STEAM Starts

7 ways to encourage early STEAM learning and inquiry in primary classrooms with picture books

By Judy Joel, Educational Consultant

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WHAT'S INSIDE

Background Information and Book Resources 2

Simple STEAM Classroom Activities 7

- Creating a Wonder Wall 7
- Exploring Biomimicry 9
- Investigating Animals through Guided Inquiry 13

STEAM Extension: Creating and Using Maker Space in Your Classroom 21

- STEAM Exploration: Constructing an Animal Habitat 22
- STEAM Exploration: Creating a Light-Up Picture 26
- STEAM Exploration: Making a Waterproof Roof 30
- STEAM Challenge: A Strong and Stable Structure 33

Appendices 36

A. Printable Handouts 36
B. Curriculum Links 54

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Background Information and Book Resources

Why STEAM Learning and Inquiry?

In order to best serve their students, twenty-first century teachers are keenly focused on extending learning beyond knowledge and understanding. Today's teachers are engaging students in deeper learning. They are implementing strategies where communication and application of knowledge and skills are used to promote critical thinking, creativity, and innovation. Through deeper learning, students develop twenty-first century competencies.

> *Researchers acknowledge that the need to engage in problem solving and critical and creative thinking has "always been at the core of learning and innovation" (Trilling & Fadel, 2009, p. 50). What's new in the 21st century is the call for education systems to emphasize and develop these competencies in explicit and intentional ways through deliberate changes in curriculum design and pedagogical practice. The goal of these changes is to prepare students to solve messy, complex problems — including problems we don't yet know about — associated with living in a competitive, globally connected, and technologically intensive world.*
>
> *— Extracted from 21st Century Competencies: Foundation Document for Discussion. Phase 1: Towards Defining 21st Century Competencies for Ontario, 2016, p. 3.*

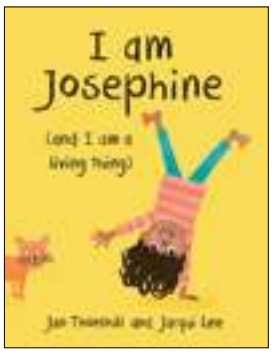
STEAM learning and inquiry builds key skills. Students develop the ability to ask questions, collect data, organize and test ideas, solve problems, and apply what was learned. STEAM learning and inquiry also provide powerful platforms for building collaborative and communication skills. Students gain a better understanding of the world around them as they analyze, create, and make connections.

Engaging student interest with something that spurs their curiosity is an important ingredient in STEAM learning and inquiry. This guidebook for teachers and others presents ways to use a group of picture books curated to support STEAM learning and inquiry and the Ontario curriculum.

The activities that follow, starting with three simpler classroom activities and then four in-depth STEAM explorations, are designed to give teachers examples of how to work through the Engineering Design Process with primary students in grades 1 to 3 in a supported and guided fashion. Each exploration can be adapted to suit different grade levels. Find full curriculum links and handouts in the appendices.

Book Resources: The STEAM Starts Selection

Find the full collection at www.shop.owlkids.com



Josephine presents her family (and herself) as examples of human beings and then familiar creatures like her dog and her mom (and herself) as examples of mammals. Next, she adds whales, lobsters, hummingbirds, and elephants (and herself) as examples of animals. Finally, she shares examples of living things, including moose, foxes, butterflies, flowers, and bugs...and, of course, herself!

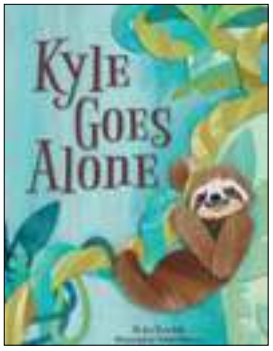
ISBN: 978-1-77147-156-5 HC
Ages: 4–8 • **Grades:** Pre-K–2
Lexile® Measure: AD530L • **Fountas & Pinnell:** F • **Reading Recovery:** 9–10

When Sammy, a young Wilson's warbler, wakes up one frosty August morning near the Arctic Circle, he instinctively knows that it's time to make his first migratory journey south to Panama. But there's one problem—where's Panama?

ISBN: 978-1-926973-88-3 HC
Ages: 5–8 • **Grades:** 1–3
Lexile® Measure: AD620L • **Fountas & Pinnell:** N

As snowshoe hare Lily learns the ways in which her forest friends prepare for winter's arrival, she becomes more and more worried about what she should be doing. Finally, the brown bear points out that Lily has been preparing without even knowing it: her fur is thickening and turning white to help her camouflage in the changing weather. This fascinating story introduces the ways in which different animals adapt to survive winter, complemented by illustrations in a mix of collage, drawing, and digital montage.

ISBN: 978-1-77147-002-5 HC
Ages: 5–8 • **Grades:** 1–3
Lexile® Measure: AD780L • **Fountas & Pinnell:** N



Kyle has to go. There's just one problem: as a young three-toed sloth, he lives high in the rainforest canopy with his mom, and it's a LONG way down to the forest floor. Like other sloths, Kyle only goes down to the ground once a week when he has to do his "business." And he's never made the journey by himself before.

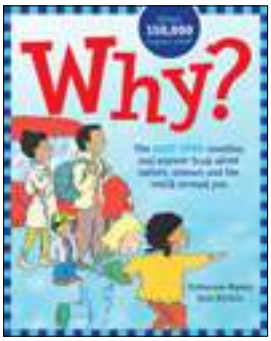
ISBN: 978-1-77147-075-9 HC
Ages: 3–7 • **Grades:** Pre-K–2
Lexile® Measure: AD340L • **Fountas & Pinnell:** K • **Reading Recovery:** 18

What's that sound? Starting with a simple question, *My House Is Alive!* takes readers on a tour of the basic inner workings of a house and explains the scientific reason for the knocks, thumps, bangs, and booms we hear. For example: that knocking sound in the walls? It's caused by the expansion and contraction of metal vents that carry air to heat your home. Creaking can happen when wood dries out, and buzzing can come from vibrating plates inside fluorescent lights.

ISBN: 978-1-77147-136-7 HC
Ages: 4–7 • **Grades:** 1–6
Lexile® Measure: AD630L • **Fountas & Pinnell:** M • **Reading Recovery:** 20

In *Skunk on a String*, we meet a skunk who has been tied to the tail of a balloon. Try as he might, the persistent critter can't get anyone to untie him. In this wordless story, he is shooed and swatted through a bustling parade, past the windowpanes of the city's apartment buildings with their diverse, busy inhabitants, then up to the construction cranes high above the city. He floats through the zoo, into traffic, under water, and eventually lands atop a Ferris wheel. When he finally unties himself, the skunk misses the aerial life—so he comes up with an inspired way to fly again.

ISBN: 978-1-77147-131-2 HC
Ages: 4–7 • **Grades:** Pre-K–2
Lexile® Measure: NP • **Fountas & Pinnell:** WB



Everyday childhood activities, such as an excursion to the park, splashing in the bathtub, or fixing a snack in the kitchen, can prompt many questions in young children. Why is the sky blue? Why does my stomach g-r-r-owl? Why do cows moo? Curious kids want to know, and no adult has all the answers.

ISBN: 978-1-926818-00-9 HC / 978-1-77147-321-7 PB
Ages: 3–7 • **Grades:** Pre-K–3
Lexile® Measure: AD810L • **Fountas & Pinnell:** M • **Reading Recovery:** 20

Wild Ideas looks deep into the forests, skies, and oceans to explore how animals solve problems. Whether it's weaving a safe place to rest and reflect, blowing a fine net of bubbles to trap fish, or leaping boldly into a new situation, the animals featured (including the orangutan, humpback whale, and gibbon) can teach us a lot about creative problem-solving tools and strategies.

ISBN: 978-1-77147-062-9 HC
Ages: 4+ • **Grades:** K–4
Lexile® Measure: AD560L • **Fountas & Pinnell:** M • **Reading Recovery:** 20

You Are Stardust begins by introducing the idea that every tiny atom in our bodies came from a star that exploded long before we were born. From its opening pages, the book suggests that we are intimately connected to the natural world; it compares the way we learn to speak to the way baby birds learn to sing and the growth of human bodies to the growth of forests. This innovative picture book aims to reintroduce children to their innate relationship with the world around them by sharing many of the surprising ways that we are all connected to the natural world.

ISBN: 978-1-926973-35-7 HC
Ages: 4+ • **Grades:** K–4
Lexile® Measure: AD770L • **Fountas & Pinnell:** N

ISBN: 978-1-926973-36-4 HC / 978-1-77147-310-1 PB
Ages: 5–7 • **Grades:** K–2
Lexile® Measure: AD560L • **Fountas & Pinnell:** K • **Reading Recovery:** 18

ISBN: 978-1-926973-82-1 HC / 978-1-77147-339-2 PB (coming Fall 2018)
Ages: 5–7 • **Grades:** K–2
Lexile® Measure: AD550L • **Fountas & Pinnell:** M • **Reading Recovery:** 20

ISBN: 978-1-926973-59-3 HC / 978-1-77147-153-4 PB
Ages: 5–7 • **Grades:** K–2
Lexile® Measure: AD640L • **Fountas & Pinnell:** M • **Reading Recovery:** 20

ISBN: 978-1-926973-87-6 HC / 978-1-77147-163-3 PB
Ages: 5–7 • Grades: K–2
Lexile® Measure: AD640L • **Fountas & Pinnell:** N • **Reading Recovery:** 20

As young readers journey into the natural world, they will discover that numbers, patterns, shapes—and much more—can be found by observing everyday plants and animals.

About the Author of This Guide

Judy Joel, B.A, B.Ed., is an independent educational consultant with over 30 years' experience teaching learners of all ages. She has taught in a variety of elementary schools for the Durham District School Board and worked as a Staff Development Facilitator for the district. Judy has facilitated domestic and international professional development workshops and presentations focused on curriculum, instruction, and classroom management strategies. She has a keen interest in effective teaching and learning practices that engage students in modes of thinking, exploration, and creation that are relevant in the twenty-first century.

Simple STEAM Classroom Activities

STEAM Learning and Inquiry – Where to Begin?

Creating a Wonder Wall

Primary students ask a lot of interesting questions and are naturally curious. You can start by letting students know that their questions are valued and have an important place in the classroom.

Creating a Wonder Wall can foster a sense of inquiry as the Wonder Wall becomes a place for student or group questions to be recorded, shared, and encouraged. The intention is not to necessarily answer all of the questions but to have a place where the class can catch their wonders. The Wonder Wall is a great start in inspiring wonder and inviting curiosity into your classroom.

The Wonder Wall can also be used to combine all the questions that arise as the class is exploring a particular topic or reading a book. Questions that are answered can be crossed off and new ones added. Often students are so intrigued with a question, they do some research on their own or with their family and come to class eager to share their discoveries.

Modelling how to form a question will help students practice STEAM learning and inquiry skills throughout the year. Below the title, "Wonder Wall," many teachers add wonder words as stems to help with forming a question:

- What...
- When...
- Where...
- Do...
- What if...
- How might...

Reading aloud the books ***Why?*** and ***My House Is Alive!*** to the class is a perfect introduction to a Wonder Wall. These books show that starting with a question can lead to learning information that helps with understanding the world around them better. ***You Are Stardust*** and ***Wild Ideas*** are also books that inspire thinking and questioning.

To further inspire questions for a Wonder Wall, have students read through a book in small groups from the STEAM Starts Selection. Each group can be assigned a different book (you may wish to assign roles). Give them a few sticky notes so that they can mark parts of the book as they are reading:

!!!!	Cool, we want to share	?	We have a question
???	Confusing	☺	We made a connection

Give each group a chance to share. More questions could be added to the Wonder Wall. The activity can be repeated so that students can experience a different book.

Allowing students to explore and pursue their interests within a broad array of non-fiction texts can help them appreciate that the world around them is intriguing, surprising, and thought-provoking. If these books are made available during independent reading time, students will be eager to select them.

There is no doubt that in a classroom where students are involved in creating a Wonder Wall, STEAM learning and inquiry will soon follow as questions are explored and discoveries are shared. Students will make more real-life connections and realize that we are always learning, growing, exploring, and experimenting.

Exploring Biomimicry

Big Idea: Problems and finding solutions to problems are a normal part of life.

Essential Question: How can humans use the amazing science of biomimicry to help solve everyday problems?

In this exploration, there are three books that will help capture student interest in solving problems:

- ***Wild Ideas*** will help primary students understand that problems are a normal part of life. In fact, ***Wild Ideas*** explores how animals big and small show an immense capacity for innovation—and the book encourages readers to seek inspiration and innovative ideas from the world around them just as scientists do.
- ***Is This Panama?*** is a picture book that can be shared at any point in the activity that follows to reinforce the values of perseverance and supporting one another as we move out of our comfort zones to learn.
- ***Skunk on a String*** is a delightful wordless picture book. The skunk in the story perseveres to solve the problem of being tied to a string and floating through the air. Working through STEAM challenges can be frustrating for students. You can bring some levity to your classroom during STEAM learning activities by sharing this book. You can also show students the book trailer.

Engagement Phase
Here are some ideas for engaging students in the topic and for building some background knowledge:

- Explain to students that problems are a normal part of everyday life and that you are going to read aloud a book about how different animals have solved some of their everyday problems.
- Read ***Wild Ideas*** aloud.
- After reading the book, have a discussion about how animals' solutions to their problems come from trying different ideas until they find something that works.
- Have students listen to one or two of the podcasts featured on OwlkidsBooks.com/WildIdeas. In each of the podcasts, author Elin Kelsey delves deeper into ideas from the book. Encourage students to listen to more of the podcasts at home.
- Work with students to create a chart of some of the problems for which the animals in ***Wild Ideas*** now have a solution. See Appendix A1 for a printable chart.
- Next, talk about how humans can learn from animals to solve problems. If you break down the word biomimicry, "bio" means life and "mimicry" means to imitate. Biomimicry means to imitate life or nature.
- Here is a video that helps explain Biomimicry, if you wish to show it:
  Video: "Biomimicry: Design by Nature"
  Source: carrickgareth, Our Renewable Nation, 2010

Introducing the Problem
Before starting a STEAM exploration with students, introduce them to the Engineering Design Process:

1. **Ask:** Engineers identify a problem that needs to be solved and do research by looking at books, reading information online, and watching videos. When researching, engineers often ask: what would nature do here?
2. **Imagine:** Engineers brainstorm ideas and choose the best one.
3. **Plan:** Engineers draw a design and gather materials.
4. **Create:** Engineers follow the plan and build what they designed, then test it out.
5. **Improve:** Engineers evaluate the model and ask: what can make it better?
6. **Share:** Engineers explain their results and new learning.

See Appendix A2 for a visual representation of this process.

Tell students that they are going to practice being engineers. Remember what we learned from ***Wild Ideas*:** when animals want to make something happen...they try and try again.

Here is a video that will help students learn to think like an engineer to solve everyday problems:

Video: "Jessi Has a Problem!"
Source: SciShow Kids, 2017

Learning Goals and Success Criteria
This is a good time to go over the learning goals and success criteria for learning the Engineering Design Process. These have been written in student-friendly language but can easily be revised to suit the needs of your students. See Appendix A3 for a form that will allow students to track their progress.

1. Ask
The goal of this section is to allow students to identify real-life problems. Model for them how to think of real problems by reminding them of some of the problems that have happened in the classroom:

- We need help to open a thermos at lunch.
- Our zippers on our winter coats get stuck.
- Our shoelaces keep coming untied.

Next, you can ask students to think about their homes, toys, games, clothes, school, and playground. Ask them to think of a time when they had a problem and needed help from an adult. Give them some time to think. They can give you a thumbs-up when they have thought of an idea. Have them talk to a partner. Students can then share ideas with the group while you record.

Here are some ideas that students have come up with:

- I can't reach my soccer ball in the garage.
- I can't fall asleep because it is too bright out.
- I can't hold on to my umbrella and play on the swing.
- I can't fit everything in my cubby.

After students have come up with problems, they each get to choose a problem to solve from the list. You may wish to have them work with a partner. If this is the first time the STEAM process has been introduced to your class, you may wish to work through a problem as a class.

Give students time to begin researching animal-inspired inventions and animals and their habitats. Have books, websites, and digital resources that you feel will be helpful to the students organized ahead of time. Give each student an information organizer to record different animal parts and human inventions that will help them solve their problem. See Appendix A4 for an information organizer for this task.

As the students work, circulate and confer with each student, noticing and naming the good thinking happening. Provide support and guide their research when necessary with prompting questions:

- Which animal would help you to...?
- Which body part reminds you of this...?

2. Imagine

Once the research is complete, students work with a partner "engineer" to brainstorm ideas for solving their problems. Using partnerships or small groups to share ideas allows students multiple opportunities to gather ideas from peers. Remind students that brainstorming is just a fancy word for coming up with ideas. They can use a brainstorming chart to record ideas. See Appendix A5 for a worksheet for this task.

3. Plan

Students pick their best idea. They are ready to work on a design. Students work at various speeds, so a method for keeping track of where students are in their investigation is important. One way is to have small icons or badges for each student and place them on the Engineering Design Process graphic (Appendix A2) to indicate the stage they are working on.

Circulate as students are working, noticing smart thinking and recording anecdotal observations. Listening will provide you with teaching points that you can work through with students through questioning, modelling, and re-teaching.

Next, it is time to review the designs and allow students time to make revisions. For example, students may come up with the idea of using suction cups on their feet to climb the walls of the school like a tree frog to retrieve lost balls. They have to be reminded that climbing the walls is against school rules, so changes to the design plan are required.

4. Create
To move to the next stage of the Engineering Design Process, materials will have to be collected that meet the needs of the designs. The materials will vary: recyclable items, boxes, PVC piping, string, masking tape, felt, hooks, old clothes, plastic cups, milk containers, Styrofoam packaging, cardboard, paper rolls, bubble wrap, etc. Parents and colleagues can be asked to donate their clean recycling to help with the project.

Give students time to build their models. A materials table can be set up for students to "shop" for supplies. It is a good idea to be at the materials table so you can give guidance on what might work.

Once students have their supplies, they can start to work. The teacher acts much like a facilitator by asking questions and reinforcing that mistakes are learning opportunities.

Students are encouraged to reflect and talk about:

- What works—what are the best design features?
- What doesn't work?
- What could work better?
- How can it be modified?

5. Improve
There will be many teachable moments as designs fail. Students will be testing out their models at different times. If a model works, they record their results and explain why they thought their design was successful. If the design doesn't work, the teacher can ask them to think about why it didn't work and try to find a way to fix the problem and rebuild. Materials can be kept for a series of days for redesign.

6. Share
Students can share how their design was created and whether or not it worked. If it didn't work and they haven't had a chance to redesign, they share next steps. This can serve as a formative assessment strategy to go along with the anecdotal notes that were recorded while you conferred with and observed students as they were working.

The Learning Goals and Success Criteria sheet (Appendix A3) can be used as a self-evaluation and reflection sheet for students once they have completed all of the tasks.

Investigating Animals through Guided Inquiry

There is no doubt that well-designed inquiry instruction provides students with richly engaging learning experiences that help them build skills and understand their world more deeply. The Inquiry Process is very similar to the Engineering Design Process. The stages include:

1. **Exploring:** initiating inquiry, choosing the topic, and developing questions
2. **Investigating:** designing the plan, selecting information, and formulating the focus
3. **Processing:** analyzing information, evaluating ideas, and organizing/synthesizing findings
4. **Creating:** making and presenting the product, assessing the product and process, and extending learning

The graphic below from the Ontario Library Association is a helpful tool as you work through the stages with students:

Taken from: Discovery and guided Inquiry – Together For Learning
Source: Ontario Library Association, 2018

The **STEAM Starts Selection** of picture books outlined at the beginning of this guide are especially well suited to kicking off an inquiry learning experience. They capture the minds of young students as they look and read like picture storybooks, but their purpose is to provide accurate information. See Appendix A6 to introduce Learning Goals and Success Criteria.

1. Exploring

Initiating inquiry is a stage that is sometimes rushed through so that students can get on with the task of research. If time is put into this stage, students have a chance to build interest, think about what intrigues them, and draw on prior knowledge. This can be spread over several days. In this phase, encourage students to be curious and excited about inquiry.

Read ***I Am Josephine*** to students for an initial spark.

Before reading

- Have students look at the front cover and elicit predictions on what they think this book is about.
- Read the book aloud without pausing, allowing students to experience the book completely and to enjoy the text and illustrations.

After reading

- Ask students what kind of book they think it is. Is it a storybook or an information book? If your students are familiar with the terms **fiction** and **non-fiction**, you can use that terminology. The discussion will get interesting, as the book is informative but different from a more traditional non-fiction book.
- Ask what they learned from the book about living things, animals, mammals, and human beings. It would be helpful to use a document camera to have the page pictured below for students to look at.
- Ask students why the informational pages at the back of the book have been set up in this way, compared to the rest of the book. Students should notice that the informational pages are in point form and act as a summary of the important information in the book.
- Ask them how they feel about information being presented in this way.
- Ask if they know of any mammals that are a lot like human beings. Point out that the way the information is set up on the informational pages makes it easy to find the answer to that question.
- Explain that the different ways that authors organize text are called "text features" and that text features help the reader understand important information and key messages in the book.
- Sum up the discussion by explaining that reading ***I Am Josephine*** is a great start to learning about animals because it gives us information about their characteristics in a way that we can understand.

Extend the discussion

- Working as a whole group, have students generate questions they would like to explore to learn more about animals. The questions at this point need to be general and not specific to any one animal. Keep the informational pages from ***I Am Josephine*** in view to help with formulating questions.
- Record the questions on the board under the heading: "What We Wonder about Animals." Questions usually include: what the animal looks like, if it has four legs, if it has hair or fur, if it lays eggs, what it eats, where it lives, if it has babies, how it moves, etc.

In the next session, read aloud ***Kyle Goes Alone***. It will serve as another spark in this exploratory phase of inquiry.

Before reading

- Explain to students that this book is about Kyle, a sloth that lives high up in the rainforest. Sloths never go down to the ground except for one reason. See if students can guess. This can be quite humorous as students think about what Kyle may need to do on the ground.
- Read the story part of the picture book, but stop once you get to the informational section.

After reading

- Have students recall all the animals Kyle meets as he very slowly makes his way to the forest floor. Make a list of the animals on the board.
- Next, show students the last two pages of the book, which provide factual information about three-toed sloths and the camouflage of other animals. Read the information aloud. Suggest to students that reading the information might make them feel like re-reading the book and taking a closer look at all of the animals hidden in the illustrations. There are so many really interesting animals to learn about.
- Explain that students will have a chance to study an animal that they want to learn more about. They will have some time to think about this. In the meantime, share another book to offer more ideas about interesting animals.

Next, introduce students to ***Winter's Coming***.

Before reading

- Explain to students that ***Winter's Coming*** is written in the same style as ***I Am Josephine*** and ***Kyle Goes Alone***. It reads like a picture storybook, but its purpose is to provide accurate information.
- Ask students if they have an idea of what they might learn from this book. They may come up with the idea of a rabbit getting ready for winter.
- Ask students how they get ready for winter, as well as the other seasons. Let them know that this book is about Lily, a snowshoe hare, who learns about winter and what she should do to prepare for its arrival. Read the story part of the book to students.

After reading

- Have a discussion about how the book helps us learn about the changing seasons and their impact on animals.
- Draw attention to how Lily learns by wondering, asking questions, and seeking answers, which is what students will be doing for their animal research.
- Also discuss the fact that the book's author would have spent time researching before writing, because the author's purpose is to give us accurate information about the animals.
- Have students recall the animals that they met in the book and add the animal names to the board.
- Show the class the last pages of the book, "Animal and Environment Facts." Use a document camera if available to show the pages.
- Let students know that they are going to study one animal together as a class to learn some research skills before studying an animal on their own. Decide on either the three-toed sloth (***Kyle Goes Alone***) or the snowshoe hare (***Winter's Coming***). You can have a class vote, or you may wish to choose one for the class depending on available resources.
- Now that the class knows which animal they will be studying, revisit the list of "What We Wonder about Animals." Ask if there are any questions that students want to eliminate or change. You can revise the list according to their responses but also to ensure that most questions will require some research and more than a one-word answer.

2. Investigating
Assign different groups of students different questions. Once students know the questions they are responsible for collecting information about, give them time to look at resources (books, websites, videos) more closely. Students can then decide which resources will be best for their group to use. Each group should have a chance to have a closer look at the books, ***Kyle Goes Alone*** or ***Winter's Coming***.

Audience is important in writing. Coming up with an audience for the research at the beginning will help students think of ways to effectively present their information. An audience could be another class that is also investigating an animal, which makes sharing information fun for students.

Once student groups have found resources that they think will help them answer the question(s) they are responsible for, they can start to record information. They will need a graphic organizer. Model how to use the graphic organizer by creating an anchor chart and using a resource to answer one of the research questions as a class. You may wish to have students use electronic tools, such as SMART Ideas, Padlet, or Bubbl.us, as information organizers. Have the source text on an interactive white board if possible and highlight key words and phrases that answer the research question before recording on the anchor chart.

See Appendix A7 for an Anchor Chart information organizer (EXAMPLE) for this task and Appendix A8 for an Anchor Chart information organizer (BLANK).

Now, give student groups time to answer the research questions they are responsible for. It is important to confer with students as you move around the room while they are completing their research. This allows you the opportunity to take anecdotal notes and also to see which students need more guidance and which students can be challenged. Students often need direction in choosing a resource at an appropriate level and a resource that will answer their research question. Encourage students to use all of the text features of the non-fiction texts to help. Also, encourage them to share what they find exciting or interesting.

Some questions to have in mind while you are conferring with students:

- Does the information you recorded help answer the research question?
- Can you show me where you found the information?
- Do you understand what that means? If you don't understand, what could you do next?
- Are you using the text features to help you understand what you are reading?
- Have you found information that is exciting or interesting to you?
- Can you tell me more so I can understand what you mean?

3. Processing
Meet as a whole class so that students can share their discoveries. This sharing time can be very valuable instruction time as you discuss the progress of the research and students learn what it is like to go through the process. A Knowledge Building Circle works well for sharing of inquiry discoveries. See Natural Curiosity: Building Children's Understanding of the World through Environmental Inquiry.

Ask students:

- What information still needs to be collected?
- Did you find some interesting information that did not really answer one of the questions we have? Should we add a question so that we can include this information? This helps students understand that during an inquiry, you may have to adjust your questions and that is okay.
- Are there any questions that you could not find answers to in the resources you had available?

Students can help each other out here. One student may have come across information that another student needs and can point them in the right direction. Let them know there are times when you might have to leave a question for another time.

Give students more time to finalize their research and make any revisions that came to mind after the discussion.

Make large charts with the research questions and post the student research pages under the appropriate question. This information will be used for the creation of a final product.

4. Creating

To culminate this whole-group investigation, introduce students to ***Why?***—a book they can use as a template to create their own book for other primary classes in the school. Explain that ***Why?*** is a little different from ***I Am Josephine***, ***Kyle Goes Alone***, and ***Winter's Coming***: there is no story to go along with the information.

Background work

- Read aloud a few pages of the book ***Why?*** and ask students how the information is presented.
- They will notice that the book is framed around questions followed by answers that involved research.
- They will also notice different fonts, the table of contents, the index, bolded words, and the illustrations.
- Compile all of their ideas on a chart titled Non-Fiction Text Features. Explain that non-fiction books often have many features to help the reader understand and find the information they are looking for.
- Have students consult the chart as they work in groups to create a page of a book.

Book creation

- Remind students that their audience is other primary classes.
- Working in groups with their animal research question, have students decide how they are going to communicate their ideas to answer the question.
- Have students make a mock-up of their book page.
- Share the mock-ups between groups so students can make note of parts that work well and parts that could be revised.
- The teacher will confer with student groups about their mock-ups and give them approval when they are ready to publish their final page.
- Have students type up the content and then illustrate, using the book ***Why?*** as a prototype. Groups that finish first can be assigned the tasks of creating a cover page, a contents page, and an index.
- Put the book together and make up a schedule so that groups of students can share with different classes. If there is a large space in the school learning commons, a sharing time could be organized and the whole class could present their book by assigning different parts to each student.
- Spend some time reflecting upon what students have accomplished by working through the inquiry research process. Students and teacher can share what they noticed, felt, and discovered. Record reflections in a chart with the title of Inquiry Research and the headings Looks Like, Sounds Like, and Feels Like. See Appendix A9 for a Y Chart information organizer for this task. The following points can help guide the "celebration reflection":

  Exploring

  - We chose a topic.
  - We got excited about the topic through information presented in different ways.
  - We came up with research questions.

  Investigating

  - We learned about the different types of non-fiction books available.
  - We chose resources to answer the research questions.

  Processing

  - We used non-fiction to learn about a topic.
  - We recorded key information on a graphic organizer to answer a research question and shared findings.
  - We looked at the information closely and revised.

  Creating

  - We made a final product.
  - We shared the findings with an audience.

Independent research

- A lot of interest and questions about animals have already been initiated. Students are now ready to choose an animal that they would like to know more about and to work through an inquiry on their own or with a partner.
- Have students choose an animal from the chart that was created during the class inquiry.
- Provide a research folder with a checklist for students to keep track of their progress through the stages of inquiry. See Appendix A10 for a checklist for this task.
- Give students time during independent reading to explore non-fiction books on animals. They will want to revisit the books you read aloud for the class inquiry. Encourage them to jot down interesting questions about their animals that come to mind as they are exploring the books.
- If your school has a teacher-librarian on staff with a schedule that allows for time to work with classes, this can really help during the stage when students are collecting information to answer their research questions. Organize a planning meeting with the teacher-librarian and schedule some time for the class to work in the library. Teacher-librarians can also help with finding appropriate resources once students have finalized their research questions.
- For the final product, students can create a report of their findings or a book on their animal. Another option is to work through **STEAM Exploration: Constructing an Animal Habitat** in this guide, which focuses on the habitats of the animals students have researched.

Note for Teachers

Encouraging reading of non-fiction has many benefits. Research has indicated that reading informational texts is just as important as reading narrative texts.

One reason reading nonfiction may be so important is that it helps students develop their background knowledge, which itself accounts for as much as 33 percent of the variance in student achievement (Marzano, 2000). Background knowledge becomes more crucial in the later elementary grades, as students begin to read more content-specific textbooks (Young, Moss, & Cornwell, 2007) that often include headings, graphs, charts, and other text elements not often found in the narrative fiction they encountered in the lower grades (Sanacore & Palumbo, 2009).

— Extracted from "Research Says / Nonfiction Reading Promotes Student Success," *Common Core: Now What?* 70, no. 4 (2012–2013): 80–82.

STEAM Extension: Creating and Using Maker Space in Your Classroom

What Next? A Maker Space in Your Classroom

Once you have progressed through the **Simple STEAM Classroom Activities**, deepen learning through more complex and hands-on **STEAM Extensions**.

In classrooms that have been working through STEAM lessons, students often ask for materials. You might hear: "Is there any more copper tape?" Or: "Can I have the leftover materials?" If questioned as to why they would like the materials, the typical response is that students have an idea of something that they would like to try and build.

Capturing this interest by creating an area for students to design, experiment, build, and invent has become increasingly popular in schools. There is no shortage of excellent resources online with tips and ideas to get you started.

Many teachers start by stocking a space in the classroom with items that are typically found around the house or at school. You can even include old toys and electronics that students can take apart to see how they work. Make sure there is a table with room for three or four students to work and a spot for displaying creations.

Keep books such as these in the area to inspire ideas:

- ***Why?***
- ***You Are Stardust***
- ***Wild Ideas***
- ***My House Is Alive!***
- **Math in Nature series**

Once you have an area established and you have worked out procedures and cleanup routines, you can always add items such as electrical kits if you find you have funds to access them. Often a school community council will donate funds to classrooms to support maker spaces.

The Ontario Government research monograph "Meaningful Making: Establishing a Makerspace in Your School or Classroom" will set you on the right path once you are ready. The author of the monograph, Canada Research Chair in Technology and Pedagogy Janette Hughes, is responsible for the STEAM3D Lab, which compiles many resources to support teachers.

Watch a video interview with Janette Hughes here.

STEAM Exploration: Constructing an Animal Habitat

The Animal Inquiry leads very well into a STEAM exploration in which students work to design and construct a habitat diorama for the animal they have completed research on. They will be given the added challenge of creating a model that shows the basic needs of the animal. Students will follow the Engineering Design Process to complete the construction (Appendix A2). The process will help to activate prior knowledge, utilize resources, and evaluate their work.

1. Ask
How can a diorama model of an animal habitat be designed to show the basic needs of an animal?

2. Imagine

- Start off the research process by showing the "What Living Things Need" video. The video engages students as they learn that living things need food, water, and air.
- Ask students to turn to a partner and see if they can think of any other things every animal needs that weren't mentioned in the video. They should come up with habitat or shelter, but you may need to add temperature.
- Explain to students that when they design a diorama model of a habitat for their animal, they will have to keep in mind that every animal needs a place to live that meets all of its needs. It has to be a place where it can find food, water, oxygen, and the proper temperature. A habitat also gives them shelter from bad weather, protection from predators, and a place to raise their young.
- Some students may have discovered through their research whether or not the animal is warm- or cold-blooded. These are things they will need to consider in the design of their diorama habitat. Many warm-blooded animals regulate their own body temperature, but some have to find a place to hibernate in winter to avoid cold temperatures. Cold-blooded animals take on the temperature of the environment, so when building the diorama model of their habitats, students may not have to consider temperature as much.
- Before students begin brainstorming all of the things they will include in the diorama model of the habitat, introduce the **Math in Nature series** of books, which gives visuals of a variety of habitats and can be used to help students think of ways to meet the needs of the animal.

Read aloud ***Counting on Fall*.**

Before reading

- Explain that this picture book has a lot of math ideas in it, but students do not need to focus on that. Have them focus instead on the illustrations, which show different animals in different habitats.

After reading

- Revisit the page with the squirrels. Ask students if they can see all of the squirrels' needs being met (food, water, shelter, air, temperature).
- They will notice the acorns for food, the trees for shelter, and the sky in the background, which indicates air all around.
- They will point out that there is no water, but if a picture of a pond were added then it would meet the project requirements.
- Turn to the pages with the bears and ask the same question. Students will notice the bear has berries for food and will notice sky indicating there is air all around. Discuss again how a pond or river might be added to show water and a hollow tree for the bear to curl up in when it is time to hibernate. This type of discussion can continue with other pages from the book that you feel work best.
- All of the books in the **Math in Nature series** are valuable to have on hand for this design challenge as they feature animals in their native habitats. The books can really inspire the students to create accurate diorama representations of the animal's habitat and spark more specific questions about habitat.
- If you feel that students need a little more in-depth information, you could have them complete a RAN (Reading and Analyzing Non-Fiction) graphic organizer. As they look through the information they have already gathered, they can review and confirm what they know about the animal's habitat and add new knowledge as it is gained from the resources available. The resources should include a selection of websites, non-fiction books, and articles about each student's selected animal that are appropriate for the primary level. See Appendix A11 for a RAN Graphic Organizer for this task.
- Revisit the books from the **Math in Nature series** and draw attention to the illustrations. Ask how students think the illustrator made the pictures. They should notice that the illustrations are made of paper. Show students illustrator Ashley Barron's website to see some of her cut-paper collage technique. Show them the video on how she made Kyle for the book ***Kyle Goes Alone***. It is sure to inspire them as they start to think more about building a diorama model for the habitat for their animal.

3. Plan

- Give students a chance to brainstorm some ideas of things they will need to include in the design of the habitat for their animal. For their diorama model, they will focus on the four basic needs: food, water, shelter, and air. See Appendix A12 for a STEAM Design Organizer for this task.
- After brainstorming, have students share their ideas with a partner or in a small group. They will listen to each other's ideas to see if the animal's needs are being met.
- Have students help each other revise their ideas. Approve each student's plan before they move on to the creation stage.

4. Create

- The students are ready to create their diorama model. This will take a few class periods. It is helpful to give students some ideas for creating their dioramas.
- Read aloud the book ***You Are Stardust***, having students pay special attention to how the artwork has been created. Discuss some of the techniques they see. For example, students may really enjoy the way that running water is shown tumbling out of a large glass on one of the pages.
- Artist Soyeon Kim explains how she creates a diorama at OwlkidsBooks.com/YouAreStardust. Instructions for creating a diorama are given on this page as well. This information can inspire students and give more ideas for supplies that work well.
- Confer with students and help them bring their dioramas and ideas to life. You may have to help search for an appropriate material or picture if students are stuck. Ask questions as they work, like: "How does your animal get water? Oh, from a river? Can you show me where the river is in your diorama?"
- Have a chart posted with the following questions so students can check to see if they are on track with their model:
  - What kind of food does your animal eat?
  - How does your animal get water?
  - What kind of shelter does your animal need?
  - How does your animal get air?
  - Does your animal need a place to hibernate?

Suggested materials

- 1 paper box lid per student
- Construction paper in various colours
- Crepe paper in various colours
- Glue and tape
- Markers and crayons
- Assorted building supplies, including Popsicle sticks, egg cartons, cotton balls, and pipe cleaners

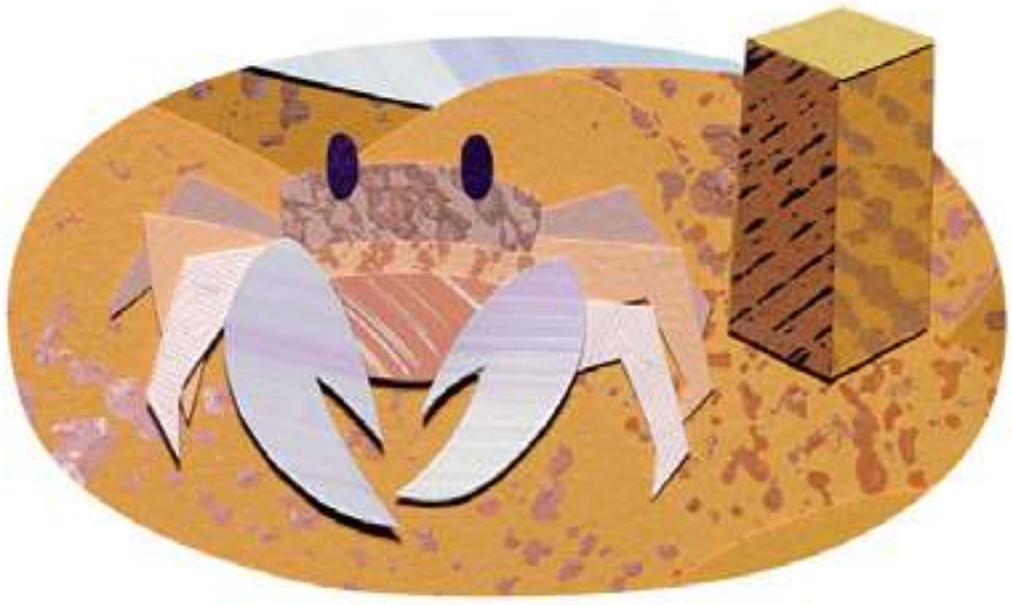
5. Improve

- Once students have completed their models, give them a chance to check their models in small groups. Students should use the posted chart of questions as their guide with two more questions added:
  - What do you really like about your model?
  - Is there anything you would like to improve or add?
- Have students record ideas they have for improvements in pictures and/or words. Allow time to make improvements to their model.
- This can serve as a formative assessment strategy to go along with the anecdotal notes that were recorded while you conferred with and observed students as they were working.

6. Share

- Record videos of students sharing their models and information about the habitat of their animal and how each habitat shows the animal's basic needs are being met.
- The Learning Goals and Success Criteria sheet can be used as a self-evaluation and reflection tool for students once they have completed all of the tasks. See Appendix A13 for a success criteria sheet for this task.

This STEAM exploration is adapted from:
https://betterlesson.com/lesson/629786/stem-lab-basic-needs-and-habitats



STEAM Exploration: Creating a Light-Up Picture

If budget allows, there are many hands-on resources available to purchase that add excitement to STEAM learning in the classroom. Chibitronics has materials that lend themselves to combining arts and crafts with electronics and programming. Primary teachers have found Chibitronics Circuit Stickers to be easy to work with in the classroom and extremely engaging. The stickers allow students to engineer a circuit through playing and crafting. The website offers templates, videos, and project ideas to guide teachers.

Creating a light-up picture or card is a STEAM exploration that will show students how to engineer a circuit as well as design and decorate a piece of artwork.

To get started on a project using Circuit Stickers you will need to have all the necessary materials at hand and you will need to make a couple of simple light-up picture cards yourself. Consult the Chibitronics website. Classroom packs are available.

Materials for each student

- 1 (3V) coin cell battery. Note: store batteries separately and away from other bits of metal—accidental connections can drain the batteries.
- 1 binder clip
- Conductive copper tape. Caution: the edges can be sharp.
- Small LED light

The simple circuit template:
https://chibitronics.com/wp-content/uploads/2017/04/Chibi_tricard_template-4.pdf

Books to inspire the final product design

- ***You Are Stardust***
- ***Wild Ideas***
- **Math in Nature series**

Art supplies suggestions

- Scissors
- Glue
- Different types of paper, cardstock, construction paper
- Pencil crayons

Big Idea: Knowledge from different areas can come together to create a new idea.

Essential Question: How can art and the knowledge of how to build a simple circuit be combined to create a more engaging picture book?

Engagement Phase

The **Math in Nature series** books are a great way to set the scene for this STEAM exploration. Pick one to read aloud, perhaps the title corresponding to the current season.

Before reading

- Ask students to think about why this is a good book that teachers would like to have in the classroom.

After reading

- Have students explain why they think teachers would like the book. They should come up with learning about science and math. They might add that the book makes students think and it has nice art.
- Point out that most man-made things in our world are the result of combining information and ideas from different things we study. This book combines science, art, and math.
- Let students know that in the next activity, they will be combining different information and ideas to create something new.

Introducing the Problem

Give students the scenario that the publisher would like to add some light-up pages to their books and needs some help. Our class has been asked to redesign some of the pages in their books so that they have a section that lights up. Review the Engineering Design Process with students using the graphic (Appendix A2).

1. Ask

- Pose the problem for this challenge: How can I make a part of a picture light up?

2. Imagine

- Explain that you will be guiding students through information that you have researched so that they have enough knowledge to complete the challenge.

3. Plan

- In order to make something on a page light up, explain that students will need some special materials.
- Using the template provided by Chibitronics, demonstrate how to make the circuit with the materials provided. As you work through the steps on the template, you can ask questions such as:
  - What would happen if...?
  - Why do you think that...?
  - How would you...?
- You could also show the "Star Card" video that is available on the Chibitronics website.
- Once the circuit is complete and working, show students a page that you have redesigned from one of the books. For example, you could colour copy or make a drawing of a page in ***Wild Ideas*** and have a part, like a star, light up.
- Give students different books with preselected pages and have them decide what could light up. It could be a moon, a star, or the sun. You can have a few students use the same page. Some examples of good choices:
  - ***Shaping Up Summer*** — sun, p. 3
  - ***Why?*** — star, p. 83
- Give students a chance to sketch a plan of the page so that it has one part that lights up. Explain that the picture does not need to look exactly like it does in the book, but it should convey the same idea.
- Have students share their plans with another student, making sure they point out the part that they plan to light up.

4. Create

- Students can now be given the template and materials to create their simple circuit. Once some students have a working circuit, they can place it under the plan they sketched.

5. Improve

- Give students who do not have a working circuit the chance to troubleshoot with other students. For example, another student may suggest that they check to see if their connections are strong enough. Give them time to revise and make improvements.
- Students will move on to creating a final version at different times. The final version of the light-up page can be created with cardstock, construction paper, pencil crayons, etc.
- You may wish to have students use a cut-paper collage technique similar to the illustrations from the books. This is a great opportunity to tie in some art lessons.

6. Share

- Have a sharing time so successes and challenges can be discussed. Use prompts such as:
  - How were you able to be successful?
  - What challenges did you have?
  - How did you fix the problem?
  - Would you do anything differently next time?
- Once students are happy with their final version, have them use the Learning Goals and Success Criteria checklist as a self-assessment and reflection tool. See Appendix A14 for a checklist for this task.
- Have a class reflection time to summarize the activity. Questions can be added to the class Wonder Wall. You can prompt with: What would you like to be able to do next with the circuits you have created? What more would you like to know about circuits?

Resources to ensure success:

- Quick Start Guide: Sticker Circuits
- Chibitronics: Introduction

STEAM Exploration: Making A Waterproof Roof

Big Idea: Problems and finding solutions to problems are a normal part of life.

Essential Questions: How do engineers decide what to design and build? How do engineers decide on materials for their designs?

Engagement Phase
Read aloud ***My House Is Alive!*** before this STEAM exploration about materials and structures to help students appreciate the importance of science in our everyday world.

Before reading

- Ask students if they have ever heard any noises in their house that have woken them up in the night or scared them.
- Explain that in ***My House Is Alive!***, a little boy finds out the scientific reasons behind the sounds.

After reading

- After reading the book, talk about how engineers design and build objects to make our life easier and more comfortable.
- A house is a good example of this: it has been designed to protect the people inside from hot, cold, windy, and/or rainy weather. If you were an engineer working on designing a roof for a house, you would need to make sure it did not let rain in.

Introducing the Problem
In this activity, students will be doing some research on materials to see if they are waterproof. Explain that this research will help them later as they work on a design for a roof of a house. Refer to the Engineering Design Process (Appendix A2).

1. Ask
How can I design a waterproof roof with the materials provided by the teacher? Which materials are absorbent and which are waterproof?

Materials

- A variety of materials that are absorbent and waterproof. Some ideas are: wax paper, burlap, netting, paper towel, cotton fabric, tin foil, etc.
- Construction paper cut-outs of people (use construction paper as it changes colour when wet)
- Spray bottles
- Sheet pan
- Basic square house frames, without roofs, assembled with cardboard and a glue gun or wood and nails

Instructions

- Hand out a variety of materials to different students. Have them work alone, in partners, or in small groups. Make sure that each student or group has at least one material that is waterproof.
- Do a quick demonstration with a sponge or paper towel to make sure they understand absorbency.
- Have students use their spray bottles to spray a little bit of water on their table. Next, they will use the sponge or paper towel to wipe up the water. Invite them to describe what happened. Explain that water was absorbed into the material.
- Looking at the materials in front of them, have students predict which are waterproof and which will be absorbent.
- Students are now ready to test the variety of materials they have been given. Instruct them to place one of the materials on top of one of the people cut-outs as a covering. Next, they will simulate rain by spraying the covering material with water. Do this for each of the materials provided.
- Ask students to describe any observations, e.g., water beading on a surface, water being absorbed into the material. When they carefully remove a covering, it should be apparent which materials are not waterproof.
- Have students record their observations on a handout. See Appendix A15 for a handout for this task.
- Students can then share results. Lead a discussion about what they noticed about the materials that were waterproof compared to the materials that absorbed water.
- Let students know that they will be given a chance to brainstorm ideas for materials that they could use to make a roof for a house. Remind them that their research will help them.
- Refer back to the page in ***My House Is Alive!*** that explains some properties of wood. That knowledge can help in material selection, too.

2. Imagine

- Give students an opportunity to brainstorm ideas about what they can use to make the roof of their house. They can use the STEAM Design Organizer sheet to record ideas. See Appendix A16 for an organizer for this task.
- Remind students that brainstorming is just a fancy word for coming up with ideas. Using partners or small groups to share ideas allows students multiple opportunities to gather ideas from peers.
- Ask students to pick their best idea and check it off on the sheet. They are now ready to work on a design.
- This is a good time to go over Learning Goals and Success Criteria with students. See Appendix A17 for a handout for this task.

3. Plan

- Have students plan their designs. Approve each design before the creation stage.
- Give students the base of a house made in advance out of cardboard or wood. You will want to test out one first before starting the activity with students.

4. Create

- Make a variety of materials available on a table for students to build their roof. Students can use one material or combine a few. Students may bring materials from home that they would like to try as well (fabrics, burlap, plastic, wax paper, foil, craft wood, materials from the recycling box, etc.).
- After students have their supplies, they can start to work. The teacher acts as a facilitator by asking questions and reinforcing that mistakes are learning opportunities.

5. Improve and 6. Share

- Once all the students have a roof they feel will be waterproof, it is test time. Place each house in an empty pan on a platform. Pour water through a strainer to simulate rain. Place a dry piece of paper towel inside the house to see if the roof leaks. Use a standard amount of water—one cup, for instance.
- If a student's design works, have them explain why they thought it was successful.
- There will be many teachable moments as designs fail. If the design doesn't work, students can offer suggestions on how the roof could be improved. Ask them to think about why it didn't work and try to find a way to fix the problem and rebuild.
- Keep materials out for a series of days to allow for redesign.
- Use the Learning Goals and Success Criteria sheet as a self-evaluation and final reflection tool (Appendix A17).

STEAM Challenge: A Strong and Stable Structure

Big Idea: Both people and animals build structures and need them to last a long time.

Essential Questions: What factors affect a structure's strength and stability? How do different shapes affect strength and stability? How do engineers decide on materials for their designs?

Engagement Phase
My House Is Alive! can be used as a springboard for this activity.

Before reading

- Explain that this book is about all the sounds a house can make.
- Ask students if they have ever felt scared of different sounds they have heard in the night.
- The discussion can continue by letting them know that the noises that they hear can be explained by science and how knowing this can alleviate fears.

After reading

- Read aloud and discuss how information from science can help us in everyday life in many ways.
- Discuss how engineers are responsible for the design of many things in a house, including the buildings themselves, and that engineers need to know a lot about science when designing. For example, revisit the page that explains that wood expands and shrinks. In designing a building, an engineer would have to take this scientific information about the material into consideration.
- Explain how the Engineering Design Process includes a research phase so that information can help us as we create.

Introducing the Problem

- Review the Engineering Design Process with students (Appendix A2) and explain how they will be working through it as they investigate a problem about how to make buildings strong and stable.
- Revisit the page in ***My House Is Alive!*** that talks about the weight of the house. Discuss the fact that a house weighs a lot and has to be able to withstand the weight of many heavy things.
- Flip through the pages of the book while students point out some of the very heavy things that a house has to be able to support (refrigerator, toilet, furniture, stairs, people, etc.).

1. Ask

What is the tallest structure you can build as a team that will support the weight of a golf ball for at least two minutes (using the materials provided by the teacher)?

- Refer to the Engineering Design Process and tell students they will be doing some research just as a team of engineers would before working on a design.
- Explain that you are going to help them with the research by doing a demonstration and showing them a YouTube video.

Demonstration

- Take a piece of cardstock at least 8.5 x 14 inches.
- Fold the cardstock lengthwise several times, making an accordion shape.
- Use two thick books (ideally an inch thick each) as supporters and place the cardstock across them like a bridge.
- Ask students what they think will happen if you stack two more books on top of the paper bridge.
- Test it out and see what happens. Ask students what they notice. They will notice that the paper is able to support a weight much heavier than itself.
- Questions to ask: Would the paper have supported the books if it weren't folded? (No.) What did the folds do? (Made the paper stronger.)

Video: "Strong Structures with Triangles"
Source: Design Squad Global/PBS Kids, 2017

- Have a discussion about some of the big ideas from the video:
  - Structures need to be strong and stable.
  - Certain shapes can change the strength of a structure.
  - Structures are affected by forces acting on them.

2. Imagine

- Show the students what materials they will be given to complete the challenge. Some suggestions: pipe cleaners, straws, paper clips, toothpicks, Plasticine.
- Have students brainstorm some ideas for their structure. Encourage them to think about what they have just learned from the research phase as they record ideas. See Appendix A18 for a STEAM Design Organizer for this task.

3. Plan

- Following their brainstorm, students can move on to drawing a design of their structure.

4. Create

- Once you have approved their design, student teams can build their structures. Remind them of the goal: to build the tallest structure that will support the weight of a golf ball for at least two minutes.
- For this challenge, having a time limit works well.

5. Improve

- Following the time limit, have the student teams test their structures as a team. During the testing, have students discuss in their teams what worked well for them and how they think they could improve their structure. Circulate amongst the groups and ask questions such as:
  - What shapes did you notice are strongest?
  - Did you try pushing one way or the other as you were building to see if your structure would collapse or not?
  - How did you make it stronger?
  - How did you take advantage of triangular shapes in your structure?
  - Do you think you could make it even stronger and more stable? How?
- Give the teams a chance to record ideas for improvement and another time limit to build again. Once the time allotted is up, students will be excited to see which team built the tallest structure.

6. Share

- The big test comes next, finding the tallest tower that is able to hold the golf ball, for two minutes.
- After each tower is tested, the students who created the tower can describe their structure, explaining the design features and the improvements they made during the design process and why. The improvement may be that the structure can hold much more weight than a golf ball, in which case, they can be given a chance to demonstrate. Also have students explain what they might do differently if they had a chance to build another structure or spend more time on this one.
- Continue testing the structures, giving other groups a chance to describe their structures in the same way.
- Have students share what they notice about the different structures. Some questions that could spark discussion are:
  - Which structure looks the most stable?
  - Which one might have turned out to be the tallest and strongest if there was more time given?
- Create a comparison chart of the height of each tower to model how to measure and what unit of measure works best for the situation.
- Have students notice information about the data, such as the difference between the height of the tallest tower and the second tallest tower or between the tallest and the shortest.

Appendix A: Printable Handouts

A1

Activity: Exploring Biomimicry

Chart: Animal Problems and Solutions

Task: Identify problems for which the animals in ***Wild Ideas*** now have a solution.

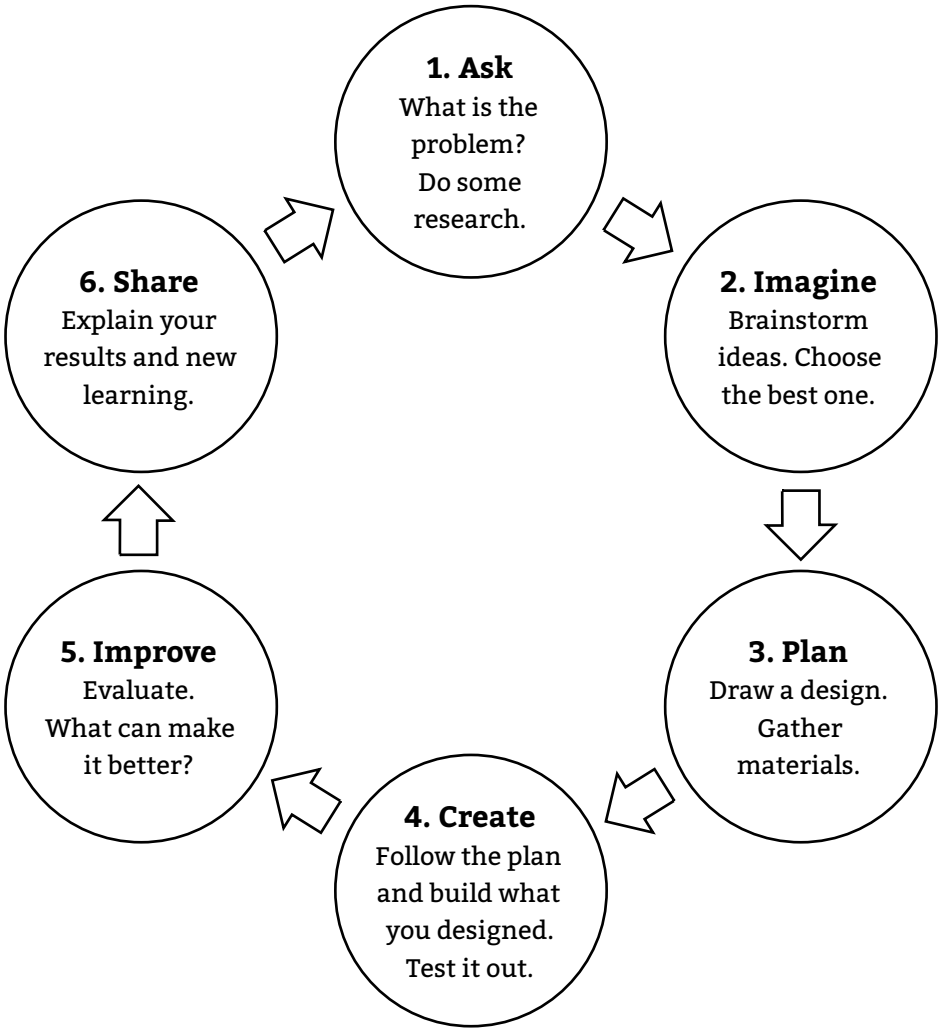
Problem	Solution
Squirrels: need to cross the road	Observe people
Orangutans: need a place to rest, plan, and think	Weave safe places to rest
Chimpanzees: need a cool drink of water	Fold leaves to use as a spoon

A2

Activity: Multiple

Chart: Engineering Design Process

Task: Learn to think like an engineer.



A3

Activity: Exploring Biomimicry

Chart: Learning Goals and Success Criteria

Task: Track progress while learning the Engineering Design Process.

Learning Goal

1. We are learning how to work like an engineer to design and create a model.
2. We are learning how studying animals can be helpful in solving everyday problems humans might have.

Success Criteria	Not Yet	Getting There	Got It!
I came up with an everyday problem to try and solve and had it approved by my teacher.			
I did some research on different animals to gather information that could help solve the problem. I recorded information on the organizer page provided.			
I brainstormed ideas that could solve the problem. I shared ideas with a partner, and I picked my best idea. I had my idea approved by the teacher.			
I drew a design of my solution with labels and had it approved by the teacher. I explained what animal feature inspired me.			
I showed perseverance as I created and tested a model.			
I explained why my model was successful or not. If it was not successful, I looked at my model and any problems with the design. I came up with next steps. I made improvements.			
I kept track of what stage of the Engineering Design Process I was working in.			

Final Reflection

Something I am proud of:

Something I learned that surprised me:

Something I wonder about:

A4

Activity: Exploring Biomimicry

Chart: Information Organizer for Animal Problem-Solving Research

Task: Record different animal parts and human inventions that will help you solve your problem.

Name:

Date:

Animal Parts	Human Invention
Elephant trunk	Robotic arm
Bird skulls	Lighter, stronger building materials

A5

Activity: Exploring Biomimicry

Chart: Brainstorming for Animal Problem-Solving

Task: Brainstorm ideas that will help you solve your problem.

Name:

Date:

Problem:

Ideas:

My design solution:

Did it work? How can I improve it?

A6

Activity: Investigating Animals through Guided Inquiry

Chart: Learning Goals and Success Criteria

Task: Track progress while learning the Inquiry Process.

Learning Goal

We are learning the Inquiry Process.

Success Criteria	Not Yet	Getting There	Got It!
I wrote a question that required some research to answer fully.			
I recorded important information to answer my research questions using an organizer.			
I effectively explained my learning to others in text form using two or more non-fiction text features.			
I explained what I did well and what I would do differently next time.			

Final Reflection

Something I am proud of:

Something I learned that surprised me:

Something I wonder about:

A7

Activity: Investigating Animals through Guided Inquiry

Chart: Anchor Chart Information Organizer for Animal Inquiry (EXAMPLE)

Task: Research information about the assigned animal and related question.

Name:

Date:

Animal: three-toed sloth

Research question: Where do three-toed sloths live?

Audience: Mrs. Smith's class

Sources: *Kyle Goes Alone*, kids.mongabay.com

Notes:

Rainforests of Central and South America	**High up in canopy**	**Trees high above ground**	
Trees are closely spaced	**In the overlapping branches and leaves**		

A8

Activity: Investigating Animals through Guided Inquiry

Chart: Anchor Chart Information Organizer for Animal Inquiry **(BLANK)**

Task: Research information about the assigned animal and related question.

Name:

Date:

Animal:

Research question:

Audience:

Sources:

Notes:

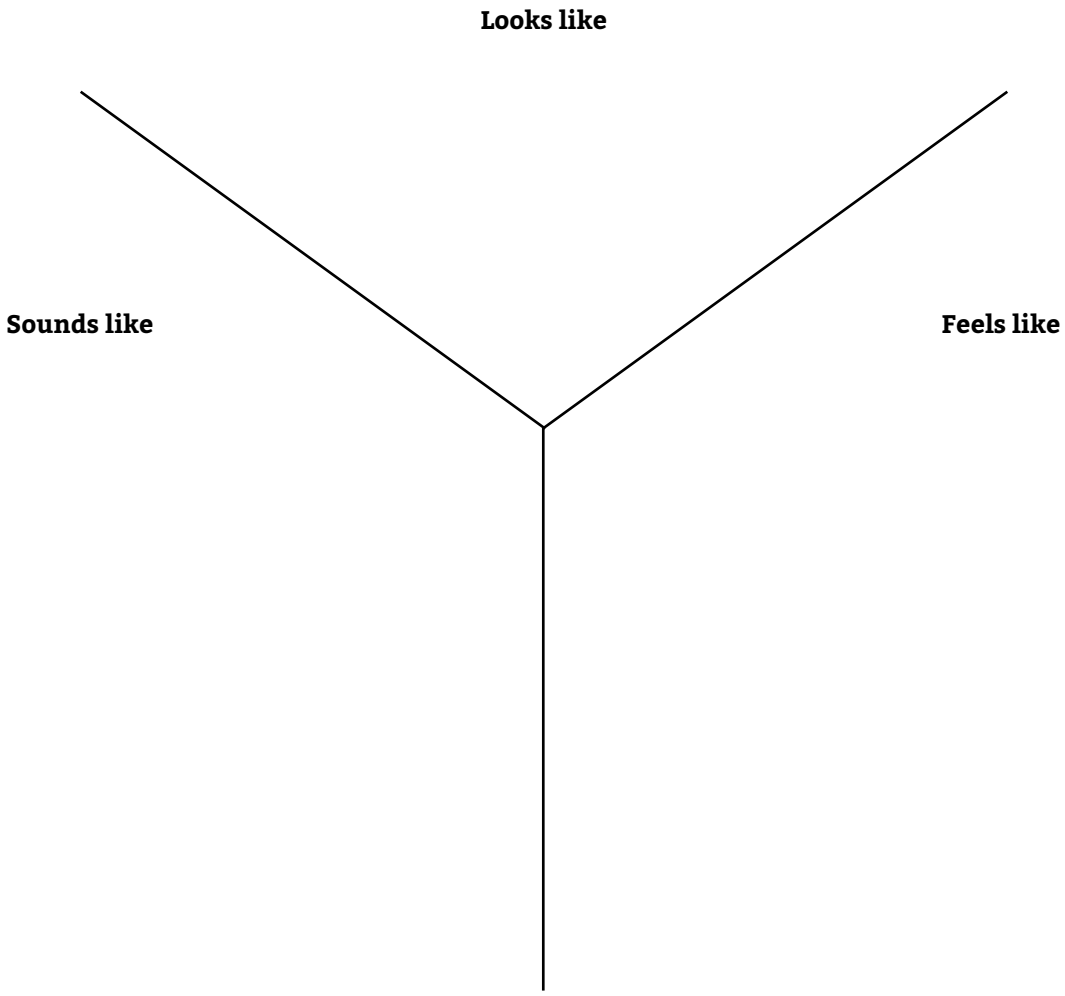
A9

Activity: Investigating Animals through Guided Inquiry

Chart: Y Chart Information Organizer for Animal Inquiry Reflection

Task: Reflect on what has been accomplished during this task.

Y Chart



A10

Activity: Investigating Animals through Guided Inquiry

Chart: Inquiry Research Checklist

Task: Keep track of progress through the stages of inquiry.

Name: **Date:**

Inquiry Research Checklist

Stage	Teacher Initials	Teacher Comments
Topic approved		
Research question approved		
Stage	**Student Initials**	**Student Comments**
I have answered all of the questions.		
I have put information into sentences for the book.		
I have listed non-fiction text features I will use in my book.		
I have drafted a book without illustrations.		
I have created a cover page.		
I have shared my book.		
I have completed a reflection using the success criteria.		

A11

STEAM Exploration: Constructing an Animal Habitat

Chart: Reading and Analyzing Non-Fiction (RAN) Graphic Organizer

Task: Gather information about animal habitats.

What I think I know	
Facts confirmed (Yes, I was right!)	
Misconceptions	
New facts/ Information	
Wonderings (Questions I still have)	

Adapted from *Reality Checks: Teaching Reading Comprehension with Non-Fiction* by Tony Stead, 2005, p. 18

A12

STEAM Exploration: Constructing an Animal Habitat

Chart: STEAM Design Organizer

Task: Organize information while constructing an animal habitat.

Name:

Date:

Problem:
How can a model of an animal habitat be designed to show the basic needs of an animal?

Ideas:

My design solution:

Did it work? How can I improve it?

A13

STEAM Exploration: Constructing an Animal Habitat

Chart: Learning Goals and Success Criteria

Task: Track progress while creating animal habitats.

Learning Goal

We are learning about the habitats of animals and the basic survival needs of animals.

Success Criteria	Not Yet	Getting There	Got It!
I created a design for a habitat for an animal based on my research. The design considers the basic needs of water, air, food, and shelter.			
I created a model of the habitat and shared it in a group to check if it would meet the needs of my animal.			
I recorded some ideas for improvement.			
I finalized the model of the habitat for the animal I researched. I can show how the basic needs of water, air, food, and shelter are included.			
I described the animal's habitat with my model and showed how its basic needs are being met.			
I showed perseverance as I worked through the Engineering Design Process.			

Final Reflection

Something I am proud of:

Something I learned that surprised me:

Something I wonder about:

A14

STEAM Exploration: Creating a Light-Up Picture

Chart: Learning Goals and Success Criteria

Task: Track progress while using circuits to create a light-up picture.

Learning Goal

We are learning how to make a light-up picture by creating a simple circuit with a circuit sticker, a coin cell battery, a binder clip, and conductive copper tape.

Success Criteria	Not Yet	Getting There	Got It!
I created a design plan for my book page that shows the part that I will light up.			
I used a template to create a simple circuit by following the instructions, testing it with my plan, and making changes when I needed to.			
I created a page to put over my circuit so that one part lights up.			
I explained why I was successful during class sharing.			
If I was not successful, I did some troubleshooting with a classmate and on my own to come up with next steps.			
I made improvements.			
I showed perseverance as I created a simple circuit and tested it to see if it made the light work.			
I showed care and concern for safety.			

Final Reflection

I learned:

Something I would like to try next:

Something I am curious about when it comes to circuits and electronics:

A15

STEAM Exploration: Making a Waterproof Roof

Chart: Waterproof vs. Absorbent Observations

Task: Observe and record which of the provided materials are waterproof and which are absorbent.

Name:

Date:

Name of Material (Attach sample of each material below)	**Observations:** Waterproof? Not waterproof?

A16

STEAM Exploration: Making a Waterproof Roof

Chart: STEAM Design Organizer for Roof Materials

Task: Brainstorm materials to construct a waterproof roof.

Name:

Date:

Problem:
How can we construct a waterproof roof?

Ideas:

My design solution:

Did it work? How can I improve it?

A17

STEAM Exploration: Making a Waterproof Roof

Chart: Learning Goals and Success Criteria

Task: Track progress while identifying materials to construct a waterproof roof.

Learning Goal

We are learning how to test a variety of materials to find ones that are waterproof.

Success Criteria	Not Yet	Getting There	Got It!
I tested different materials to find ones that are waterproof and recorded my results accurately.			
I made a design for a roof based on what I learned about waterproof materials.			
I made a roof for the model provided by the teacher and tested how waterproof it was.			
I explained why my model was successful or not.			
If it was not successful, without help from the teacher, I looked at my model and noted any problems with the design.			
I came up with next steps.			
I made improvements.			
I showed perseverance as I created a model and tested it out.			

Final Reflection

What are the best design features of my model?

What other materials do I wish I had to work with and why?

Something I wonder about:

A18

STEAM Exploration: A Strong and Stable Structure

Chart: STEAM Design Organizer

Task: Organize information while creating a strong and stable structure.

Name:

Date:

Problem:
What is the tallest structure that your team can build, using the materials provided, that will support the weight of a golf ball for at least two minutes?

Ideas:

My design solution:

Did it work? How can I improve it?

Appendix B: Curriculum Links

Simple STEAM Classroom Activities

Creating a Wonder Wall

This exploration aligns very well with the three goals of the Ontario Curriculum, Grades 1–8: Science and Technology (2007) to

1. relate science and technology to society and the environment;
2. develop the skills, strategies, and habits of the mind required for scientific inquiry and technological problem solving; and
3. understand the basic concepts of science and technology.

A classroom Wonder Wall also aligns with the following sections of the skill continua for scientific inquiry and technological problem solving:

- Beginning: students ask questions that demonstrate curiosity about the world around them.
- Exploring/Emerging: students ask questions that could lead to investigations, and choose one that will be the basis for an investigation; students ask questions that can be answered through tests/experimentation, and choose one to investigate.
- Emerging/Competent: students ask questions that could lead to investigations and formulate a specific question that will be the basis for an investigation; students ask questions that can be answered through tests/experimentation.
- Proficient: students ask questions that arise from practical problems and issues and formulate a specific question that will be the basis for an investigation.

This exploration aligns very well with the three goals of the Ontario Curriculum, Grades 1–8: Science and Technology (2007) to

1. relate science and technology to society and the environment;
2. develop the skills, strategies, and habits of the mind required for scientific inquiry and technological problem solving; and
3. understand the basic concepts of science and technology.

More specific links:

Grade 2

Section	Specific Expectations
Relating Science and Technology to Society and the Environment By the end of Grade 2, students will: demonstrate an understanding that animals grow and change and have distinct characteristics.	**1.1, 1.2** identify positive and negative impacts that animals have on humans (society) and the environment, form an opinion about one of them, and suggest ways in which the impact can be minimized or enhanced.
Developing Investigation and Communication Skills By the end of Grade 2, students will: investigate similarities and differences in the characteristics of various animals.	**2.3** assess ways in which animals have an impact on society and the environment and ways in which humans have an impact on animals and the places where they live; investigate similarities and differences in the characteristics of various animals; demonstrate an understanding that animals grow and change and have distinct characteristics. **2.6** use scientific inquiry/research skills and knowledge acquired from previous investigations to investigate the basic needs, characteristics, behaviour, and adaptations of an animal of their choice. **2.7** use appropriate science and technology vocabulary, including life cycle, migration, adaptation, and body coverings, and classify in oral and written communication.

Understanding Basic Concepts By the end of Grade 2, students will: demonstrate an understanding that animals grow and change and have distinct characteristics.	**3.2** describe an adaptation as a characteristic body part, shape, or behaviour that helps a plant or animal survive in its environment. **3.3** identify ways in which animals are helpful to, and ways in which they meet the needs of, living things, including humans, to explain why humans should protect animals and the places where they live.
Oral Communication By the end of Grade 2, students will: use speaking skills and strategies appropriately to communicate with different audiences for a variety of purposes.	**2.1** identify a variety of purposes for speaking. **2.2** demonstrate an understanding of appropriate speaking behaviour in a variety of situations, including paired sharing and small- and large-group discussions. **2.3** communicate ideas, opinions, and information orally in a clear, coherent manner using simple but appropriate organizational patterns. **2.7** use a few different visual aids.
Reading By the end of Grade 2, students will: read and demonstrate an understanding of a variety of literary, graphic, and informational texts, using a range of strategies to construct meaning; recognize a variety of text forms, text features, and stylistic elements and demonstrate understanding of how they help communicate meaning.	**1.1** read some different literary texts. **1.2** identify several different purposes for reading and choose reading materials appropriate for those purposes. **2.3** identify some text features and explain how they help readers understand texts (e.g., table of contents, index, chart).
Writing By the end of Grade 2, students will: generate, gather, and organize ideas and information to write for an intended purpose and audience.	**1.1** identify the topic, purpose, audience, and form for writing. **1.4** sort ideas and information for their writing in a variety of ways, with support and direction (e.g., by using simple graphic organizers such as webs or a Venn diagram). **1.6** determine whether the ideas and information they have gathered are suitable for the purpose and gather new material if necessary.

This exploration aligns very well with the three goals of the Ontario Curriculum, Grades 1–8: Science and Technology 2007 to

1. relate science and technology to society and the environment, and
2. develop the skills, strategies, and habits of mind required for scientific inquiry and technological problem solving.

More specific links:

Grade 2: Understanding Life Systems Growth and Changes in Animals

Section	Specific Expectations
Developing Investigation and Communication Skills By the end of Grade 2, students will: investigate similarities and differences in the characteristics of various animals.	**2.5** investigate the ways in which a variety of animals adapt to their environment and/or to changes in their environment, using various methods (e.g., read simple non-fiction texts). **2.6** use scientific inquiry/research skills (see p. 15 of the Ontario Curriculum, Grades 1–8: Science and Technology, 2007) and knowledge acquired from previous investigations to investigate the basic needs of an animal of their choice. **2.7** use appropriate science and technology vocabulary, including life cycle, migration, adaptation, body coverings, and classify in oral and written communication. **2.8** use a variety of forms (e.g., oral, written, graphic, multimedia) to communicate with different audiences and for a variety of purposes.
Understanding Basic Concepts By the end of Grade 2, students will: demonstrate an understanding that animals grow and change and have distinct characteristics.	**3.1** identify and describe major physical characteristics of different types of animals (e.g., insects, mammals, reptiles). **3.2** describe an adaptation as a characteristic body part, shape, or behaviour that helps a plant or animal survive in its environment.

Grade 2 Oral Communication

Section	Specific Expectations
By the end of Grade 2, students will: use speaking skills and strategies appropriately to communicate with different audiences for a variety of purposes.	**2.1** identify a variety of purposes for speaking. **2.2** demonstrate an understanding of appropriate speaking behaviour in a variety of situations, including paired sharing and small- and large-group discussions. **2.3** communicate ideas, opinions, and information orally in a clear, coherent manner using simple but appropriate organizational patterns. **2.7** use a few different visual aids.

Grade 2 Reading

Section	Specific Expectations
By the end of Grade 2, students will: read and demonstrate an understanding of a variety of literary, graphic, and informational texts, using a range of strategies to construct meaning; recognize a variety of text forms, text features, and stylistic elements and demonstrate understanding of how they help communicate meaning.	**1.1** read some different literary text. **1.2** identify several different purposes for reading and choose reading materials appropriate for those purposes. **2.3** identify some text features and explain how they help readers understand texts (e.g., table of contents, index, chart).

Grade 2 Writing

Section	Specific Expectations
By the end of Grade 2, students will: generate, gather, and organize ideas and information to write for an intended purpose and audience.	**1.1** identify the topic, purpose, audience, and form for writing. **1.4** sort ideas and information for their writing in a variety of ways, with support and direction (e.g., by using simple graphic organizers such as webs or a Venn diagram). **1.6** determine whether the ideas and information they have gathered are suitable for the purpose, and gather new material if necessary.

This exploration aligns very well with the three goals of the Ontario Curriculum, Grades 1-8: Science and Technology (2007) to

1. relate science and technology to society and the environment;
2. develop the skills, strategies, and habits of the mind required for scientific inquiry and technological problem solving; and
3. understand the basic concepts of science and technology.

More specific links:

Grade 2: Understanding Life Systems Growth and Changes in Animals

Section	Specific Expectations
Developing Investigation and Communication Skills By the end of Grade 2, students will: investigate similarities and differences in the characteristics of various animals.	**2.1** follow established safety procedures. **2.5** investigate the ways in which a variety of animals adapt to their environment and/or to changes in their environment, using various methods (e.g., read simple non-fiction texts). **2.6** use scientific inquiry/research skills (see p. 15 of the Ontario Curriculum, Grades 1–8: Science and Technology (2007)) and knowledge acquired from previous investigations to investigate the basic needs of an animal of their choice. **2.7** use appropriate science and technology vocabulary, including life cycle, migration, adaptation, body coverings, and classify in oral and written communication. **2.8** use a variety of forms (e.g., oral, written, graphic, multimedia) to communicate with different audiences and for a variety of purposes (e.g., a diorama of the animal's habitat).

	3.1 identify and describe major physical characteristics of different types of animals (e.g., insects, mammals, reptiles).
Understanding Basic Concepts By the end of Grade 2, students will: demonstrate an understanding that animals grow and change and have distinct characteristics.	**3.2** describe an adaptation as a characteristic body part, shape, or behaviour that helps a plant or animal survive in its environment (e.g., some birds migrate to a warmer climate for the winter; the design of a whale's flipper allows the whale to turn, steer, and balance; the cecropia moth has the pattern of a snake's head on its wings, hypothesized to frighten its predators away).
Visual Arts: Creating and Presenting By the end of Grade 2, students will: apply the creative process (see pp. 19–22 of the Ontario Curriculum Grades, 1–8: The Arts (2007)) to produce a variety of two- and three-dimensional art works, using elements, principles, and techniques of visual arts to communicate feelings, ideas, and understandings.	**1.1** create two- and three-dimensional works of art that express feelings and ideas inspired by activities in their community or observations of nature. **1.4** use a variety of materials, tools, and techniques to respond to design challenges.

There are no grade-specific expectations for this exploration, however, this exploration aligns very well with the three goals of the Ontario Curriculum, Grades 1–8: Science and Technology (2007) to

1. relate science and technology to society and the environment;
2. develop the skills, strategies, and habits of the mind required for scientific inquiry and technological problem solving; and
3. understand the basic concepts of science and technology.

This exploration also aligns very well with planning recommendations in the Ontario Curriculum, Grades 1–8: Science and Technology (2007):

When planning a program in science and technology, teachers must take into account considerations in a number of important areas, including those discussed below.

INSTRUCTIONAL APPROACHES
Trying to understand how the world works is what children do naturally, and it is what you need to take advantage of when teaching science [and technology]. Just remember: Avoid being the knowledge authority. … Instead, cultivate a sense of excitement for exploring and inquiring about our world and for generating and testing possible explanations.

— *Jeffrey W. Bloom,* Creating a Classroom Community of Young Scientists, *2nd ed. (2006), p. 4*

One of the primary objectives of elementary science and technology curricula has always been, and must continue to be, development of curiosity and wonder. Students come to school with a natural curiosity. They also bring with them individual interests and abilities as well as diverse personal and cultural experiences, all of which have an impact on their prior knowledge about science, technology, the environment, and the world in which they live. Effective instructional approaches and learning activities draw on students' prior knowledge, capture their interest, and encourage meaningful practice both inside and outside the classroom. Students will be engaged when they are able to see the connection between the scientific and technological concepts they are learning and their application in the world around them and in real-life situations.

This exploration aligns very well with the three goals of the Ontario Curriculum, Grades 1–8: Science and Technology (2007) to

1. relate science and technology to society and the environment;
2. develop the skills, strategies, and habits of the mind required for scientific inquiry and technological problem solving; and
3. understand the basic concepts of science and technology.

More specific links:

Grade 1: Understanding Structures and Mechanisms: Materials, Objects, and Everyday Structures

Section	Specific Expectations
Developing Investigation and Communication Skills By the end of Grade 1, students will: investigate structures that are built for a specific purpose to see how their design and materials suit the purpose.	**2.1** follow established safety procedures during science and technology investigations. **2.3** investigate, through experimentation, the properties of various materials (e.g., the best materials for absorbing or repelling water). **2.4** use technological problem-solving skills and knowledge acquired from previous investigations to design, build, and test a structure for a specific purpose. **2.5** use appropriate science and technology vocabulary. **2.6** use a variety of forms (e.g., oral, written, graphic, multimedia) to communicate with different audiences and for a variety of purposes (e.g., orally explain choice of materials and design decisions when presenting structures).
Understanding Basic Concepts By the end of Grade 1, students will: demonstrate an understanding that objects and structures have observable characteristics and are made from materials with specific properties that determine how they are used.	**3.7** describe the properties of materials that enable the objects and structures made from them to perform their intended function.

This exploration aligns very well with the three goals of the Ontario Curriculum, Grades 1–8: Science and Technology (2007) to

1. relate science and technology to society and the environment;
2. develop the skills, strategies, and habits of the mind required for scientific inquiry and technological problem solving; and
3. understand the basic concepts of science and technology.

More specific links:

Grade 3: Understanding Structures and Mechanisms: Strong and Stable Structures

Section	Specific Expectations
Developing Investigation and Communication Skills By the end of Grade 3, students will: investigate strong and stable structures to determine how their design and materials enable them to perform their load-bearing function.	**2.1** follow established safety procedures during science and technology investigations. **2.2** investigate, through experimentation, how various materials (e.g., paper and wood) and construction techniques (e.g., folding, adding layers, twisting/braiding, changing shapes) can be used to add strength to structures. **2.3** investigate, through experimentation, the effects of pushing, pulling, and other forces on the shape and stability of simple structures. **2.5** use appropriate science and technology vocabulary, including compression, tension, strut, ties, strength, and stability, in oral and written communication. **2.6** use a variety of forms (e.g., oral, written, graphic, multimedia) to communicate with different audiences and for a variety of purposes (e.g., an oral report to the class on the results of experiments to strengthen materials).

By the end of Grade 3, students will: demonstrate an understanding of the concepts of structure, strength, and stability and the factors that affect them.	**3.3** identify the strength of a structure as its ability to support a load. **3.4** identify the stability of a structure as its ability to maintain balance and stay fixed in one spot.