Grade 3 How does the design of a structure and materials used impact its stability?

Experience 2: Structure challenges

Long Range Plan Grade 3 Model 2

Overview:

This series of learning experiences invites students to engage with the definition and characteristics of structures through meaningful reflection, hands-on building, and authentic connections with the world around them.

Three specific experiences are outlined in detail:

- Experience 1: Concept attainment approach and reflection on structures
- Experience 2: Building challenges to explore what makes a structure strong and stable
- Experience 3: Applying learning to build a winter shelter for a plant

Students will use a concept attainment approach to explore the meaning of “structure” and address any misconceptions. They will reflect on how their thinking has changed.

Building on their understanding of the definition of a structure, students will use recycled materials to complete a series of challenges and encourage scientific discussion and use of specific scientific vocabulary.

Students will apply these terms - and their understanding of what a strong and stable structure is - to a specific issue in their own community. Through outdoor education, they will identify a perennial plant that could benefit from a shelter to protect it during the winter. Students will design and build a model of a shelter, integrating three strands of the Science curriculum: Strong and Stable Structures, Forces and Motion, and Growth and Changes in Plants.

Extensions and cross-curricular opportunities are provided throughout the series, encouraging teachers to tailor the experiences to the strengths and needs of their students. Assessment for, as, and of learning is a key component of the series as well.

In the real world, scientists and engineers need to record their thinking and keep records of their scientific processes and engineering designs for a number of different reasons. In these experiences, students will be using a science journal as a way of tracking their scientific thinking as they emulate scientists and engineers while engaging in the learning to make predictions, record processes, and observations, and draw conclusions about scientific phenomena. The journal will also be used during STEM. investigations as a place for working through solutions to

real-world problems (brainstorming, describing plans, and drawing designs for prototypes) and will be an evidence-based source of assessment information.

Overview of learning experiences – why these activities	In this second experience, students build on their understanding of the definition of a structure. They use recycled materials to complete a series of challenges that involve designing, building, and testing structures while engaging in scientific discussion and developing their scientific vocabulary. These learning experiences relate to the Grade 3 long-range plans (October/November and December): Long Range Plan Grade 3 Model 2
Prior Knowledge / Prior Skill Set(s)	**Teachers:** Teachers should be familiar with the concepts included in these experiences, such as strength and stability. Definitions for specific terms are provided later in this document. Teachers should be aware of structures in their communities, as well as needs that could be addressed through the construction of new structures. They should have some familiarity with outdoor plants on the school grounds or in the immediate area around the school. Teachers should be open to using thinking routines (like See, Think, Wonder, and "I used to think… but now I think…" with their classes - the more they use these routines, the more comfortable and reflective students will be with them. **Students:** It is important to continue to consider each student's schema regarding structures and also to be aware of possible misconceptions. As students build, they may need guidance to translate the definition

Strand A - STEM Investigation and Communication Skills	**A1. STEM Investigation and Communication Skills** use a scientific research process, a scientific experimentation process, and an engineering design process to conduct investigations, following appropriate health and safety procedures  **A1.3** use an engineering design process and associated skills to design, build, and test devices, models, structures, and/or systems  **A1.4** follow established health and safety procedures during science and technology investigations, including wearing appropriate protective equipment and clothing and safely using tools, instruments, and materials  **A1.5** communicate their findings, using science and technology vocabulary and formats that are appropriate for specific audiences and purposes  **A3. Applications, Connections, and Contributions:** demonstrate an understanding of the practical applications of science and technology, and of contributions to science and technology from people with diverse lived experiences  **A3.1** describe practical applications of science and technology concepts in their home and community, and how these applications address real-world problems  **A3.2** investigate how science and technology can be used with other subject areas to address real-world problems
Overview / Big Ideas/Fundamental Concepts	These experiences are designed to help students engage with the concepts of form and function in relation to structures - and, specifically, what makes structures strong and stable. The goal is for students to understand and apply some key scientific terms while thinking generally about structures and also applying their learning and taking an activism approach by designing a specific structure to meet a need in their community.

	Big Ideas: ● Relationships ● Cause & Effect ● Systems & Structures Students will focus on the interrelationship between the function of a natural or human-made object and the form it takes. The goal is for students to understand that the properties of structures affect their function. As they investigate how best to build structures for specific purposes and how to help them withstand forces, students will gain a deeper understanding of cause and effect. Students will explore the purpose of structures and the interrelationship between stability and forces.
Learning Goals / Success Criteria	Students will be applying their understanding of structures to a series of engineering challenges, using recycled materials. Educators are encouraged to co-create success criteria with students and share “I Can Statements” based on the curricular expectations. Opportunities to do so are addressed throughout this series of lessons. Further evidence for assessment can be gathered and observed through ● Scientific journals ● Student conferences ● Community walks ● Peer discussions (in breakout rooms if online) ● Teacher documentation ○ Anecdotal notes ○ Photographs Ministry of Education Key Points: ● STEM Skills & Connections ● Research & Experimentation Processes ● Engineering Design Process ● Hands-on, Experiential Learning ● Coding ● Contributions to Science and Technology

Learning Experience(s)	**Experience 2: How might the design of a structure and materials used impact its stability** This experience takes the form of one or more building challenges - 4 possibilities are provided here. Teachers should also consider student-generated ideas and questions as the basis for other building challenges. **Guiding questions:** How do the design of a structure and the materials used impact its stability? What are some careers in design and building? (also addressed in the next experience) **Minds On (15 min):** Invite students to review the definition of a structure. Refer to the anchor chart posted on the wall in the previous lesson, if applicable. Read a book related to engineering, such as **Rosie Revere, Engineer (Rosie géniale ingénieure)**. If you don't have access to hard copies of these books, consider finding videos of them online. ● Before reading, give students a mission: listen for clues about the mindset of an engineer. ● After reading, discuss their thinking, focussing on the idea that engineers have a growth mindset that allows them to take responsible risks and learn from each experience. ● Explain to students that they will be taking on the roles of engineers, building structures to meet specific criteria. Review health and safety procedures with students **Action (20 min per challenge):** Distribute recycled materials to each student or pair of students, depending on whether you would like them to work individually or together. Be sure that students have the same number of materials, but also an assortment of shapes, sizes, and materials. Before starting any challenge, you may wish to provide your students with a set amount of "discovery time" (3-5 minutes or so often works well). This is an opportunity to work with recycled materials without any specific guidelines (other than safety) or tasks. You may find that students
⊕**A1.4**	

A1.3	naturally start engaging in exploring ideas very similar to the ones included in these challenges. Discovery time also helps students focus afterward by providing them with a preemptive opportunity to play freely with the materials. Select one or more of the following challenges each period. Students may be inspired to suggest their own challenges as well - take note of their ideas and incorporate them, if possible. **Challenge 1:** What is the tallest structure you can build? **Challenge 2:** How might you build a structure to support the heaviest possible load? ● Use this opportunity to introduce students to the concepts of struts and ties ● Provide students with a uniform load to use as they build and test their structures - a textbook or dictionary works well for this - how many can they pile onto their structure? ● See the resources section for a video with suggestions regarding how to make paper towers stronger for this purpose. ○ You may choose to have students work with paper only for this challenge, or you may ask them to apply what they learn from the video as they continue to use recycled materials. **Challenge 3**: What is the strongest and most stable bridge you can build? ● give students a uniform item that should fit under their bridge to ensure that their structure is indeed elevated - a toy card is ideal, but you may choose to use a classroom item such as a glue stick. **Challenge 4:** How might you build a structure that can withstand a given force? ● provide a force, such as wind from a fan or hairdryer Teachers should provide students the opportunity to experience a gallery walk both during and after the building process. Focus on stability - what could you change to make your structure more stable? What worked? Periodically, ask students to pause - use this time to share observations of the processes they're using, meaning not what they're building, but how. This is also an opportune time to introduce scientific vocabulary (see Vocabulary section) in the moment (e.g. "I notice that this group has included struts and ties to balance the forces acting on their bridge.

	Triangles are a very strong shape."). As you share definitions and point out examples of concepts in action, post the definitions somewhere in the classroom so that students can continue to refer to them during this experience and the next. These challenges offer an opportunity to take photos of students as they work. If possible, print these photos and post them so that students can reflect on the process and make connections. **Consolidation (10 min):** After each structure challenge, provide an opportunity for students to discuss what worked well and what didn't - remind them that both of these things are an important part of the design process. You may choose to do so in the form of a community circle in which everyone has an opportunity to participate. Another possibility is doing a think-pair-share. Provide "can-answer" sentence-starters, such as ● I persisted by… ● I was surprised that… ● What worked best for me was… ● I overcame a challenge by… ● I realized that structures… ● I'm proud of… ● I'd like others to notice that… Also, include a "must-answer" sentence starter to help students connect their learning with the real world. For example: ● I could apply my learning at home/school by… ● I could continue to explore these ideas in other subject areas by…
A1.5 **A3**	Sample responses: - I could apply my learning at home by creating a structure to hold my toys. - I could continue to explore these ideas in math by measuring the height of the structures I create. Sentence-starters should be posted somewhere in the classroom so students can refer to them as they reflect and share. After each challenge, students should complete a ticket out the door in which they reflect on their process and product. This could be completed

	in their science journals (see Appendix A: Science Journals). You may ask students to write this in the form of an "I Can" Statement (e.g. I can use what I know to build a strong structure; I can show persistence). Possible extensions: Share a non-fiction book that celebrates a Black engineer, such as Lonnie Johnson, and illustrates the importance of persisting during the scientific research and engineering process. Ask students to write a written reflection connecting the text to themselves, another text that they know, and/or the world. Invite students to use Scratch Jr. or a similar resource to create a story about one of the structures they created (e.g. The Day a Dragon Landed on the Tallest Tower). **What the students do:** Initiating and Planning ● Respond to specific challenges Performing and Recording ● Participate in building challenges Analyzing and Interpreting ● Test their structures Communicating ● Share their process and product ● Share their observations, conclusions, and further wonderings in their science journal
Science and Technology Expectations	**D. Structures and Mechanisms** **Strong and Stable Structures** **D1. Relating Science and Technology to Our Changing World** **Overall expectation**: assess the importance of form, function, strength, and stability in structures to society and the environment D1.1 assess the effects on society and the environment of strong and stable structures

	How do I test a structure to improve it using form and function? **D2. Exploring and Understanding Concepts** **Overall expectation:** demonstrate an understanding of the concepts of strength and stability as they relate to structures with various forms and functions, and of the factors that affect structures' strength and stability D2.1 describe a structure as a supporting framework that holds a load and has a definite size, shape and function and identify structures in the natural environment and in the built environment D2.2 demonstrate an understanding of the relationship between form and function for various structures D2.3 identify the strength of a structure and its ability to support a load D2.4 describe the stability of a structure and its ability to keep its shape, maintain balance, float/and or stay fixed in one spot when a force is applied to the structure, and provide ways to improve a structure's stability D2.5 identify properties of materials that need to be considered when building structures D2.6 describe ways in which different forces can affect the shape, balance or position of structures D2.7 explain the role of struts and ties in structures under load **C. Matter and Energy - Forces and Motion** **C2. Exploring and Understanding Concepts** **Overall expectation:** demonstrate an understanding of how forces cause motion and changes in motion C2.1 describe different types of contact forces and non-contact forces C2.2 describe different ways a force can be exerted on an object C2.4 identify ways in which forces are used in their daily lives

Science and Technology Vocabulary	**Key concepts and vocabulary** **Balance:** stability produced by even distribution of weight on each side of the vertical axis **Force** (contact and non-contact)**:** strength or energy exerted or brought to bear; cause of motion or change; active power - often characterized as a push or a pull **Form:** the shape and structure of something as distinguished from its material **Function:** the action for which a person or thing is specially fitted or used or for which a thing exists - its purpose **Material:** the elements, constituents, or substances of which something is composed or can be made; or an act, process, or instance of changing place - movement **Stability:** the strength to stand or endure - firmness; or the property of a body that causes it when disturbed from a condition of equilibrium or steady motion to develop forces or moments that restore the original condition **Strength: the** power to resist force - solidity or toughness **Structure:** a supporting framework that holds a load and has a definite size, shape, and function **Strut:** a structural piece designed to resist pressure in the direction of its length **Tie**: a structural element (such as a rod or angle iron) holding two pieces together - a tension member in a construction
Equipment and Materials	• Journal pages or journal notebook - see Appendix A: Science Journals • Vocabulary wall or chart paper (create as you introduce structures definition and new vocabulary) • Recycled materials (e.g. cardboard boxes, plastic containers) • A book and/or read-aloud video featuring a story about engineering **Challenge 2**: • Textbooks or another set of books of a uniform size and shape **Challenge 3:** • Toy car or another item to roll under a bridge

	Challenge 4: ● Hairdryer or fan to create a wind-like force (if these materials are difficult to access, you can fold a piece of paper and use it manually as a fan or designate a student to do so)
Timeline and Preparation	**First steps** Speak with a school custodian and/or other teachers or office staff about sending recycled materials your way and/or invite students and their families to send in materials. ● Be sure to set a timeline for collection (2-3 weeks works well) and be clear about how much you'd like to collect, depending on your storage possibilities - e.g. one small grocery bag per family. Bring in some extra recycled materials of your own in case some students forget or are unable to contribute. ● Materials should be clean (rinsed and dried in advance as needed) ○ Ensure that none contained allergens such as peanuts or tree nuts ● Be sure to make families and/or school community aware that you are not collecting or using any glass materials Determine whether you would like students to complete the building challenge(s) individually or in partners. If the latter, create partnerships in advance. Decide whether you would like students to keep the same partner for all challenges or if you would like them to work with a different partner each time. **Next Steps** Approximate time for the learning experiences: 45 or so minutes for each challenge You may choose to complete anywhere from 1-4 challenges - or add/substitute any suggested by your students or arising from your observations. These experiences can be extended based on student engagement/interest/driving questions/inquiry.

Safety Considerations	**Personal Protective Equipment (PPE)** -none **What does the teacher do?** ● Be aware of up-to-date safety information ● Plan activities with safety as a primary consideration ● observe students to ensure that they are following safe practices ● Explain and review what makes recycled materials appropriate or not appropriate for collection - e.g. must be clean, no glass, never contained any allergens such as peanuts ● Wash or sanitize hands before and after working with recycled materials **What do the students do?** ● Carefully follow the instructions and example of the teacher ● Consistently show care and concern for their safety and that of others ● Follow established safety procedures ● maintain a well-organized and uncluttered workspace ● follow established safety procedures ● identify possible safety concerns ● Utilize tools and materials in a safe manner ● Wash or sanitize hands after investigations Refer to these safety resources: ● Safety in Elementary Science and Technology (STAO) ● Safe Activity Foundations in Education Document (SAFEdoc) Science and Technology, Grades 1-8 (OCTE) ● Ontario Curriculum Program Planning – Health and Safety
Opportunities For Assessment	**Assessment FOR Learning** Use checklists/or and anecdotal notes during ● Review of structure definition ● Book discussion **Assessment AS Learning**

	This activity is designed to provide students with hands-on experiences with structures and what makes them strong and stable. Record your observations and evaluate what students already know and any misconceptions they may have. This is a good opportunity to use photography as a form of documentation, if possible. **Assessment OF Learning** As students progress through the challenges, use anecdotal notes and/or a checklist to record evidence of how they engage with the materials and each other, as well as the scientific vocabulary that they use. The students' journal pages can be used as an example of student thinking and understanding.
Instructional Strategies and Adaptability	This learning experience makes use of a variety of instructional strategies. You are encouraged to become a co-learner with students when uncovering science content with them. Look for ways to embed culturally responsive and student-centred instructional practices, celebrating diverse voices and perspectives and inviting students to share their thinking in ways that are meaningful to them. Offer flexibility in how students access material, engage with concepts, and demonstrate their learning. These learning experiences look different in different settings. Some specific suggestions for supporting student learning needs: ● Break down instructions step-by-step and/or ask students to repeat them as needed ● Scribe ideas and/or offer assistive technology for students who require extra support with written output ● Offer the vocabulary and definitions on a handout sheet to students who may benefit from being able to see and refer to this information (in addition to the anchor chart) - include visuals as much as possible ● Include some pre-organized scaffolded statements for students to use in their science journals, particularly those who struggle with literacy (e.g. I noticed _____ about the building). Consider also providing examples of ways to express curiosity and wonder (e.g. I wonder how tall I could build this using my technique?)

Additional Supporting Resources	**Resources:** Teachers can include one or both of these hands-on challenges to deepen students' understanding of strong and stable structures: **Ontario Science Centre** Natural Structures - Let's Build a Bird Nest **Science North** Structures & Mechanisms - Column Challenge! (first resource on webpage) Scientific vocabulary definitions adapted from Mirriam-Webster: https://www.merriam-webster.com/ Learning games and activities for support: ● Building materials: ○ Lego or Duplo ○ K'NEX ● Virtual building experiences: ○ Minecraft ○ Roblox Videos: Kidztube **Giant Paper Book Tower Stacking Challenge!** https://www.kidzsearch.com/kidztube/watch.php?vid=f58b60113 ***Note:** This video is in English only, but it connects well with this learning experience. French teachers could be encouraged to show it on mute and either narrate themselves or ask students to describe what they see.
Cross-Curricular Opportunities	**Language:** **Oral Communication:** 1. listen in order to understand and respond appropriately in a variety of situations for a variety of purposes 2. use speaking skills and strategies appropriately to communicate with different audiences for a variety of purposes **Reading:**

	1. read and demonstrate an understanding of a variety of literary, graphic, and informational texts, using a range of strategies to construct meaning Display the read-aloud book and any other related texts in the classroom and encourage students to access them in order to learn more about structures **Media Literacy:** 3. create a variety of media texts for different purposes and audiences, using appropriate forms, conventions, and techniques Research a famous structure past or present and create a brochure or presentation about it **Mathematics:** **Geometric and Spatial Reasoning:** E1.2 compose and decompose various structures, and identify the two-dimensional shapes and three-dimensional objects that these structures contain Encourage students to identify two- and three-dimensional shapes in the structures that they create
Future Opportunities / Next Steps	**Further moving forward opportunities for students:** ● Write or code a sequence of steps required to get from your house to the school or another important structure in your life **What will learners do when the work is completed/if they finish early?** ● Sketch in their journals different examples of natural and/or human-made structures and write a caption for each one ● Engage in the following activism and design challenge: ○ Investigate a natural disaster that has occurred in the world. How might you design a structure to withstand that force of nature? **Contributions to Science and Technology** ● Connect with members of the local community to learn more about careers connected with this set of learning experiences (architect, engineer, city planner, landscape architect) ● Investigate contributions made by Black and FNMI individuals or groups to design and building

Appendix A: Science Journals

Name: _____ Date: _____

Data/Observation Recording

What Did You Notice? (Draw, Write, Record, Paste, etc.)

What Do You Wonder? (Draw, Write, Record, Paste, etc.)

Science Journal Entry

Plan/Design

My Ideas (Draw, Write, Record, Paste, etc.)

What I Need (Draw, Write, Record, Paste, etc.)