ONTARIO COUNCIL FOR TECHNOLOGY EDUCATION

Grade 7
Form and Function
ONLINE RESOURCE

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Form and Function Grade 7

Activity 1 - The Perfect Chair

Development of Curiosity and Wonder

Scientific and Technological Concepts:

Every object you encounter is a structure. A structure is the arrangement of parts put together for a particular purpose. In our everyday life we encounter many natural structures as well as human made structures. Each structure serves a purpose. Different structures can serve the same purpose ex: A bench and a high chair both serve as a seat.

One way structures can be classified is by their form. The form is the shape and physical appearance of the structures. You can classify them into 3 main categories based on their form:

1) Frame: made of parts fastened together. They can exist as just the parts fastened together or with a coating on top. A dish drying rack is a frame structure with just a frame where a car is a frame structure covered with some material.
2) Shell: Hollow structure, they have space inside of them and often use little material when building ex: Cardboard box, balloon, egg carton
3) Solid: solid all the way through ex: Mountains

Learning Goal:

Form and Function Grade 7

Students will

- Students will classify structures as solid structures, frame, or shell structures.
- Build 3 structures - one of each form that serve the same function

Expectations (Overall & specific):
2.1 follow established safety procedures for using tools and handling materials
2.3 investigate the factors that determine the ability of a structure to support a load
2.6 use appropriate science and technology vocabulary, including truss, beam, ergonomics, shear,and torsion), in oral and written communication
3.1 classify structures as solid structures (e.g., dams),frame structures (e.g., goal posts), or shell structures (e.g., airplane wings)

Equipment & Materials	**Personal Protective Equipment (PPE)**
• Popsicle sticks • Tape • Recycled cardboard • Plasticine or playdough • Tooth picks • BBQ Skewers	• Safety goggles (if cutting anything)

Safety Considerations:

- Ensure hair is tied back
- If materials need to be cut ensure you have proper supervision

What does the teacher do?	**What do the students do based on the Technological Problem-Solving Skills Continuum?**
• Introduce the topic by showing pictures of	**Initiating and Planning**

Form and Function Grade 7

various structures to the class. Ask students to place them in categories. For example students might classify them by size, by material used or by how they look. *See Appendix A : Classifying structures* • Once students have had a chance to classify the structures themselves, discuss with students one way that structures can be classified is their form: frame, shell and solid. • Have the students classify the structures in Appendix A due to their form • Students will use *Appendix B: "A chair for Everyone"* to design 3 chairs - each one a different form. Students will test their chairs using a weight to determine which one can withstand the most weight. Remind students to use the same weight to test each chair (control variable). Students should attempt to make each chair approximately the same size, as another control variable. • When students are finished, you can have them share their pictures on a slideshow or Jam Board. • Discuss which form held the most weight. Why might this information be important when designing structures? Why are not all chairs solid? What did they learn while making their chairs? **Sample accommodations:** • If students do not have the materials they can use other household objects as long as they	• Sort the various kinds of structures found in Appendix A, two different ways, independently • Sketch a design and create a plan for their 3 chairs. Determine which material they will use for all 3 chairs. • Review key scientific terms such as: a frame, shell and solid • Hypothesize which type of structure will sustain the heaviest weight **Performing and Recording** • Create their 3 chairs • Test which one withstands weight using Appendix B **Analysing and Interpreting** • Discuss results • Determine through discussion with peers why knowing that a solid can withstand the most weight is important

Form and Function Grade 7

are safe • Appendix A can be made interactive or as a boardmaker activity	

Opportunities for assessment (Links to assessment pieces, organizers):

- Student slideshow with pictures of their design and actually building
- Could also do a final Jamboard and have students comment on other students' work to have them share their ideas with their classmates and receive peer feedback.

Success Criteria

	Met	Not Met
Create 3 mini-chairs that represent a frame structure, a shell structure and a solid structure		
All 3 structures used the same materials and are approximately the same size		
Student's design shows creativity, is neat and esthetically pleasing		
Questions are answered with detail using scientific terms		
Comments:		

References:

Form and Function Grade 7

Corrigan, K. (2015). *Discover Science Through Sport*. Toronto, ON: Jennifer Geary.

Appendix A

Structures All Around Us

Sort the following structures into categories

Bike	bridge
Igloo	CN Tower
Mountain	Water bottle
Pop can	Skeleton
Turtle Shell	Concrete block

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I would classify the following items by _____
Create a graphic organizer showing the categories you sorted the structures in to

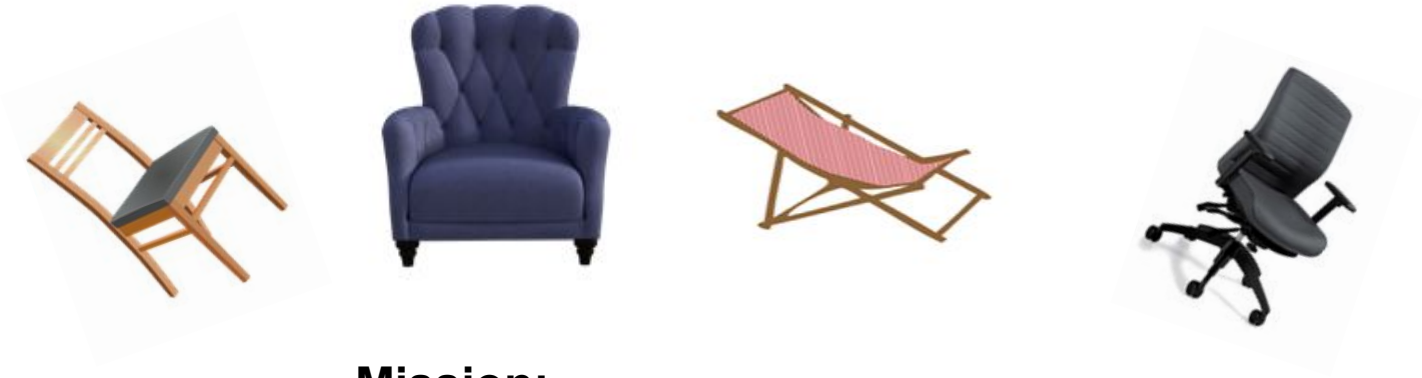
Another way I could classify these structures is by _____

Appendix B

A chair for Everyone

Some structures, depending on their function may be made in different forms.

Form and Function Grade 7



Mission:

Your mission is to build 3 small chairs. One of each different form of structure (Shell, Frame and Solid).

Materials

*You must use the **same** materials for **all 3** chairs *

- Tooth picks
- Popsicle sticks
- BBQ Skewers
- Marshmallows
- Playdough
- Tape

Step 1: Design your chairs what materials are you going to use?

Form and Function Grade 7

Chair #1 Design:

Chair #2 Design:

Form and Function Grade 7

Chair #3 Design:

What did we learn?

1. **Which form held the most weight?**

2. **Why might this information be important when designing structures?**

3. **What did you learn from your design?**

Form and Function Grade 7

Activity 2: A Balancing Act

Structured to develop technological problem solving skills

Scientific and Technological Concepts:

Gravity is the force that attracts a body toward the centre of the earth or toward any other physical body having mass The point at which a body's mass is concentrated and is equally balanced in all directions is known as your centre of gravity. The centre of gravity of a structure depends on its shape and how its mass is distributed. Sometimes the centre of gravity is outside the object (ex: a roll of tape)

Stability: The ability of a structure to remain in or return to a stable balanced position when forces act on it. To improve stability and balance in a structure, the centre of gravity should be low and close to the point of balance. Symmetry, when each side is arranged the same plays an important role in the stability of a structure. For example you can balance a ruler with one figure if you balance it in the middle of the ruler because the weight is equal on both sides.

Centre of Mass and Stability: **https://www.youtube.com/watch?v=ajTyhbvMEAg**
Centre of Mass: **https://www.youtube.com/watch?v=qRsJXXb9WNE&t=114s**

Learning Goal:

Students will

- Investigate centre of gravity and how it relates to structural stability
- Determine how to change the center of gravity in order for a structure to balance

Expectations (Overall & specific):

Overall:

Design and construct a variety of structures, and investigate the relationship between the design and function of these structures and the forces that act on them;

Specific:

2.1 follow established safety procedures for using tools and handling materials
2.2 design, construct, and use physical models to investigate the effects of various forces on structures
2.5 investigate methods used by engineers to ensure structural safety

Form and Function Grade 7

2.6 use appropriate science and technology vocabulary, including truss, beam, ergonomics, shear, and torsion, in oral and written communication
3.2 describe ways in which the centre of gravity of a structure (e.g., a child's high chair, a tower) affects the structure's stability
3.6 identify and describe factors that can cause a structure to fail (e.g., bad design, faulty construction, foundation failure, extraordinary loads

Equipment & Materials	**Personal Protective Equipment (PPE)**
• Paper • Tape (masking or clear) • Pencil • Paper clips • Cardboard • Recycled materials • Glue • Toothpicks • Playdough • Plasticine	• Safety goggles need to be worn when using a hot glue gun

Safety Considerations:

- Ensure your hair is tied back
- Students need to be cautious if using a glue gun to join materials. Glue gun use should be supervised and goggles need to be worn

What does the teacher do?	**What do the students do based on the Technological Problem-Solving Skills Continuum?**
• Introduce the topic by talking about balance. What makes something balanced? • Review with the students' centre of gravity:	**Initiating and Planning** • Design their balance toy using Appendix C • Determine what materials to use and a plan

Form and Function Grade 7

Centre of gravity: The point at which a body's mass is concentrated. The body is equally balanced in all directions at this point. ● Have students balance a ruler on one hand. How did they balance it? ○ Sample answers: I moved my finger to the middle of the object. ○ Review that you are able to do this because in the middle of the ruler it is symmetrical ● Introduce *Appendix C: "Balance Fun"* to students. Students will be creating a balance toy on one finger using found material to balance it. ● Show students either pictures of examples or some of the videos shared in the links below https://www.youtube.com/watch?v=ZgN-iictJ5w&t=28s **Remind students that most of the weight needs to be below the centre of balance** ● Discuss as a class or make a follow up video on what worked well. Let students know that to improve stability and balance in a structure, the centre of gravity should be low and close to the point of balance. ● Discuss how most of the weight of the successful toys were below the centre of gravity ● Discuss how this knowledge extends to real life (ex: tightrope walker uses a pole) **Possible Extensions:** Have students create a commercial or poster	for how to have their toy balance **Performing and Recording** ● Create and build their balance toy. They will record their trials and errors in a chart provided in Appendix C. **Analysing and Interpreting** ● Determine through investigation and analysis questions on how to lower ones centre of balance **Communicating** ● Share their findings with their peers and teachers through class discussion ● Share a video of their toy balancing

Form and Function Grade 7

advertising their toy. **Sample accommodations:** • Students may use ideas from the internet • Students can share their thinking in a voice note for the analysis questions • Students may use other objects as long as they are safe **Sample Troubleshooting:** • Remind students to ensure their toy is symmetrical to help with balance • Students can use ideas from the internet	

Opportunities for assessment (Links to assessment pieces, organizers):
Name:
Project: Balance Toy

Criteria	Level 1	Level 2	Level 3	Level 4
Design process	Develops an unfinished plan with various considerations missing Somewhat uses the design process (plan, build, test, evaluate, communicate)	Develops a workable plan with some steps missing Somewhat uses the design process (plan, build, test, evaluate, communicate)	Develops a clear workable plan using appropriate materials Uses the design process (plan, build, test, evaluate, communicate) as expected	Develops a workable plan and modifies the plan as necessary Demonstrates the design process (plan, build, test, evaluate, communicate) effectively
Product -Final product is	Unable to determine centre of gravity No symmetry	Determines centre of gravity Some symmetry used	Determines centre of gravity through investigation Used symmetry to help toy	Efficiently determines centre of gravity through investigation

Form and Function Grade 7

able to balance -final product is symmetrical	present in design Design does not balance	Toy balances	balance Toy balances	Toy balances with finesse Creatively uses symmetry to help toy balance and add to its esthetics
Evaluation Questions	Does not answer any evaluation questions	Answers questions with minimal detail and no scientific terminology	Answers questions fully, with scientific terminology	Answers questions fully and insightfully ,with explanations and scientific terminology

Cross Curricular Opportunities:
Language:
3.4 produce a variety of media texts of some technical complexity for specific purposes and audiences, using appro-priate forms, conventions, and tech-niques

References
Balancing Pencil Challenge. (n.d.). Retrieved from https://www.scienceworld.ca/resource/balancing-pencil-challenge/

Form and Function Grade 7

Appendix C:

Balance for Fun

Situation:

The centre of mass plays an important factor in determining a structure's stability. An object can be made to balance by having their centre of gravity below their pivot point. If an item is symmetrical you can balance it at its midpoint.

Form and Function Grade 7

Problem: You have been asked to create a balance toy that a child could balance on one finger or on a surface. The only supplies the company has given you is recycled material found around your house.

Materials Chosen: (Write down the materials you will use include quantity and length)

-
-
-
-
-

Designs:

Include a labelled sketch of your design here

Sketch 1:

Form and Function Grade 7

Sketch 2:

Observations:

Test it out as you go! Record your qualitative observations here. Record your toy balancing or take a picture if you are unable to videotape.

Form and Function Grade 7

Trial	Observation	Action taken to fix
	Ex: When I added a paper clip to the left side it started to tilt more to the left	-I added a paper clip to the right side
1		
2		
3		

Reflection:

1. How well did your structure work? What helped it be successful or what could you do to make it more successful?

2. What do you think would happen if one side was heavier than the other, why?

Form and Function Grade 7

3. What role does symmetry play in balancing an object?

4. What would you like me to notice about your structure?

5. If I were to do this project again, two things I would do differently are?

Form and Function Grade 7

Activity 3: It's a Dogs Life

Guided development of technological problem solving skills

Scientific and Technological Concepts:

Every object you encounter is a structure. A structure is the arrangement of parts put together for a particular purpose. In our everyday life we encounter many natural structures as well as human made structures. Each structure serves a purpose. Different structures can serve the same purpose ex: A bench and a high chair both serve as a seat

One way Structures can be classified is by their form. The form is the shape and physical appearance of the structures. You can classify them into 3 main categories based on their form:

4) Frame: made of parts fastened together. They can exist as just the parts fastened together or with a coating on top. A dish drying rack is a frame structure with just a frame where a car is a frame structure covered with some material.
5) Shell: Hollow structure, they have space inside of them and often use little material when building ex: Cardboard box, balloon, egg carton
6) Solid: solid all the way through ex: Mountains.

Forces act on structures all the time. Internal Forces are forces that act within a structure such as tension and compression. Where external forces are forces that act outside of a structure such as wind, gravity etc.. Structural components such as beams, columns and trusses can add to a structure's stability when forces act on it.

Learning Goal:

Students will

- Design and build a prototype of a dog's house
- Include a minimum of 2 structural components

Form and Function Grade 7

- Build a structure that can withstand external forces as wind and load

Expectations (Overall & specific):
Overall:
Design and construct a variety of structures, and investigate the relationship between the design and function of these structures and the forces that act on them
Demonstrate an understanding of the relationship between structural forms and the forces that act on and within them.
Specific:
2.1 follow established safety procedures for using tools and handling materials
2.2 design, construct, and use physical models to investigate the effects of various forces on structures
2.4 use technological problem-solving skills (see page 16) to determine the most efficient way for a structure (e.g., a chair, a shelf, a bridge) to support a given load
2.6 use appropriate science and technology vocabulary, including truss, beam, ergonomics, shear, and torsion), in oral and written communication
3.3 identify the magnitude, direction, point of application, and plane of application of the forces applied to a structure
3.6 identify and describe factors that can cause a structure to fail

Equipment & Materials	Personal Protective Equipment (PPE)
• Paper • Recycled materials found in the house such as as boxes and paper towel rolls • Playdough • Plasticine • Sticks • Popsicle sticks • Card stock • Found items outside such as sticks	• Googles if using a hot glue gun

Safety Considerations:
- Students need to be cautious if using a glue gun to join materials. Glue gun use should be supervised and goggles need to be worn

Form and Function Grade 7

What does the teacher do?	What do the students do based on the Technological Problem-Solving Skills Continuum?
• Before completing this lesson students should have knowledge of the forces that act on a structure as well as structural components and the way they help a structure maintain stability. • Introduce *Appendix D: "A Dog's Lifetime"* • Provide students with ample time to plan, design and build their dog house. • You can have students share their videos and assign a few peers to give 2 stars and a wish for feedback. • Either through a slide show, whole class discussion on an online platform of your choice, review what worked well for students and what they learned if they were to build it again. Extensions: • Students' structures have to maintain a rain test. Place a small object inside the structure when light water is sprayed on the structure, the object should not get wet **Sample accommodations:** • Students may use voice to text to fill out Appendix D or use voice notes to record their thinking. • Reduced expectations such as number of structural components, size of base etc. may	**Initiating and Planning** • Design their dog house using *Appendix D: "It's a Dog's Life"* • Determine what materials they will use, what forces will act upon the dog house (internal, external) and how they will use structural components to help stabilize it. **Performing and Recording** • Using appropriate safety considerations students will build their dog house. • Maintain a detailed log of what they did each day they worked on the project, as well as any successes or failures they experienced along the way.*Example in Appendix D * • When the dog house has been built, students will test their dog house with a weight test as well as a wind test. They will record their results in Appendix D. **Analysing and Interpreting** • Students will identify a minimum of 2 structural components they used and explain why they used them • Students will share what worked well in their design and what they would change if they were completing it again. **Communicating**

Form and Function Grade 7

be given **Sample Troubleshooting**: • Remind students of strong shapes to use, ex: triangles	• Students will take pictures of their structure and record their tests • Students will share their ideas through their journal and analysis questions

Opportunities for assessment (Links to assessment pieces, organizers):

	Level 1	**Level 2**	**Level 3**	**Level 4**
Design Process -Appropriate materials are chosen -Detailed sketch of Dog house design -Includes structural components	Plan is unfinished No structural components are present	Develops a plan with some steps missing One structural component is used	Develops a clear plan with the use of appropriate materials Two structural components are used	Develops a clear plan with the use of appropriate materials, modifies the plan as needed Two or more structural components are used
Model -Translates plan to model	Develops an unfinished plan with various considerations missing. Makes changes to the model with no change in plan.	Develops a workable plan with some steps missing. Makes some changes to model and does not update plan to show all changes made Somewhat uses the	Develops a clear workable plan using appropriate materials Uses the design process (plan, build, test, evaluate, communicate) as expected	Develops a workable plan and modifies the plan as necessary Demonstrates the design process (plan, build, test, evaluate, communicate) effectively

Form and Function Grade 7

	Somewhat uses the design process (plan, build, test, evaluate, communicate)	design process (plan, build, test, evaluate, communicate)		
Analysis -Answers reflection questions using proper terminology and refers to concepts	Does not answer any evaluation questions Little evidence of learned scientific concepts	Answers questions with minimal detail and no scientific terminology Some evidence of learned scientific concepts	Answers questions fully, with scientific terminology Evidence of learned scientific concepts and how it relates to our everyday life	Answers questions fully and insightfully, with explanations and scientific terminology Clear evidence of learned scientific concepts and how it relates to everyday life

Cross Curricular Opportunities:

Language:

1.4 sort and classify ideas and information for their writing in a variety of ways that allow them to manipulate informa-tion and see different combinations and relationships in their data

Form and Function Grade 7

Appendix D:

It's a Dogs Life

Congratulations! You have been hired to create a dog's house for outside. Using your knowledge of forces and loads, you are to design a comfy outdoor retreat for a dog.

Requirements: *Your design must meet the following specifications*

- Contain a minimum of 2 structural components
- Withstand a load of 2 large books
- Have a base no larger than 20 cm on any side
- Have an opening that is 5cm by 10 cm for the dog to enter
- A minimum height of 30 cm

Form and Function Grade 7

- Withstand a wind test

Part A: Planning

Materials: List your chosen materials include size and quantity

-
-
-
-

Sketch two ideas for your dog house or two different views:
Identify the structural components you are using

Sketch #1:

Sketch # 2:

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Part B: Build your dog house

- Remember to keep a record of the building purpose in a journal. Your journal entries are to include the date, what you accomplished that day and any observations or things you have learned while working on the project. Take pictures of each stage if you would like
- Take a picture of your completed dog house

Example of a journal entry:
September 15, Day 1

Today I received the outline for my project. I started to brainstorm what I would like to design. I came up with 3 different ideas, see my drawings below. I am going to look around my house for different items I have and then make my decision on what I think will work best once I know what materials I can use.

Part C: Testing

In this section you will complete two tests to determine if your structure can withstand external forces.

Test One: Wind Test

Form and Function Grade 7

Since your structure will be outside it needs to be able to withstand the elements, one of these elements is wind.

1. Find a household fan or a hair dryer
2. Place the fan beside your structure and turn it on. Record your results in the table below

Trial	Distance from fan	Able to stay stable (yes or no)	Observations and any changes made before the next trial?
1			
2			
3			

Form and Function Grade 7

4			

Test 2: Load Test

How much weight can your structure hold? Can it hold a minimum of two large textbooks? Take a picture of your structure holding the weight.

Record your results in the table below:

Trial	Weight used Ex: Textbook	Quantity of Weight used (ex: 2 textbooks and a can of sauce)	Able to stay stable (yes or no)	Observations and any changes made before the next trial?
1				
2				

Form and Function Grade 7

3				
4				

Form and Function Grade 7

Part D: Analysis

1. What were the structural components you used in your design? Why did you choose these components?

2. How well did your structure work? What helped it be successful or what could you do to make it even more successful? (Think forces and structural stability)

3. What do you think would happen if you had a smaller base? How would your design change if you did not need to use a shell form?

4. What would you like me to notice about your structure?

5. If you were to do this project differently, what would you change?