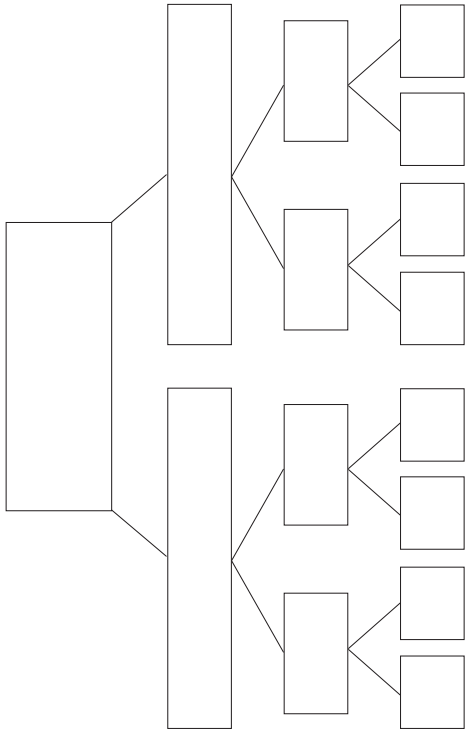
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1.2.2

Name: _____

Date: _____

Using a Tree Diagram



1.2.2

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Appendix: Image Banks

Images in this appendix are thumbnails from the Image Banks referenced in the lessons.

Corresponding full-page, high-resolution images can be printed or projected for the related lessons. Download the digital resources for this book, including the image banks and reproducibles, using the instructions below. You may return to this link to download the desired files until a new edition is available for pre-order.

1. Go to the Portage & Main Press website at <https://www.portageandmainpress.com/isbn/9781774920718>.

NOTE: The angle brackets (< and >) are not part of the above URL.

2. On the product page, select the button labelled Download Digital Resources. A new page will appear, requesting a password.
3. Type the password XXXXXX into the password field. The password is case sensitive, so be sure to use the correct capitalization.
4. Select Submit. A new page will appear, listing the download options for this book.
5. Click Retrieve Your Download to download the digital resources, including the image banks and reproducibles for this book.
6. Save the file to the desired location on your computer.

NOTE: This is a large file. Download times will vary due to your internet speeds.

Lesson 3: How Is the Animal Kingdom Organized?

The Animal Kingdom



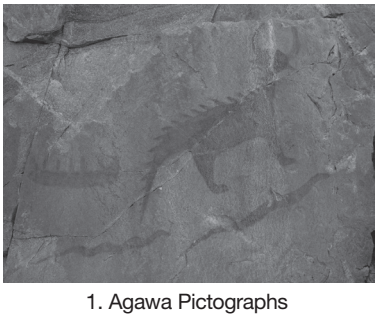
1. Diagram: The Animal Kingdom

Image Credits:

1 – © Portage & Main Press

Lesson 4: How Can We Compare and Contrast Animals?

Indigenous Art – Animals



1. Agawa Pictographs



2. Totem Pole Carving



3. Arrival of the First Man by Philip Cote

Image Credits:

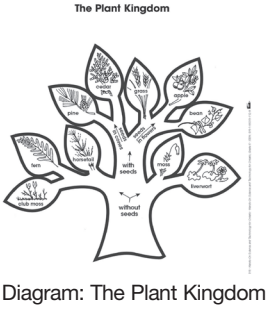
1 – "Agawa Pictographs, Mishibizhiw, Mishipizheu" by Adam Kahtava. Used under CC BY 2.0 licence.

2 – McCord Museum ME937.19.1-2

3 – "Arrival of the First Man," created in 2017, acrylic on concrete, and found under Old Mill Station (King's Mill Park) in Toronto, Ontario. Used with the permission of Indigenous artist Philip Cote, MFA.

Lesson 5: What Are Characteristics of Organisms in the Plant Kingdom?

The Plant Kingdom



1. Diagram: The Plant Kingdom

Image Credits:

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Kellie Ierullo (she/her/hers) has been an educator with the Toronto District School Board for over 20 years, including as a classroom teacher, special education teacher, and now as a teacher-librarian, technology chair, and science/STEM lead educator. Kellie is passionate about helping teachers engage students through meaningful coding and STEM activities and encouraging students to move beyond navigating technology to creating it for themselves. Kellie lives in Woodbridge, Ontario, with her family.

Jennifer H. Manitowabi (she/her/hers) is an Ojibway educator and PhD candidate at Lakehead University. Throughout her career in education in both Canada and the United States, she has worked as a bus driver, classroom teacher, principal, and education director. Jennifer encourages all educators to incorporate Indigenous worldviews in their teaching and to find opportunities to build relationships with the First Nations of Turtle Island. Jennifer is a member of Lac Seul First Nation, where she currently resides, and can often be found creating artwork that celebrates her culture.

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