Grade 3

Cluster 2: Materials and Structures

Overview

Students learn about the nature of materials not just by observing them but, more importantly, by using them. In this cluster, students experience the design process as they manipulate and test materials, build structures, and select and use materials suitable to the task at hand. Students find that the strength and stability of structures in their community, as well as those they build themselves, are linked to the properties of the materials used and to the particular way the materials are configured and joined. This cluster further develops the concept of materials introduced in *Kindergarten, Cluster 3: Paper* and built upon in *Grade 1, Cluster 3: Characteristics of Objects and Materials.*

PRESCRIBED LEARNING OUTCOMES	SUGGESTIONS FOR INSTRUCTION
Students will...	
3-2-01 Use appropriate vocabulary related to their investigations of materials and structures. Include: strength, balance, stability, structure, frame structure, natural structure, human-built structure, force. GLO: C6, D3	➢ Introduce, explain, use, and reinforce the vocabulary throughout the cluster.
3-2-02 Conduct experiments to compare the strength of common materials. *Examples: wooden toothpicks, plastic straws, paper, cardboard, polystyrene foam...* GLO: A1, A2, C2, D3 **3-2-03** Explore to determine ways to strengthen a material used for building. Include: changing shape, bulk, and number of layers. GLO: B1, C2, D3	➢ **Gaining Student Interest** Ask students the following questions: • Why are certain materials selected or rejected for building structures? • How can the strength of some materials be increased? ➢ **Sorting Objects by Strength** Provide a variety of materials for students to sort according to strength. Include toothpicks, spaghetti, popsicle sticks, straws, and an assortment of paper and polystyrene foam. Have students predict material strength by listing materials in order of strength from weakest to strongest. ➢ **Investigating Materials for Strength** Brainstorm, with the class, several methods for comparing the strength of various materials. Have students identify variables that will affect the investigations. For example: use similar amounts of the various materials in the test. As a class, create a plan for each method of investigation. In small groups, have students: carry out the investigations, record the steps they followed, and record their observations and the conclusions based on their results. Example of a sample method: Use various materials to make bridges and test each with various weights or objects.  **Testing the Strength of Bridge Materials**
3-0-1b. Make predictions based on observed patterns, collected data, or data provided from other sources. (ELA 1.1.1; Math SP-IV.2.3) GLO: A1, C2 **3-0-3a**. Brainstorm, with the class, one or more methods of finding the answer to a given question and reach consensus on which method to implement. GLO: C2, C7 **3-0-3b**. Identify, with the class, variables that have an impact on an investigation. GLO: A1, A2, C2, C7 **3-0-3c**. Create, with the class, a plan to answer a given question. (ELA 3.1.4) GLO: C2, C7 **3-0-4a**. Carry out a plan, and describe the steps followed. (Math SP-V.2.3) GLO: C2 **3-0-5a**. Make observations that are relevant to a specific question. GLO: A1, A2, C2 **3-0-6c**. Place materials and objects in a sequence or in groups using two or more attributes, and describe the system used. (Math PR-I.1.3) GLO: C2, C3, C5 **3-0-7a**. Draw a simple conclusion based on their observations. GLO: A1, A2, C2	

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TEACHER NOTES

SUGGESTIONS FOR ASSESSMENT

Have students use Blackline Master 2: Scientific Inquiry Recording Sheet: Grades 3 and 4.

Students must begin to recognize that factors or **variables** must be kept the same in order to be able to draw reasonable conclusions. Students should be encouraged to focus on one aspect or variable at a time, and try to control all the other variables. This way, any differences observed can be more accurately attributed to the variable being studied.

Observation Checklist: Investigating Materials

The student

- ❑ makes predictions based on data gathered from other sources
- ❑ brainstorms to develop a method to answer the question
- ❑ identifies variables
- ❑ contributes to the development of a plan
- ❑ carries out the plan
- ❑ describes the steps followed
- ❑ makes relevant observations
- ❑ records observations
- ❑ orders the materials according to strength
- ❑ draws a conclusion based on observations
- ❑ works cooperatively

PRESCRIBED LEARNING OUTCOMES	SUGGESTIONS FOR INSTRUCTION
Students will...	
3-0-7b. Explain why conclusions related to classroom experiments should be based on multiple trials or classroom data rather than on an individual result. GLO: A1, A2, C2 **3-0-8a**. Recognize that valid experiments normally have reproducible results, which may vary slightly. GLO: A1, A2, C2	➢ **Investigating Ways to Increase Strength** Brainstorm with the class possible ways to strengthen paper. Have students explore ways to fold and combine paper to make it stronger. (Students may fold paper into an accordion, make rolls and glue them together, combine layers of flat sheets, or make sandwich layers with folded and rolled paper. Use a plasticine weight, graduated weights, bricks, wooden blocks, or books as weights to test the strength of each paper configuration. Students should describe each paper configuration they used and record the weight it supported by using a chart. Ask students the following reflection questions to guide classroom discussions: • What did you do to get your paper to support a greater load? • How do we use this information in our everyday lives? (e.g., corrugated cardboard) ➢ **Science Learning Logs** Have students reflect on their learning and record their understandings in their science journals. (See *ELA, Strategies*, p. 110.)
3-2-04 Explore to determine an appropriate method for joining two materials for a specific use. GLO: C2, D3 **3-0-4f**. Assume roles and share responsibilities as group members. (ELA 5.2.1) GLO: C7 **3-0-4h**. Follow given safety procedures and rules, and explain why they are needed. GLO: C1 **3-0-5c**. Estimate and measure mass/weight, length, volume, and temperature using standard units. (Math SS-IV.1.3, SS-I.1.3, SS-III.1.3, SS-VIII.4.3) GLO: C2, C3, C5 **3-0-6a**. Display data using more than one way to represent the same data. (Math SP-III.2.3) GLO: C2, C6 **3-0-6b**. Discuss data and generate new questions from displayed data. (Math SP-IV.1.2) GLO: A1, A2, C2, C5	➢ **Investigation of Fasteners** Have students work in small groups to determine the most appropriate method for joining materials. Challenge each group to construct four towers of a specific height using a given number of plastic straws. Each tower should use a different type of material or object for fastening. The amount of material or number of objects provided should be the same for each group. Example: 30 cm of masking tape or 12 paper clips per group. **Samples of fasteners for straws:** paper clips, tape, pipe cleaners, twist ties, glue, plasticine/modelling clay, marshmallows **for wood (popsicle sticks):** glue, nails, tape **for paper:** glue, tape, paper clips, staples

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TEACHER NOTES	SUGGESTIONS FOR ASSESSMENT
	Science Journal Entry: Increasing Strength Provide students with the following scenario: Your group has been chosen to represent your school at a Science Olympics Competition. Your group's first task is to construct a paper tower that will support a 500 g weight. The other group members are not sure how to make the paper strong enough to support the required weight. What would you suggest to them? Explain your thinking. Look for ideas such as the following: ❑ folding the paper so that it has pleats (accordion-like) ❑ layering the paper ❑ rolling the paper
This investigation builds on student understanding of methods for joining materials begun in Grade 1, Cluster 3: Characteristics of Objects and Materials (1-3-09).	**Self-Assessment: Investigation of Fasteners** Answer Yes or No. 1. I knew my job in the group. _____ 2. I shared responsibilities with the group. _____ 3. I worked cooperatively. _____ 4. I used the tools and materials appropriately and safely. _____ 5. I measured accurately. _____ 6. I recorded my observations and measurements carefully. ____ Complete the following phrases: In this investigation I learned _____ _____. I still would like to know more about _____ _____.

PRESCRIBED LEARNING OUTCOMES	SUGGESTIONS FOR INSTRUCTION
Students will...	

Have students compare the capability of each tower to support a given mass/weight. Use standard weights or equal-sized plasticine balls to test the strength of each tower. Students should record their results on a chart such as the one below.

Strength of Straw Towers with Fasteners

Fastener	Mass/Weight It Supported
glue	_____
masking tape	_____
plasticine	_____
paper clips	_____

Provide time for students to reflect on and discuss their findings using the following questions to guide discussion:

- Which tower supported the most mass/weight?
- Which tower was the most difficult to build?
- Which tower was the most stable?
- Which tower looked the best?

3-2-05 Recognize that balance affects the stability of a structure.

Examples: a domino tower that leans to one side is more likely to tip over than one that stands straight...

GLO: D4

3-0-4b. Construct an object or device to solve a problem or meet a need. GLO: C3

3-0-8b. Recognize that scientists develop explanations from observations and what they already know about the world, and that good explanations are based on evidence. GLO: A1, A2, C2

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➢ **Investigating Balance**

Have students build a tower with dominoes. Ask students the following questions:

- How high can you make the tower?
- What did you notice just before the tower collapsed?

Have students build the tallest tower they can out of cards. Ask them what they notice just before the tower collapses.

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TEACHER NOTES

SUGGESTIONS FOR ASSESSMENT

Science Journal Entry: Investigating Balance

Have students answer the following question in their journals:
Why is it important to build a balanced structure? Use both words and labelled diagrams in your answer.

The student

- ❑ draws a balanced tower (doesn't lean to one side)
- ❑ explains that the tower must be balanced or it will tip over

PRESCRIBED LEARNING OUTCOMES

Students will...

3-2-06 Explore to determine ways to improve the strength and stability of a frame structure.
Examples: use of triangulation or a cross member...

GLO: C2, D4, E2

3-2-07 Identify shapes that are part of natural and human-built structures from various cultures and describe how these shapes help to provide strength and stability.
Examples: cylinders, triangles, hexagons in outdoor play structure, hexagons in a honeycomb...

GLO: A4, D4, E2

3-0-1a. Ask questions that lead to investigations of living things, objects, and events in the local environment. (ELA 1.2.4) GLO: A1, C2, C5

3-0-5a. Make observations that are relevant to a specific question. GLO: A1, A2, C2

3-0-5b. Use tools to observe, measure, and construct. Include: ruler, metre stick, pan balance, magnifying glass, bathroom scale, thermometer, magnet. (Math SS-I.1.3, SS-III.1.3, SS-IV.1.3, SS-VII.4.3) GLO: C2, C3, C5

3-0-5c. Estimate and measure mass/weight, length, volume, and temperature using standard units. (Math SS-IV.1.3, SS-I.1.3, SS-III.1.3, SS-VIII.4.3) GLO: C2, C3, C5

3-0-5d. Estimate and measure the passage of time using standard units. Include: seconds, minutes, hours. (Math SS-VI.1.3) GLO: C2, C3, C5

3-0-5e. Record observations in a variety of ways. *Examples: point-form notes, sentences, simple diagrams, charts...* (ELA 3.2.1, 3.3.2, 4.1.3; Math SP-II.2.1, SP-V.2.3) GLO: C2, C6

3-0-9c. Take the time to repeat a measurement or observation for greater precision or detail. GLO: C5

SUGGESTIONS FOR INSTRUCTION

➢ Identifying Frame Structures

Have students sort pictures of a variety of structures as "frame" and "other structures." Include pictures of bridges, towers, playground equipment, and commercial and residential buildings. Discuss to ensure students understand the concept of frame structures.

➢ Investigating Strength of Frame Shapes

Part 1 — Construction

Ask students: What shape makes the strongest and most stable frame structure? Have students use straws joined with twist-ties to construct a variety of shapes, e.g., triangular prism, square prism, pentagonal prism, etc. Have students test their frame structures to see which structure supports the most weight and is the most stable. Tests should involve loads of increasing mass/weight or time to see how long the structure remains standing.

Note: **Part 2 — Improving Design** will be completed following **Observing the Environment.**

➢ Observing the Environment

1. Natural Structures

Have students look at examples of structure/shapes occurring in nature. Examples: bees'/wasps' nests, sea shells, ant/termite hills, birds' nests, etc.

2. Structures from Many Cultures

Have students view and discuss illustrations of a variety of structures from different cultures, e.g., arches, columns, piers, teepees, earthlodges, quinzhees, etc.

3. Local Structures

Take a walk through the schoolyard and around the immediate neighbourhood to observe natural and human-built structures. Encourage students to make scientific notes about the shapes they see and what has been done to ensure the stability of each structure.

Pose the following reflection questions to help students determine what they know about structures:

- What types of shapes are most common in our environment?
- Who or what makes structures in our environment?
- What types of shapes are common in other parts of the world?
- How are structures made strong and stable?

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TEACHER NOTES

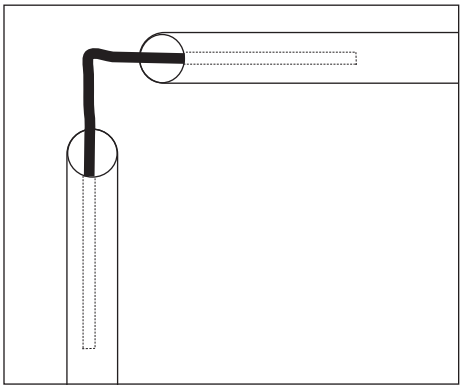
A **structure** can refer to any type of object, be it natural or human-made. It must support its own weight and whatever load is placed upon it. Structures can be grouped into the following three broad categories:

Solid Structures are made from a solid piece of material, having little or no space inside, e.g., solid rubber ball, hockey puck, stone monument, etc.

Frame Structures are made from parts joined together in a framework, e.g., construction crane, skeleton, suspension bridges, etc.

Shell Structures are held together by an outer "skin," e.g., drink can, egg carton, etc.

Many objects are a combination of a frame and shell structure, such as the human body or a tent. In this cluster, the focus is on frame structures.



Joining Straws with Twist-Ties

SUGGESTIONS FOR ASSESSMENT

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PRESCRIBED LEARNING OUTCOMES	SUGGESTIONS FOR INSTRUCTION
Students will...	
	➢ **Investigating Strength of Frame Shapes** **Part 2 — Improving Design** Have students use understandings about structures from **Exploring the Environment** to modify one of the frame structures they constructed to make it stronger or more stable. Have students test their structures again. Pose the following questions to enable students to reflect on what they have learned: • Which shape was the strongest? • How did you get your shape to become stronger and more stable? • What natural or human-made structure gave you ideas for improving your frame structure?
3-2-08 Identify characteristics of materials that need to be considered when choosing materials for building structures. *Examples: strength, flexibility, durability, surface texture...* GLO: D3 **3-0-4e**. Respond respectfully to the ideas and actions of others, and recognize their ideas and contributions. (ELA 1.1.2, 5.2.2) GLO: C5, C7	➢ **Activate Prior Knowledge** Set the purpose for building structures using the following questions to stimulate thinking and generate discussion: • What materials are best suited for specific structures when building the frame? • What materials are best suited for specific structures when constructing the surface? • What conditions determine the materials used? ➢ **If, Then . . .** Have students work in small groups to reflect on and discuss responses to "If… then..." scenarios such as the following: • If we needed to build a boat launch for a steep riverbank, then what materials would we use for the frame? For the surface? Why? • If we needed to build a bridge over a river with many rapids, then what materials would we use for a frame? For the surface? Why? • If we needed a fire tower built in the forest, then what materials would we use for the frame? For the surface? Why? Have students make a list of the materials they would use to construct the particular structure for each scenario and justify their choices (terms such as strong, smooth/rough, durable should emerge). (Note: you may wish to provide students with illustrations of some structures to aid them with this task.) Have students summarize the characteristics they considered when deciding what material to use.

TEACHER NOTES

Encourage students to use cross-bracing or triangulation to increase the stability of structures. The **triangle** is a very strong shape and it is often used to stabilize structures. Structures made from many triangles put together are very strong. **Cross-braces** are additional beams or pieces that can be added on to a structure to stabilize or strengthen it.

Discuss with students what they should do if they see an unsafe structure.

SUGGESTIONS FOR ASSESSMENT

Paper and Pencil Task: Frame Shapes and Structures

Have students answer True or False.

1. The triangle is a very strong shape.
2. There are many examples of structures/shapes in nature.
3. Many cultures use the same shapes in their structures.
4. Balance does not affect the stability of a structure.
5. Many of the shapes found in nature can be found in structures around the school.

Provide students with a picture of a playground structure or another human-made structure.

Have students observe the picture and then answer the following questions:

1. What shapes do you see in the picture?
2. How do these shapes help to provide strength and stability to the structure?

PRESCRIBED LEARNING OUTCOMES	SUGGESTIONS FOR INSTRUCTION
Students will...	
3-2-09 Use the design process to build a structure that meets given criteria related to strength, stability, and function. GLO: A3, C3	➢ **Design Project** Have students work in small groups to solve a given problem using the skills and knowledge already learned in this cluster. Establish specific criteria regarding size, strength, and amount of materials needed. Problems can emerge from literature or other subject areas such as social studies or physical education. **Sample Project: The Incredible Marble Game** Construct a table game for younger children. The game must be a linked collection of free-standing structures along which a marble will roll. Provide students with a selection of materials to use and assign each a dollar value. Give students a budget to which they must adhere during the construction phase. Criteria for evaluating the finished design include the following elements: • fits on a student desk • contains at least two identifiable structures modelled on natural or human-made structures observed in this cluster • uses at least two different fastening or joining methods • includes a path for the marble • utilizes materials provided • is within budget • is safe for young children
3-0-1c. Identify practical problems to solve in the local environment. GLO: C3 **3-0-3d**. Brainstorm, in small groups, possible solutions to a practical problem, and reach consensus on which solution to implement. GLO: C3, C7 **3-0-3e**. Create, in small groups, a written plan to solve a problem or meet a need. Include: identify steps to follow, prepare a simple diagram. (ELA 1.2.3) GLO: C3, C7 **3-0-4b**. Construct an object or device to solve a problem or meet a need. GLO: C3 **3-0-4c**. Test an object or device with respect to pre-determined criteria. GLO: C3, C5 **3-0-4d**. Identify and make improvements to an object or device, and explain the rationale for the changes. GLO: C3 **3-0-4f**. Assume roles and share responsibilities as group members. (ELA 5.2.1) GLO: C7 **3-0-7c**. Identify new problems that arise. GLO: C3 **3-0-8c**. Recognize that designing a solution to a simple problem may have considerations, such as cost, materials, time, and space. GLO: B2, C3	
3-2-10 Describe the effects of various forces on different structures. *Examples: bookshelf sagging under the mass/weight of books, tent blowing over in a storm...* GLO: D4, E2 **3-2-11** Evaluate simple structures to determine if they are safe and appropriate to the user. *Examples: classroom furniture...* GLO: C1, C3, C4, D4	➢ **Houses Fall Down** Read or retell the story of *The Three Little Pigs*. Ask students the following questions: • What caused the stick house to blow down? • Do you think it was a strong structure? Why or why not? • Why didn't the brick house fall down? • Can any forces knock down brick houses? ➢ **Withstanding Forces** Have students read or view informational resources about the way structures are designed to withstand forces. Have students identify some of the forces that may affect structures, such as wind, water, earthquakes, and tornadoes. Discuss and record interesting facts they discover.
3-0-2a. Access information using a variety of sources. *Examples: children's magazines, local farmers, CD-ROMs, Internet...* (ELA 1.1.2, 3.2.2; Math SP-I.1.2.3; TFS 2.1.1) GLO: C6 **3-0-2b**. Review information to determine its usefulness to research needs. (ELA 3.2.3, 3.3.3) GLO: C6, C8 (continued)	(continued)

TEACHER NOTES	SUGGESTIONS FOR ASSESSMENT
Have students use Blackline Master 4 Design Process Recording Sheet: Grades 3 and 4. In Grade 3, students will begin planning steps to follow and identifying evaluation criteria in small groups, rather than with the whole class. It is important for the teacher to ensure strong group-work skills are in place and to provide support to groups as needed.	**Design Process Checklist** The student ❑ understands the problem ❑ actively participates in small-group brainstorming ❑ includes written list of steps to follow ❑ includes simple diagram ❑ contributes to the development of design criteria ❑ constructs the structure ❑ tests the structure based on given criteria ❑ identifies improvements to be made ❑ makes improvements ❑ works cooperatively ❑ shares group responsibilities **Student/Group Assessment of the Process and Structure** As a group, we ❑ planned our structure before building ❑ estimated the cost ❑ reflected on our plan before the construction ❑ cooperated and shared ideas as we were building ❑ tested our structure and made changes ❑ reflected on what we did well and what we would change the next time
The concept of forces acting on different structures is a link to Grade 3, Cluster 3: Forces that Attract or Repel. Recognition of gravity as a force is addressed in that cluster.	**Paper and Pencil Task: Picturing Force** Student directions: Draw a picture to show the effect of a force on a structure and explain what is happening through words and diagrams. The student ❑ clearly shows the effect of the force ❑ clearly explains what is happening using the term “force”

PRESCRIBED LEARNING OUTCOMES	SUGGESTIONS FOR INSTRUCTION
Students will...	
3-0-7d. Examine how new experiences, ideas, and information connect to prior knowledge and experiences, and record these connections. (ELA 1.2.1, 2.1.2, 3.3.3) GLO: A2, C6 **3-0-7e**. Communicate results and conclusions in a variety of ways. *Examples: point-form lists, sentences, simple diagrams, charts, demonstrations...* (ELA 2.3.5, 3.3.2, 4.1.3; Math SP-III.2.3; TFS 2.1.4) GLO: C6	➢ **School Structures: Labelled Diagrams** Have students draw and label diagrams of structures in their school environment. Students should include information to explain structural designs and materials that make these objects safe. Include items such as desks, bookshelves, computer tables, AV carts, gym equipment, outdoor play structures, etc. Ask the following questions to help students clarify what they learned: • What helped the structures to be safe? • What could cause them to become unsafe?
3-2-12 Investigate to identify hobbies and jobs related to construction, engineering, and architecture. GLO: B4 **3-0-4g**. Verbalize questions, ideas, and intentions during classroom-learning experiences. GLO: C6	➢ **Identifying Jobs and Hobbies** As a class, brainstorm and list jobs and hobbies that involve knowledge of structural design and materials. ➢ **Guest Speakers** Invite a guest speaker such as an engineer, architect, and/or construction worker to discuss his/her career, job responsibilities, and training with regard to forces and structures.
3-2-13 Identify various materials used in the construction of buildings in their community and in communities around the world. GLO: A4, B1, D3, E1 **3-0-1a**. Ask questions that lead to investigations of living things, objects, and events in the local environment. (ELA 1.2.4) GLO: A1, C2, C5 **3-0-2a**. Access information using a variety of sources. *Examples: children's magazines, local farmers, CD-ROMs, Internet...* (ELA 1.1.2, 3.2.2; Math SP-I.1.2.3; TFS 2.1.1) GLO: C6 **3-0-2b**. Review information to determine its usefulness to research needs. (ELA 3.2.3, 3.3.3) GLO: C6, C8 **3-0-3a**. Brainstorm, with the class, one or more methods of finding the answer to a given question and reach consensus on which method to implement. GLO: C2, C7 **3-0-7e**. Communicate results and conclusions in a variety of ways. *Examples: point-form lists, sentences, simple diagrams, charts, demonstrations...* (ELA 2.3.5, 3.3.2, 4.1.3; Math SP-III.2.3; TFS 2.1.4) GLO: C6	➢ **Inquiry Chart: Building Materials Here and Around the World** Have students work individually or in pairs to answer the following inquiry questions: • What materials do we use most in Canada for building homes, bridges, and towers? • What materials are used most in _____ (name of country) for building homes, bridges, and towers? The country could include a place students are currently studying in social studies. Have students describe the style and identify some of the reasons for the design of: buildings in earthquake areas such as California or Japan; thatched-roof dwellings in Africa; etc. Have students carry out research through interviews, magazine pictures, videotapes, CD-ROMs, the Internet, etc. Students could present their findings using an Inquiry Chart (Hoffman, 1992 and 1997 and *ELA, Strategies*, pp. 83 - 88).

TEACHER NOTES	SUGGESTIONS FOR ASSESSMENT
Discuss with students what they should do if they see an unsafe structure.	
	Learning Log: Building Materials Here and Around the World Have students summarize what they learned about materials and style used in buildings around the world by completing the following: 1. In Canada we use these materials: _____. 2. Other countries use materials such as: _____. 3. People in different places use different materials for building homes because: _(available materials, climatic conditions, other) _____.

NOTES