Curriculum Connections

**Fundamental Concepts:**
- Structure and Function
- Energy

**Overall Expectations:** Understanding Structures and Mechanisms—Form and Function

1. Think-Pair-Share (Cooperative Learning)*
2. Choice Board**
3. Co-construction of Criteria (Setting Objectives and Providing Feedback)*
4. Investigation (Generating and Testing Hypotheses)*
5. Communicating Understanding

**Specific Expectations:**

2.2 Design, construct and use physical models to investigate the effects of various forces on structures (e.g., the struts of a roof experience compression forces from shingles; the support cables of a suspension bridge are in tension; a twisted ruler experiences torsion forces; the pin that holds the two parts of a pair of scissors together has shear forces acting on it).

3.4 Distinguish between external forces (e.g., wind, gravity, earthquakes) and internal forces (e.g., tension, compression, shear, torsion) acting on a structure.

**Learning Goals:**
- Design a physical model to investigate how forces act on structures
- Investigate and explain how various forces act on structures

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**Differentiated Instruction Details**

**Knowledge of Students:**
- Differentiation based on student:
  - Readiness
  - Interests
  - Preferences:
    - Styles
    - Intelligences
    - Other (e.g., environment, gender, culture)

**Need to Know:**
- Readiness of students to design their own structure and to simulate forces

**How to Find Out:**
- Observe students during Minds On: Think-Pair-Share activity

**Differentiated Instruction Response:**
- Learning materials (content)
- Ways of learning (process)
- Ways of demonstrating learning (product)
- Learning environment

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**Big Idea:** The interaction between structures and forces is predictable

**Materials and Resources**

**Assessment and Evaluation**

**Assessment/Success Criteria:**
- Identification of six forces
- Describes the effects of various forces on structures

**Thinking and Investigation:**
- Designs a "testable" structure
- Sketches the structure so that parts are labeled, approximate measurements are given and materials are listed and justified
- Pre-tests the structure and modifies as necessary
- Tests the structure and records observations

**Communication:**
- Records observations during testing
- Shares understanding through discussion and product development using appropriate scientific terminology

**Assessment Tools:**
- Anecdotal Comments
- Checklist

**Prior Learning:**
- Prior to this lesson, students will have:
  - An understanding of safety procedures
  - Explored classification of structures, centre of gravity of a structure, characteristics of forces, external forces (e.g., wind, gravity, earthquakes), and internal forces (e.g., tension, compression, shear, torsion)
  - Experience using the skills outlined in the Skill Continua For Scientific Inquiry and Technological Problem Solving (i.e., initiating, planning, performing, recording, analyzing, interpreting, and communicating). See The Ontario Curriculum, Grades 1–8, Science and Technology.

**Materials:**
- Appendix A: Choice Board: Centres Preparation—one for teacher reference prior to lesson
- Appendix B: Sample Assessment Checklist: Investigating the Effects of Forces on Structures—one per student or per pair
- Appendix C: Choice Board: Investigating the Effects of Forces on Structures—one per student or per pair
- Appendix D: Instructions: Investigating the Effects of Forces on Structures—one per student or per pair
- Appendix E (pp. 1 & 2): Observation Chart: Investigating the Effects of Forces on Structures—one per student or per pair

**Internet Resource:**

**Resources:**
**Teaching/Learning Sequence: Grade 7 Science and Technology—Form and Function**

**MINDS ON**
- Establishing a positive learning environment
- Connecting to prior learning and/or experiences
- Setting the context for learning

**ACTION**
- Introducing new learning or reinforcing prior learning
- Providing opportunities for practice and application of learning (guided → independent)

**Whole Class → Anchor Chart Discussion**
Direct students’ attention to previously developed Anchor Charts and review types of forces (internal and external), centre of gravity and structures (solid, framed or shell structures).

**Pairs → Think-Pair-Share**
Students individually think of a structure and a force that might affect that structure. They share their idea with a partner and then, together, are challenged to list six forces. Observe and note anecdotal the names of students who struggle with identifying types of forces and structures.

**Whole Class → Discussion**
Review established safety procedures, particularly the use of tools and personal protective equipment (e.g., safety glasses).

**Whole Class → Discussion: Co-Constructing Design Criteria**
Share the learning goal—“Explain how various forces act on structures.”

Briefly explain the investigation in its entirety: Students will design and build a structure, investigate the effects of forces acting on the structure and communicate their understanding.

Work with students to develop criteria for designing a structure. Show examples of design sketches and have students identify strengths and weaknesses. Some of the criteria to discuss might include:
- The use of approximate measurements
- Labelling of parts according to scientific and technical conventions
- A materials list, perhaps with justification of material choices
- Create a checklist with students that includes these criteria. See Sample Assessment Checklist (Appendix B).

**Pairs → Choice Board**
Pair students according to the same level of readiness, based on Anecdotal Comments recorded during the Think-Pair-Share activity. If students had difficulty identifying and describing types of forces and structures, they choose and sketch their structure from the options provided in row A of the Choice Board (Appendix C). Students who did not have difficulty are free to choose any of the options provided on the Choice Board (Appendix C).

Students check their sketch against the criteria they helped to establish (Appendix B), initial all criteria have been satisfactorily addressed, and submit the sketch.

Review sketches before next day’s class, setting aside those sketches that did not fulfill the design criteria. Meet with those students at the beginning of the next day’s class.

**Day 2**

**Whole Class → Discussion: Co-Constructing Building and Testing Criteria**
Review the steps of the process.

Work with students to develop any necessary criteria for building, testing and modifying the structures, for recording observations, and for group norms such as listening to each other and accepting ideas from both partners. Add these criteria to the Assessment Checklist; see Sample Assessment Checklist (Appendix B).

Meet with students who need to further develop their design while other students begin to build their structures.

**Pairs → Investigation**
Students:
- Build their structure according to their design
- Follow the steps on Instructions: Investigating the Effects of Forces on Structures (Appendix D) to pre-test, modify, test, and observe the effects of forces on their structure
- Consider what “real-life” force and “real-life” impact each simulation replicates (e.g., a fan simulates wind; a fan on the high setting simulates hurricane winds)
- Record their learning on the Observation Chart (Appendix E) using a note taking method of choice (e.g., outline, point form text, images and point point format text, or web)
- Evaluate the effectiveness of the structure as a physical model (e.g., Was it a suitable structure to investigate the effect of forces on a structure?)

**Day 3**

**Pairs → Analyzing and Interpreting**
Students:
- Determine whether forces were internal or external
- Evaluate the effectiveness of the structure as a physical model (e.g., Was it a suitable structure to investigate the effect of forces on a structure?)

**CONSOLIDATION AND CONNECTION**
- Helping students demonstrate what they have learned
- Providing opportunities for consolidation and reflection

**Whole Class → Discussion**
Engage students in a discussion of the following questions:
- What were the effects of each of the six forces?
- What conclusions can we draw about the effects of various forces on structures?
- What challenges did we encounter while building our structure or conducting our investigation? How did we solve them?
- If we could repeat this investigation, how would we do it differently?

**Individuals → Communicating Understanding**
Students individually share their understanding of the learning goals in the format of their choice. Formats offered must have been taught. Possibilities include: a Mind Map or web, notes, a storyboard, and a cause and effect graphic organizer. Students refer to their Assessment Checklist (Appendix B) to guide their response.

Review the submitted products to determine if students require additional work on the learning goals.