



GRADE THREE

UNIT PLAN

STRONG AND STABLE STRUCTURES



Nanabush Builds a Bridge by Steven Trudeau (2013)

This unit covers the **Understanding Structures and Mechanisms** strand of the Grade 3 Ontario Science and Technology Curriculum, **Strong and Stable Structures**, through use of culturally representative Indigenous (Aboriginal) stories and learning materials.

It is readily combined with the Grade 3 Ontario Social Studies curriculum, and is thus ideal for use as part of a project-based learning classroom.

This unit also introduces students to the Engineering Design Process, a universal approach to science and engineering problem-solving.

LESSON SEQUENCE

1. Nanabush Builds a Bridge
2. Structures in our Lives
3. Basic Building
4. Push and Pull
5. Exploring Natural Structures
6. Exploring Built Structures
7. Build a Shelter for an Animal Brother

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GRADE THREE STRONG AND STABLE STRUCTURES

LESSON ONE NANABUSH BUILDS A BRIDGE

Time frame: 1 class period (40 minutes)

OVERALL AIM OF THE LESSON

Students will engage in a hands-on, open-ended engineering design activity and be introduced to the terms strong, stable and structure.

SPECIFIC CURRICULUM LINKS

Ontario Curriculum Grade 3 Science and Technology

Students will

3.3 identify the strength of a structure as its ability to support a load;

3.6 describe ways in which the strength of different materials can be altered (e.g. by folding, adding layers, twisting/braiding, changing their shape);

3.7 describe ways to improve a structure's strength (e.g. by using triangulation or cross-members) and stability (e.g. by lowering the centre of gravity)

LAUNCH

It will help to familiarize students with Nanabush prior to launching the unit. This lesson centres around a story featuring the Anishinaabe culture hero/trickster figure **Nanabush**. In traditional stories, Nanabush appears as a rabbit and could be characterized as a trickster figure, but he is also a shape-shifter and able to take the form of a man. He was sent to Earth by Gitchi Manitou (the Creator) to teach the Anishinaabe. One of his first tasks was to name all the plants and animals, a story which will feature later in this unit.

Have you ever had a time when things didn't go as you hoped and planned? Did you have to figure out how to get yourself out of a problem situation? The same type of thing happens to Nanabush on occasion. Let's see what he gets into on this particular day, and see if we might be able to help him out of his problem.

Read the story "Nanabush Builds a Bridge", as told by Eileen Conroy. You may display the artwork by Anishinaabe artist Steven Trudeau, which was created for this story (SS3.1, SS3.2)

MATERIALS

Nanabush Builds a Bridge story and illustration (SS 3.1, SS 3.2)

Engineering Design Process Diagram (SS 3.3)

1 sheet paper, for each student (can be recycled/reused paper, as long as everyone has the same size)

Goldfish crackers or counters

Additional weighted bags
**optional, example of birch bark

PREPARATION AHEAD OF TIME

- Prepare goldfish bags and weighted bags
- Decide where bridges must span (between desks is usually sufficient)

TALK TIME

Before we try to help Nanabush, what are some things a bridge must be able to do?

Answers should include holding the weight of Nanabush, weight of the fish, cross the stream, etc.

Introduce the vocabulary words **STRONG** and **STABLE** in the context that we would want to build a bridge that is **strong enough** and **stable enough** to hold the weight of Nanabush and the fish.

CHALLENGE

Each student will have one sheet of paper, to represent the birch bark that Nanabush found.

The engineering challenge is to design a bridge that will span a crossing (approximately 15cm). This bridge must be able to hold the weight of Nanabush and his packs of fish.

Students will test their designs after being given approximately 3-5 minutes to complete the bridge. No other materials can be used, as Nanabush only had birch bark (paper)

COMING TOGETHER

When everyone has finished with their design, come together as a group to test them. Should you decide it is appropriate for your class, you may increase the load (weight) being carried by the packs to see who had the strongest structure.

TO THINK ON

How could designs have been made stronger? Think of bridges in real life...what have students noticed about them?

Engineers are people who work on designing things like bridges as part of their jobs. They follow something called the **Engineering Design Process** when taking on the challenge of designing something new. Show students the Engineering Design Process diagram (SS3.3) and notice how many steps they used when designing their bridge...without even knowing they were doing so!

EXTENSION

If time allows, let the students try to build another bridge, this time using what they have learned from testing the first bridges. This is the redesign phase of the Engineering Design Process.



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GRADE THREE STRONG AND STABLE STRUCTURES

LESSON TWO STRUCTURES ALL AROUND US

Time frame: 2 class periods (80 minutes)

STUDENT TAKE AWAY OVERALL AIMS OF THE LESSON

Students will identify built structures in their immediate world. Structures include anything made to hold a load and to stay in place – buildings, bridges, roads, play structures, etc.

SPECIFIC CURRICULUM LINKS

Ontario Curriculum Grade 3 Science and Technology

Students will

- 3.1 define a structure as a supporting framework, with a definite size, shape, and purpose, that holds a load;
- 3.2 identify structures in the natural environment and in the built environment;
- 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.

LAUNCH

First work period

Recall and discuss making bridges to help Nanabush. **What did we do?** [We built].

People build lots of different things. Animals do as well. We build things to help make our lives and work less difficult.

Today we're going to take a walk outside our school building and yard to find examples of structures. You will take your field notebook and each team will record through pictures, drawings, and words the structures that you find. Be ready to share them with the class tomorrow!

MATERIALS

BLM Field Notebook (SS 3.4)

PREPARATION AHEAD OF TIME

- BLM Field Notebooks
- Decide route of on-site field trip

TALK TIME

From students, encourage examples of what makes a structure a structure.

Key vocabulary words: **STRONG** and **STABLE**

CHALLENGE

Remainder of work period is outside, around your school. Students will take their field note book with them to record what they find.

Examples students should find include the school building, adjacent buildings, play structures, out-buildings, traditional structures, roads, etc.

COMING TOGETHER

Second work period

In this period, bring the class together in a circle to discuss their findings. Did they find similar structures? Have the group come up with ways to classify their findings in an organizational chart.

Were any of the structures **ANIMAL** structures?

[bee hives, beaver dams, birds' nests, etc.]

What structures do our animal brothers build to shelter and protect themselves? Do they have to be STRONG and STABLE too? [yes]

For the remainder of the period, watch

<https://www.youtube.com/watch?v=IFg21x2sj-M>

**Potential question from students – what happened to the ants?

[It is unclear if the ants were still there or not]

Why would we have to cast it in concrete? Why not just dig it away?

[digging away would erode the structures that the ants have built]

TO THINK ON

After seeing this video, would you say that ants are engineers? Do you think they designed that colony in order to meet certain requirements? [Yes. They found fungus gardens, storage and waste area, ventilation shafts, tunnels to shorten routes, etc]



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GRADE THREE STRONG AND STABLE STRUCTURES

LESSON THREE BASIC BUILDING EXPLORATIONS

Time frame: 3-4 class periods (120-160 minutes)

STUDENT TAKEAWAY

OVERALL AIMS OF THE LESSON

Students will experiment with different techniques and materials to attain the goal of building strong and stable structures.

SPECIFIC CURRICULUM LINKS

Ontario Curriculum Grade 3 Science and Technology

Students will

- 2.2 investigate, through experimentation, how various materials and construction techniques can be used to add strength to structures;
- 3.1 define a structure as a supporting framework, with a definite size, shape, and purpose, that holds a load;
- 3.2 identify structures in the natural environment and in the built environment;
- 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;
- 3.5 identify properties of materials that need to be considered when building structures;
- 3.6 describe ways in which the strength of different materials can be altered;
- 3.7 describe ways to improve a structure's strength and stability;
- 3.8 explain how strength and stability enable a structure to perform a specific function.

MATERIALS

- Miniature marshmallows or clay
- Wooden stir sticks/craft sticks
- Toothpicks
- Carpenter's glue or hot glue gun/glue sticks
- Paper cups
- Newspapers
- Cardboard from cereal boxes, etc.
- Masking tape
- Commercial building toy product– K'Nex, Lego, etc.

PREPARATION AHEAD OF TIME

- Purchase materials or ask for donations, if necessary
- Cut cardboard to reasonable sizes so as to avoid waste by students cutting into it freely
- Prepare one example of a rolled-up newspaper beam



LAUNCH

First work period
Recall field trip findings from previous lesson

Are some things stronger than others? What makes them this way? [materials used, how they are built, methods of construction]

For the next few days, we are going to get a chance to explore different ways of building things and try to make them as STRONG and STABLE as we can. How can you tell if a structure is STRONG? How can you tell if a structure is STABLE?

TALK TIME

Review safety considerations associated with scientific experimentation, as specified by your school or board policies.

Review expectations with regard to record-keeping.

While you are working, it will be important to record your work using pictures, drawings and words.

CHALLENGE

Students will work at one station for the remainder of this period, with a partner.

Over the next two periods, they will complete work at additional stations.

The final day will have them return to their favourite building project to finish it up and/or strengthen it. This likely cannot include the toy building material station, as there will not be enough material should everyone choose it. It should be removed.

BUILDING EXPERIMENTATION STATIONS

Station 1: clay/marshmallows and toothpicks

Station 2: cups and cardboard, scissors

Station 3: stir sticks and glue (possibly hot glue, review safety!)

Station 4: newspaper and tape

Station 5: toy building materials – K’Nex, Lego, etc.

COMING TOGETHER

In a circle, present various building projects to the class. You may ask students questions such as:

How do you know your structure is stable?

How do you know your structure is strong?

What tests did you do to make sure it was strong and stable?

How did you make your building STRONGER and/or MORE STABLE?

What building techniques did you use?

TO THINK ON


How do materials affect your building outcomes?

Students will notice that some materials work better than others

EXTENSION

Invite a class of older or younger students into your classroom, and have students share their building designs and projects.

Encourage questions from visitors!



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GRADE THREE STRONG AND STABLE STRUCTURES

LESSON FOUR PUSH AND PULL

Time frame: 2 class periods (80 minutes)

STUDENT TAKEAWAY

OVERALL AIMS OF THE LESSON

Using the towers and structures built in the previous exploration, students will redesign their projects in order to better resist pushing and pulling forces of wind, weight and gravity.

SPECIFIC CURRICULUM LINKS

Ontario Curriculum Grade 3 Science and Technology

Students will

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.

LAUNCH

First work period

As a class, review findings from the building experiments.

Which structures were stronger and more stable? What made them stronger? Did anyone use struts or ties to help strengthen their structure?

Remember, there are people who think about building designs as part of their jobs! They are called engineers. Let's meet a couple of engineers now.

Introduce students to the book "We're Going to be Civil Engineers". You may read aloud from it, or request a class set for everyone to have a copy.

MATERIALS

We're Going to be Civil Engineers booklet, available at www.aboriginalaccess.ca

Engineering Design Process Diagram (SS 3.3)

Craft sticks (10 cm)

Craft Sticks (15 cm)

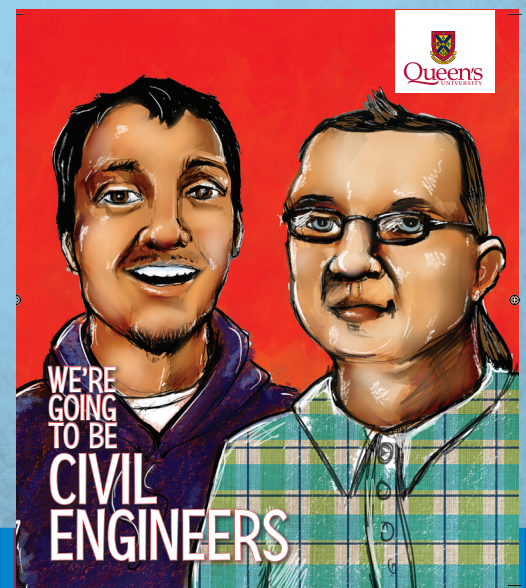
Corners


Glue

Optional: commercial building kit: K'Nex recommended

PREPARATION AHEAD OF TIME

- Prepare an example of a basic square frame





Class sets of “We’re Going to be Civil Engineers” are available freely to teachers and schools in Canada by requesting them through www.aboriginalaccess.ca/resources/ordering-publications

Read pages 1-5 of “We’re Going to be Civil Engineers”

TALK TIME

What are some of the new words we’re hearing from Haven and Oke in this book? [loads, forces, stress]
What puts stress on a structure? [loads and forces]

Forces will PUSH and PULL on a structure. Gravity causes weight to PULL down on a structure, like Haven sitting up on the deck of the longhouse on p.4....gravity is pulling his weight down. This is called STRESS, and it pushes the structure down, or COMPRESSES it.

Winds outside the longhouse will PUSH the structure. Builders had to think carefully about that and make sure that their longhouse design allowed for it to be PUSHED and PULLED by FORCES.

Explain to students that longhouse builders didn’t just know how to do things right the first time – they learned over generations what ways were best to build a strong and stable structure, and passed that traditional engineering knowledge down through teaching the younger generations.

Today and tomorrow we are going to build a simple structure and see if we can make our structures STRONGER so that they can resist being pushed and pulled. We will be testing them together, but you may test them as you work in order to make good changes and re-design it afterwards, just like an engineer would.

Review the Engineering Design Process diagram with students (SS3.3)

CHALLENGE

Demonstrate the technique to build a basic square-framed bridge or building.

Students then build their own square frame. They can think of ways they can make their structures stronger. The instructor can circulate to discuss ideas. Before students begin trying to strengthen their design, they may test their structures, but with lighter weight materials to ensure they don’t break!

Testing materials are made available so students can test their modifications – cardboard surface and weights, fan.

Students will likely begin to realize that using a triangular shape will strengthen the frames on their structure. Introduce the words **STRUTS** and **TIES** when these discoveries are made.

COMING TOGETHER


Once students have had adequate time to revise their designs, bring the class together for testing. This is not intended to be a competition, but rather a test to see if the structures are stronger than before.

Students can share what they modified and how they achieved the modification. Use the vocabulary for the lesson – **STRUTS** and **TIES** will help make the structure **STRONGER** and more resistant to **FORCES** of pushing and pulling.

TO THINK ON

Read page 6 of *We’re Going to be Civil Engineers*. This page references an idea brought up in the previous lesson – that types of materials are important. Why would we have done the lesson today using sticks and corners, rather than marshmallows?

Some engineers work just on designing new materials! What are some materials that engineers have designed? Wood is natural...but what other materials do we use these days to build structures?



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GRADE THREE STRONG AND STABLE STRUCTURES

LESSON FIVE EXPLORING NATURAL STRUCTURES

Time frame: 1-2 class periods (40-80 minutes)

STUDENT TAKEAWAY

OVERALL AIMS OF THE LESSON

Students will recognize and identify animal builders in their environment, and be able to comment on the impact those animal building practices would have on local ecosystems.

SPECIFIC CURRICULUM LINKS

Ontario Curriculum Grade 3 Science and Technology

Students will

- 1.1 assess the effects of strong and stable structures on society and the environment;
- 1.2 assess the environmental impact of structures built by animals and those built by humans.

LAUNCH

We've seen the importance of strength in building a structure. Do you think this same principle – strong and stable structures – would apply to the engineering that animals do? Do animal builders need strong and stable structures too? What are some animal builders we can think of? [ants, beavers, bees, birds, etc.]

We're going to read a legend as told by the Miq'maw people. Many of the Miq'maw traditional stories feature a giant man called Glooscap, who helped the Miq'maw people.

Read the legend of *How Glooscap Created Sugarloaf Mountain* aloud to the class.

Alternatively, you may read the book *Glooscap, the Beavers and the Sugarloaf Mountain* (Mitcham and Sock)

MATERIALS

How Glooscap Created Sugarloaf Mountain as told by Elders Margaret Labillois and Luke Simon (SS 3.5)

Glooscap, the Beavers and the Sugarloaf Mountain picture book by Mitcham and Sock (optional)

PREPARATION AHEAD OF TIME

- Reproduce BLM Glooscap and Sugarloaf Mountain (SS 3.6)

CHALLENGE

Students will complete the blackline master of comprehension questions regarding the Glooscap legend. Alternatively, the story can be reviewed orally and questions and answers derived from class discussion.

TO THINK ON

Beavers are excellent dam builders. Can you help a beaver build a dam? Try the beaver building activity game at http://assets.aboriginalaccess.ca/bearpaw/willows_prings/index.htm. You may also play some of the other “Animal Engineer” games assembled there.

EXTENSION

An excellent extension to this activity would be to go on an animal builders’ tour in your local environment, particularly if students noticed animal structures in their initial observations of buildings around the school. Evidence of animal builders would be beehives, beaver dams, fox holes, ant hills, etc.



http://assets.aboriginalaccess.ca/bearpaw/willows_prings/index.htm

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GRADE THREE STRONG AND STABLE STRUCTURES

LESSON SIX EXPLORING BUILT STRUCTURES

Time frame: 1 class period (40 minutes) plus field trip

STUDENT TAKE AWAY

OVERALL AIMS OF THE LESSON

Strong and stable structures endure over TIME. This can mean there are both societal and environmental impacts created by the building of these structures.

SPECIFIC CURRICULUM LINKS

Ontario Curriculum Grade 3 Science and Technology

Students will

- 1.1 assess the effects of strong and stable structures on society and the environment;
- 1.2 assess the environmental impact of structures built by animals and those built by humans.

LAUNCH

Last class, we looked in our surrounding for animal structures... now I have asked you to bring in photos of human-built structures.

Share pictures the students bring in. They will likely be locally-known landmarks, and can range in age from current builds to those hundreds of years old.

MATERIALS

We're Going to be Civil Engineers
booklet, available at
www.aboriginalaccess.ca

BLM Venn Diagram (SS 3.7)

PREPARATION AHEAD OF TIME

- Assign homework task – students need to bring in a picture of a local structure

TALK TIME

Have humans always built things the way we do now? How can we tell from our photo collection how things have changed? What are some traditional structures you know about?

Re-read pages 1-2 of “We’re Going to Be Civil Engineers”. The Haudenosaunee peoples built longhouses for their villages. Other Indigenous structures include wigwams, tipis, adobe brick houses, etc.

CHALLENGE

In what ways are the buildings from the past, in traditional North American Indigenous cultures, similar to the buildings of today? In what ways are they different?

Have students work with a partner to complete the Venn diagram, comparing two specific buildings (tipi and local library, longhouse to their own house, etc.)

COMING TOGETHER

As a class, review some of the Venn diagrams. **What are some of the similarities?** These will likely center around societal purpose for the structure – to keep people warm, protect from elements, etc. **What are some of the differences?** These are more likely to focus on physical aspects of the structures, such as size, shape and building materials used.

Which building has more of an impact on the environment?

TO THINK ON

Comparisons can also be made between historically different cultures, and this unit can be integrated with the Ontario Social Studies curriculum. Historical structures from different cultures, Indigenous and Settler, may be referenced in order to draw these comparisons.

www.edu.gov.on.ca/eng/curriculum/elementary/sstudies18curr.pdf

EXTENSION FIELD TRIP

As an extension of this lesson, the class may be taken on a local field trip, where they will learn about a community structure. In particular, focus on the function of the building and its’ impact on the community, but also its’ impact on the local environment.

If available to you, take students to buildings built at different points in history, and notice some of the similarities and differences.



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GRADE THREE STRONG AND STABLE STRUCTURES

LESSON SEVEN BUILDING A SHELTER FOR OUR ANIMAL BROTHERS

Time frame: 4-6 class periods (160-240 minutes)

STUDENT TAKEAWAY OVERALL AIMS OF THE LESSON

Students will use what they have learned throughout the unit and apply their knowledge in response to a specific setting, and use the Engineering Design Process.

SPECIFIC CURRICULUM LINKS

Ontario Curriculum Grade 3 Science and Technology

Students will

2.4 use technological problem-solving skills, and knowledge acquired from previous investigations, to design and build a strong and stable structure

2.5 use appropriate science and technology vocabulary, including compressions, tension, strut, ties, strength and stability, in oral and written communications;

2.6 use a variety of forms to communicate with different audiences for a variety of purposes.

LAUNCH

Background: Nanabush

As we spoke of earlier on in our introduction to Nanabush, he had the challenge of naming all of the animals. He also sat down with them and spoke of their responsibilities.

Read the story **Nanabush Builds a Shelter for his Animal Brothers**, as told by Anishinaabe storyteller Eileen Conroy, and display the illustration *Nanabush and his Animal Brothers* by Anishinaabe artist Steven Trudeau.

MATERIALS

Nanabush Builds a Shelter for his Animal Brothers story and illustration (SS 3.8, SS 3.9)

Engineering Design Process Diagram (SS 3.3)

BLM Package (SS 3.10)

Long bamboo sticks

Popsicle sticks/Craft sticks

Toothpicks

Paper

Tape

Cord or twine

PREPARATION AHEAD OF TIME

- Reproduce BLM package (SS 3.10)
- For a larger class, you may want to cut cord to 1m lengths
- Optional: bring small stuffed animals to class. Students like to build their homes around an actual “animal”.



TALK TIME

Before we try to help our animal brothers, we must make a plan of action. What things would we consider when trying to build a shelter? What forces might act on it? [weight of snow, wind etc] What have we learned about building that would help us in our plans? [The Engineering Design Process]

Display the Engineering Design Process diagram (SS 3.3) once more.

CHALLENGE

Students may work in groups of 2-3. Each student will be given access to building materials. In order to make the engineering design challenge more realistic, they will have limited amounts of materials available. Each student gets a certain number of items, and therefore working in a bigger group will give each group more material to work with. But it also means cooperation and communication becomes more important!

Suggested materials list as follow, per student:

1m tape

1m string

10-15 sticks of their choice

1 piece of paper

By keeping materials to a minimum, students' creativity will be exercised.

Allow students ample time to meet and plan their ideas before receiving their materials. The design plan BLM should be filled in to the appropriate point and oral assessment of planning processes can take place throughout the planning stage.

Student groups work on their projects, allowing sufficient time for testing. Testing stations may be set up with a fan (wind) and weights (load), to allow students to test their own designs and make modifications.

The engineering re-design process is one of the KEY steps in the learning process. Students are encouraged to learn from their mistakes, and to redesign with an aim to avoid those mistakes.

COMING TOGETHER

Once everyone is satisfied with their structures (or after a reasonable working period is up), have the class come together to test their structures. Student groups are invited to present their structures to the class, and to answer any questions from classmates. The structure will then be put to the test of forces - wind and weight.

You may choose to allow complete redesign and build of the project, or simply evaluate students in how they propose to redesign their work.

In the case of a redesign, students from other classes could be invited for the re-testing, at which point students can present their initial project, results from testing, and then features of the redesign that they feel will make the structure stronger and more stable.

EXTENSION

Math can be worked into this activity if you decide to have a materials supply "store" and ask students to budget for their materials purchases.

