Grade 7: Exploration and Application of Innovative Technologies - Structural Strength and Stability

Experience 2: Conceptual Exploration

Long Range Plan: Grade 7 Model 1

Overview:
This series of activities is meant to serve as a collection of activities to be used during Innovative Technologies in Grade 7 Long Range Plans - Model 1. The purpose of this collection is to provide a creative way to introduce the concepts that will be studied throughout the unit through an initial exploration, an example of concept exploration that could be used in the midst of the unit, as well as a culminating activity for this unit.

Overview of learning experiences – why these activities	**Experience 2:** Conceptual Exploration Sample Lesson In this sample concept exploration, students will explore concepts related to structural design, focusing on connections to skilled trades and considerations of forces, and the impact upon the environment and considerations regarding preparing a site to build a structure upon it. Specifically, students will study the force of compression, and relate it to the dead load of a structure - and the impact of compressibility of different ground materials. These activities are meant to be used with Long Range Plan: Grade 7 Model 1 – April and May units related to Innovative Technology.
Prior Knowledge / Prior Skill Set(s)	Carrying out a building challenge requires careful planning with regard to the organization of materials and anticipating student questions. This activity is meant to serve as an introduction, so little to no prior content knowledge is required. However, students should be familiar with routines and expectations for group work and be willing to work with a variety of peers. The focus throughout this task is to

	have students engage in effective problem-solving, perseverance, and collaboration.
Strand A - STEM Investigation and Communication Skills	**Minds On**  **A3.1** describe practical applications of science and technology concepts in various occupations, including skilled trades, 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 **Action**  **A1.1** use a scientific research process and associated skills to conduct investigations  **A1.2** use a scientific experimentation process and associated skills to conduct investigations  **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 (demonstrate understanding of hand tool, machine, and D&T room safety protocols). **Consolidation**  **A1.5** communicate their findings, using science and technology vocabulary and formats that are appropriate for specific audiences and purposes
Overview / Big Ideas/Fundamental Concepts	During this experience, students will explore forces related to soil compaction, and why this is an important consideration when preparing to build structures on a site. Students will explore dead loads and compression through the examination of different ground materials. These explorations will lead to connections with the construction of structures as students learn the importance of

	investigating and preparing land in order to make use of the land for building.
Learning Goals / Success Criteria	Students will be provided with content knowledge through demonstrations of compression and dead loads, and different methods to test soil compaction, and then they will take part in an activity to model and explore impact soil compaction testing. Students will document their exploration and observations and draw conclusions about a variety of ground materials. The main goals of this activity are for students to learn about the concepts of dead loads and compression. Throughout this experience, students will learn about how dead loads and compression impact ground materials. Students will also gain insight into the application of this knowledge to the construction industry through a form of impact compression testing. Success Criteria will be co-created with students in order to help students to identify whether they have met the goals of the experience. Throughout this experience, students will have opportunities to develop their understanding of these Ministry of Education Key Points: ● STEM Skills and Connections; ● Research and Experimentation Processes, and; ● Skilled Trades as they take part in Experiential Hands-On Learning.
Learning Experience(s) **A3**	**Minds On (20-30 Mins)** Begin by sharing the slide deck: The Leaning Tower of Pisa**.** The slide deck contains an image of the Leaning Tower of Pisa, and some guiding questions to promote discussion: ● Why do you think it leans? ● What could go wrong? ● If you could straighten it, would you? ● How Might you straighten or stabilize the tower?

A1.1	It finishes with a short video that summarizes the history of the tower. Why doesn't the Leaning Tower of Pisa fall over? - Alex Gendler Explain to students that, over the course of this experience, they explore some of the forces involved in preparing a site to build structures, and take part in hands-on exploration. **Action (Remainder of Period 1, Part of Period 2)** The Action phase of this experience will take place in 2 parts. **Part 1 - Demonstration of compression, and loads.** In the first part of this experience, the teacher will provide small rectangular sponges with grids drawn on them (as per the image below). Additionally, provide students with a small weight (100-200 g). First, students will push on the sponge from opposite ends and make observations about what happens to the grid lines. Explain to students that this is a demonstration of the force of compression. Ask students to work in their pairs or small groups to try to think of other words that you could use to describe compression (squish, press, crunch, press, compaction - relate to trash compaction) and then write a description of what the force of compression is, and describe how it occurs. Next, ask students to place their weight on top of the sponge, and to describe what is happening to the sponge as a result of the load being placed upon it. Encourage students to use compression and other forces in their descriptions. Explain to students that - when structures are built, they have many forces acting upon them internally and externally, but the structures themselves also create a load upon the ground that they are built. The dead load of a structure is the actual load of all the materials that make the structure up. The live load would be any content that gets added to the structure. Both are important to consider when planning to build.
A1.2	**Part 2 - Soil Compaction Testing**

A1.5	Explain to students that there are different ways that have been developed to test soil for compaction and that they will be carrying out a classroom version to help them understand the effects of soil compaction. You may wish to show the students an example of the Proctor Compaction Test, as found in this YouTube video (Key time: 6:07 - 6:52). At the very least, teachers should review this clip to gain an understanding of how to prepare the soil compaction test materials. Today's exploration will be based upon this test, with materials readily available. Provide students with the materials and procedures provided in the student activity guide (see Appendix A: Student Activity Guide - Soil Compaction) for this Experience. (The teacher may wish to pre-prepare some materials to save time in the classroom, such as pre-measuring the different materials into the cylinders, and setting up the card stock tube and weight mechanisms). Read through the procedure with the students, modeling the process for one sample as you do so, to ensure students understand the instructions. Provide students time to complete their tests, and to make observations on the provided student activity guide. A possible extension could be to add varying amounts of water to one type of material and repeat the testing to explore the impact of water content on compaction. **Consolidation** (**20 mins)** Briefly discuss the environmental impacts of preparing a site for construction, and the impacts of moving, replacing, and modifying ground materials in order to ensure your ground is suitable for construction needs. Post the following prompts for students to respond to in the application and extension section of their Student Activity Guide for this experience: ● Which type of material had the most compaction? ● Why is it important to understand the properties of compaction in ground material before building a structure?

	● If you were going to build a house on a surface, what would you want the ground material to be? Why? ● What could happen if there were different types of ground material? ● What are the environmental impacts and concerns when preparing a site for construction? ● Describe each ground material as a pure substance, solution, or mixture. If you identify one as a mixture, explain whether it is a heterogeneous or homogeneous mixture.
Science and Technology Expectations	**Strand B: Life Systems** **Overall Expectations** Relating Science and Technology to Our Changing World **B1.** assess the impact of human activities and technologies on the environment, and analyse ways to mitigate negative impacts and contribute to environmental sustainability **Specific Expectations** **B1.2** assess the effectiveness of various ways of mitigating the negative and enhancing the positive impact of human activities on the environment **Strand C: Matter and Energy** **Overall Expectations** **C2**. Exploring and Understanding Concepts demonstrate an understanding of the nature of matter, including the properties of pure substances and mixtures, and describe these properties using particle theory **Specific Expectations** **C2.2** use particle theory to distinguish between pure substances and mixtures **C2.3** distinguish between homogenous and heterogenous mixtures **Strand D: Structures and Mechanisms** **Overall Expectations** **D2. Exploring and Understanding Concepts** demonstrate an understanding of the relationship between structural forms and the forces acting on them

	Specific Expectations **D2.3** identify the magnitude, direction, point of application, and plane of application of the forces applied to a structure **D2.5** describe factors that can cause a structure to fail **D2.6** identify the factors that determine the suitability of materials for use in manufacturing a product or constructing a structure **D2.7** describe methods engineers and other professionals use to assess, improve, and maintain the safety of structures
Science and Technology Vocabulary	● compression ● compaction ● internal forces ● external forces ● live load ● dead load ● mixtures ● structural integrity ● Sustainability
Equipment and Materials	**Equipment and Materials Per Group** ● 3 clear plastic graduated cylinders (at least 300-500mL) ● 200mL of each type of ground material samples (sandy soil, top soil, small gravel) ● Card stock page (8 ½ by 11) ● Tape ● String (30-40cm) ● 200g weight ● Funnel **Detailed explanation of Ground Materials:** **Topsoil** - as purchased or acquired from school greenhouse (if available) **Sandy Soil** - mix topsoil with fine sand at a ratio of 1:1, or source from a known location of sandy soil **Gravel** - small, crushed stone gravel or “crusher dust”
Timeline and Preparation	This Experience should take place over the course of 2-3 classes, depending upon time required to carry out testing, and student engagement in consolidation discussions.

	Additionally, teachers may wish to spend more time exploring a variety of compaction tests prior to carrying out the activity or to extend the compaction testing by adding the variable of water content. **Opportunities to Extend Learning Beyond This Experience:** ● Have students research innovative technologies in studying the makeup of ground materials and report upon them. ● Students perform a more thorough exploration of the environmental impact of site preparation, and considerations to ensure minimal environmental damage from construction ● How does soil compaction impact other industries, such as agriculture?
Safety Considerations	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 Throughout the experience, teachers should ensure that students are handling materials and equipment with care. During compaction testing, students need to be mindful of their surroundings and handle the weights with care. Students should be standing, with no chairs or other hazards nearby. Students need to be attentive to each member of their group and work together to ensure the procedures are carried out with precision and care.
Opportunities For Assessment	**Assessment as Learning Opportunity:** While students are carrying out their compaction testing, the teacher can observe and have conversations with students, and contribute to their anecdotal notes regarding student conduct, inquiry, collaboration, and problem-solving skills. Providing direct, specific

	feedback will help students to adjust, and to work to meet identified goals. **Assessment of Learning Opportunity:** Assessment of Students related to their understanding of concepts and ability to communicate their thinking should be based upon the level and detail of their responses to the consolidation prompts.
Instructional Strategies and Adaptability	By engaging in this collection of experiences, students will be developing many transferable skills. These include critical thinking and problem-solving, collaboration, and communication. Detailed supports and explanation of these skills are found here:
Additional Supporting Resources	Tools for Measuring Soil Compaction(Agriculture) Types Of Soil Tests For Building Construction Proctor Compaction Test
Cross-Curricular Opportunities	**Language** **Writing** 1. generate, gather, and organize ideas and information to write for an intended purpose and audience; 2. draft and revise their writing, using a variety of informational, literary, and graphic forms and stylistic elements appropriate for the purpose and audience; 3. use editing, proofreading, and publishing skills and strategies, and knowledge of language conventions, to correct errors, refine expression, and present their work effectively **Mathematics** use knowledge of numbers and operations to solve mathematical problems encountered in everyday life **Data Literacy** manage, analyse, and use data to make convincing arguments and informed decisions, in various contexts drawn from real life
Future Opportunities / Next Steps	This experience represents a sample of how students could access content knowledge, and make connections. The expectation is that experiences prior to - and following this one would be connected

	back to the main idea of Innovative Technology and the other key concepts of Structures and Mechanisms. As noted above, students who complete their work early should be encouraged to explore one or more of the following: **Opportunities to Extend Learning Beyond This Experience:** ● Have students research innovative technologies in studying the makeup of ground materials and report upon them. ● Students can perform a more thorough exploration of the environmental impact of site preparation, and considerations to ensure minimal environmental damage from construction. ● How does soil compaction impact other industries, such as agriculture?

Appendix A: Student Activity Guide - Soil Compaction

Soil Compaction

Purpose

Students will explore the difference in compaction between different types of soils.

Materials (for each group)

- 3 clear plastic graduated cylinders (at least 300-500mL).
- 200mL of each type of ground material samples (sandy soil, top soil, small gravel)
- Card stock page (8 ½ by 11)
- Tape
- String (30-40cm)
- 200g weight
- Funnel

Preparation of Materials

1. Carefully, using a funnel, add the different materials to the graduated cylinder (in a manner that will not compress or pack the material in) until it reaches the 200 mL mark.
2. Using the card stock and tape, roll the card stock into a tube that is wide enough for the 200g weight to fit inside without friction as it slides down to drop on the ground material. (This tube will ensure the weight falls in the intended location).
3. Tie a string to the weight so that the weight can be held up with the string.

Procedure

1. Select a ground material to begin with.
2. One person needs to hold the card stock tube over the material inside the graduated cylinder, above the material, but not pushing or resting on the material, making sure it is vertical (and not leaning). The card stock tube should be inside the cylinder.
3. Another person will hold the weight so that the bottom edge of the weight is even with the top edge of the card stock. Let the string hang down, outside the tube. (It will be used to retrieve the weight).
4. Drop the weight by releasing it carefully. It should fall down the tube to impact the ground material.
5. Use the string to lift the weight back up to the top of the tube.
6. Move the tube so that it is over another part of the material (it is ok to overlap if needed).
7. Repeat steps 4-6 twenty-four (24) more times to have a total of 25 impacts upon your ground material.
8. Using the scale on the graduated cylinder, record any changes in volume.
9. Repeat steps 1-8 with each material.
10. Remove your materials from the cylinders, and loosen the material so that any compaction is removed.
11. Complete 3 trials for each material to help ensure the reliability of results.

Hypothesis
State your hypothesis here. Predict which material will result in great compaction.

Observations
Add your measurements to this table and then calculate your average final volumes, and the average differences by subtracting your average final volume from 200 mL

	Material					
	Topsoil		Sandy Soil		Gravel	
Trial	Iniital Volume	Final Volume	Iniital Volume	Final Volume	Iniital Volume	Final Volume
1	200 mL		200 mL		200 mL	
2	200 mL		200 mL		200 mL	
3	200 mL		200 mL		200 mL	
Averages:	200 mL		200 mL		200 mL	
Average Differences:						

Conclusions
Summarize your observations, and state whether your hypothesis was correct.

Applications and Extensions
Respond to the prompts posted on the board here. Use complete sentences and be sure your responses make sense without having the question on the page.