Tall Tower

2nd Grade
Unit 6 – Taking Care of Ourselves
Text Connection: *The Skeleton Inside You* by Phillip Balestrino

Design Challenge Summary
Challenge: What will the students be required to do?
The main job of the skeleton is to provide support for our body. Today your challenge is to design the tallest tower you can build with your materials that can support the weight of a golf ball for two minutes.
Standards: What standards are addressed?
Science: NS.1.2.1 Communicate observations orally, in writing and in graphic organizers NS.1.2.2 Develop questions that guide scientific inquiry NS.1.2.3 Conduct scientific investigations as individually and in teams NS.1.2.4 Estimate and measure length… NS.1.2.5 Collect measurable empirical evidence in teams and as individuals NS.1.2.6 Make predictions in teams and as individuals based upon empirical evidence NS.1.2.7 Use age-appropriate equipment and tools in scientific investigations LS.2.2.5 Identify the major parts and functions of the skeletal system PS.5.2.2 Investigate the effect of physical phenomena on various materials PS.6.2.1 Investigate the relationship between force and motion **Math:** Mathematical Practice Standards 2.MD.1 Measure the length of an object by selecting and using appropriate tools such as rulers, yardsticks, meter sticks, and measuring tapes 2.MD.3 Estimate lengths using units of inches, feet, centimeters, and meters 2.MD.7 Tell and write time from analog and digital clocks to the nearest five minutes 2.MD.9 Generate measurement data by measuring lengths of several objects to the nearest whole unit, or by making repeated measurements of the same object. Show the measurements by making a line plot, where the horizontal scale is marked off in whole-number units **Other:** W.2.2 Write informative/explanatory texts in which they introduce a topic, use facts and definitions to develop points and provide a concluding statement or section W.2.3 Write narratives in which they recount a well-elaborated event or short sequence of events, include details to describe actions, thoughts and feelings, use temporal words to signal event order, and provide a sense of closure W.2.7 Participate in shared research and writing projects SL.2.1 Participate in collaborative conversations with diverse partners about grade 2 topics and texts with peers and adults in small and larger groups SL.2.3 Ask and answer questions about what a speaker says in order to clarify comprehension, gather additional information or deepen understanding of a topic or issue SL.2.4 Tell a story or recount an experience with appropriate facts and relevant, descriptive details, speaking audibly in coherent sentences SL.2.6 Produce complete sentences when appropriate to task and situation in order to provide requested detail or clarification

Tall Tower

Result: What will students know, value, and be able to do as a result of the lesson? What's the big idea?

Know and apply the engineering design loop process.
Demonstrate ability to modify designs based on observations and predictions.
Work collaboratively on solving a problem.
Experiment with the effect of weight/force on a structure.
Use measurements effectively.
Generate line plots using measurement data.

Assessment: What evidence will be used to determine student learning?

Did they build a tower that would support a golf ball for 2 minutes?
How tall was their tower? How did it compare to the other towers? (measurement data)
Did they follow the design loop process?
Did they work collaboratively?

Prior Knowledge/Experiences: What prior content knowledge and skills will the students need?

Experience with the Engineering Design Loop process
Connections to the Mathematical Practices
Investigations/inquiry in Science
Experiences with measurement in standard units

Summary/Connections: How will this design challenge connect with new/future learning, other content areas, real world experiences, etc.?

This lesson will help students develop problem solving skills and collaboration skills that are essential in succeeding in the 21st century. It will allow student the opportunity to transfer and apply skills from various content areas within one task.

***This challenge was adapted from the "Tall Tower Challenge" from www.tryengineering.org. The full lesson is attached at the end of this document. You will find great questions to ask students, resources to use, and information regarding structural engineering.**

Math – Measurement Data:
After students have completed their tasks, generate a line plot with the measurement data of the heights of the towers. Discuss the data and discuss why certain towers were "taller" and still supported the weight of the golf ball. **2.MD.9**

As a summary activity, you could engage students in:
W.2.2 Write informative/explanatory texts in which they introduce a topic, use facts and definitions to develop points and provide a concluding statement or section
W.2.3 Write narratives in which they recount a well-elaborated event or short sequence of events, include details to describe actions, thoughts and feelings, use temporal words to signal event order, and provide a sense of closure

Extensions:
How could you design your tower to be taller and still support the weight of the golf ball?
Research tall towers in the US or the World. Find out what engineers do structurally to stabilize the towers and how they are able to build them as tall as they are, etc. **W.2.7**

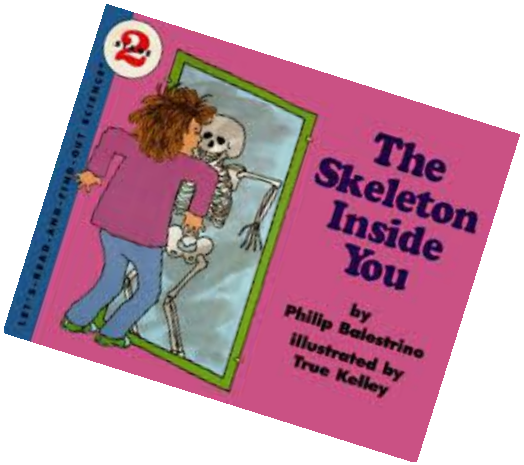
Tall Tower

Materials/Equipment/Preparation: What materials and equipment will students need to successfully complete this design challenge?
Straws (50 per group) Pipe Cleaners (50 per group) Paper Clips (25 per group) Golf balls (1 per group)

*This challenge was adapted from the "Tall Tower Challenge" from www.tryengineering.org. The full lesson is attached at the end of this document. You will find great questions to ask students, resources to use, and information regarding structural engineering.

Not everything in the original lesson is appropriate for 2nd grade students.

Tall Tower



The main job of the skeleton is to provide support for our body. Today your challenge is to design the tallest tower you can build with your materials that can support the weight of a golf ball for two minutes.

Group Supplies:

50 straws, 50 pipe cleaners, 25 paper clips, golf ball

Tall Tower Challenge

Provided by TryEngineering - www.tryengineering.org

Lesson Focus

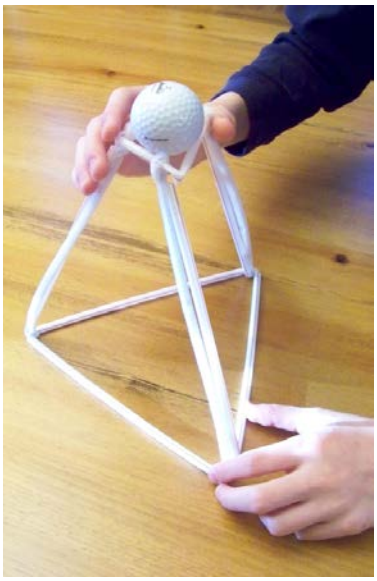
Lesson focuses on the growth of tall buildings and their structures. Students work in teams to develop the tallest tower they can build with limited materials that can support the weight of a golf ball for two minutes. They develop a design on paper, build their tower, present and test their tower to the class, evaluate their results and those of their teammates, and complete reflection sheets.

Lesson Synopsis

The "Tall Tower Challenge" activity explores the design of tall structures such as sky scrapers and telecommunication towers. Students work in teams to engineer the tallest tower they can build using just straws, pipe cleaners, and paperclips. The tower must be strong enough to support the weight of a golf ball for two minutes.

Age Levels

8-18.



Objectives

- Learn about structural engineering.
- Learn about engineering design and redesign.
- Learn how engineering can help solve society's challenges.
- Learn about teamwork and problem solving.

Anticipated Learner Outcomes

As a result of this activity, students should develop an understanding of:

- structural design and engineering
- engineering design
- teamwork

Lesson Activities

Students explore the tallest buildings in the world and how they were designed and constructed. They then work in teams to develop the tallest tower they can to support the weight of a golf ball for 2 minutes. They are provided with 50 straws, 50 pipe cleaners, and 25 paperclips. They develop a plan on paper, build the tower, test it, and compare their results with those of their classmates.

Resources / Materials

- Teacher Resource Documents (attached)
- Student Resource Sheet (attached)
- Student Worksheet (attached)

Alignment to Curriculum Frameworks

See curriculum alignment sheet at end of lesson.

Internet Connections

- TryEngineering (www.tryengineering.org)
- Burj Khalifa Tower Design and Construction (www.burjkhalifa.ae/language/en-us/the-tower.aspx)
- CN Tower (www.cntower.ca)
- National Science Education Standards (www.nsta.org/publications/nses.aspx)
- ITEA Standards for Technological Literacy (www.iteaconnect.org/TAA)

Recommended Reading

- How Tall Is Tall?: Comparing Buildings (ISBN: 978-1432939557)
- Reinforced Concrete Design of Tall Buildings (ISBN: 978-1439804803)
- Construction Technology For Tall Buildings (ISBN: 978-9812818614)

Optional Writing Activity

- Write an essay or a paragraph about how engineering advances led to the explosive growth of vertical buildings at the turn of the 20th century.

Tall Tower Challenge

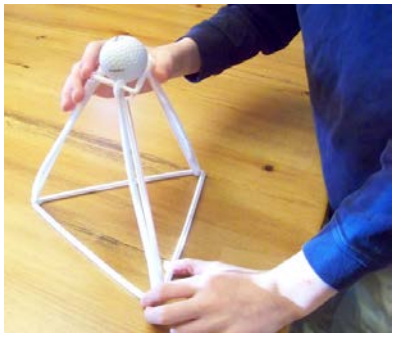
For Teachers:
Teacher Resources

◆ Lesson Goal

Lesson focuses on the growth of tall buildings and their structures. Students work in teams to develop the tallest tower they can build with limited materials that can support the weight of a golf ball for two minutes. The golf ball must be supported near the top of the tower, with the bottom of the ball no more than 20% below the upper height of the tower. They develop a design on paper, build their tower, present and test their tower to the class, evaluate their results and those of their teammates, and complete reflection sheets.

◆ Lesson Objectives

- ✦ Learn about structural engineering.
- ✦ Learn about engineering design and redesign.
- ✦ Learn how engineering can help solve society's challenges.
- ✦ Learn about teamwork and problem solving.



◆ Materials

- Student Resource Sheets
- Student Worksheets
- Set of materials for each team: 1 golf ball, 50 plastic straws, 50 pipe cleaners, 25 metal paperclips.

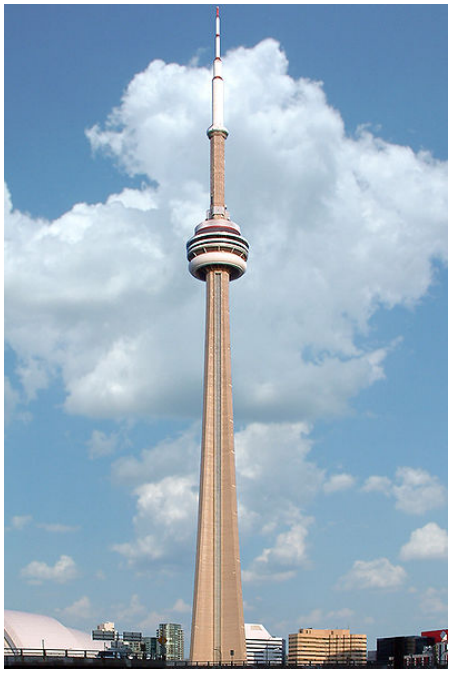
◆ Procedure

1. Show students the student reference sheets. These may be read in class or provided as reading material for the prior night's homework.
2. To introduce the lesson, discuss with students the increase in the height of buildings over the last century. Perhaps consider what the highest building in your community might be, and compare that with some of the tallest buildings in the world.
3. If possible, have students explore the design and manufacturing resources on the Burj Khalifa Tower Design and Construction website and have them consider the shape of the tallest structures. (www.burjkhalifa.ae/language/en-us/the-tower.aspx)
4. Teams will consider their challenge and draw a diagram of their planned tower on paper.
5. Teams next construct their towers, and test them within their team.
6. All teams then present their towers to the class and demonstrate the ability of the tower to hold the golf ball.
7. All towers are measured to determine the tallest tower.
8. Student teams complete a reflection sheet and share their experiences with the class.
9. Note: This lesson can be completed with a full grade of students instead of one classroom so students compete against all others in the school.

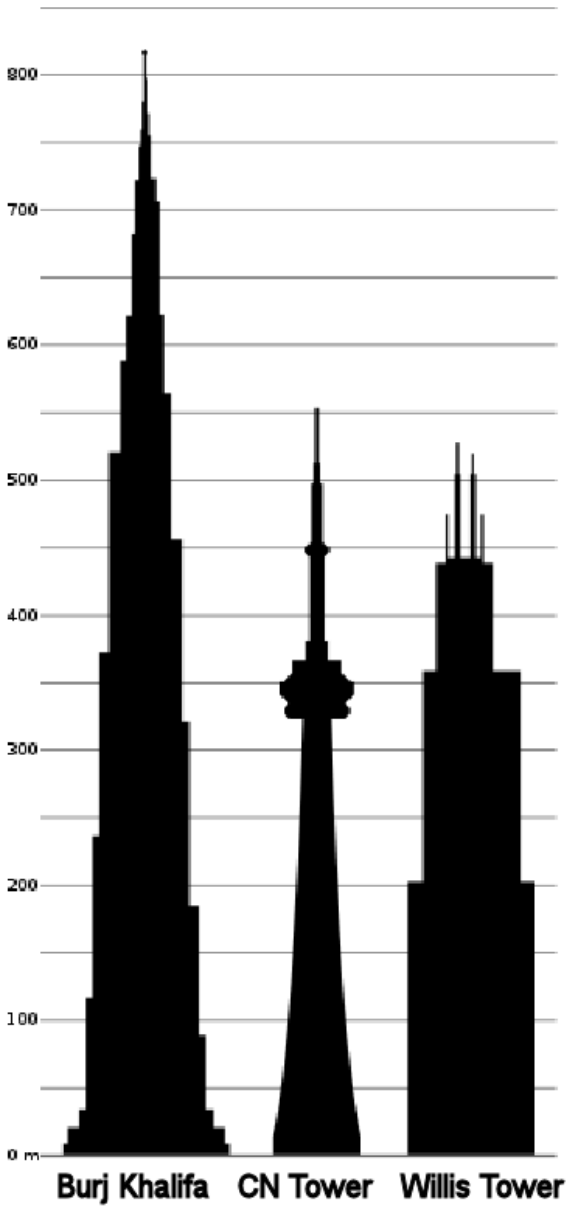
◆ Time Needed

One to two 45 minute sessions.

Student Resource: Tall Structures



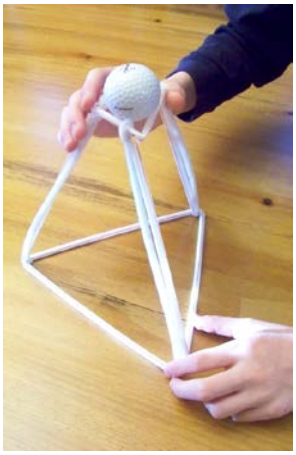
The CN Tower (picture to the left), located in Toronto, Ontario, Canada, is a communications and observation tower standing 553.3 metres tall. It was recognized as the tallest free-standing structure on land in the world for 31 years until it was recently surpassed in height by the Burj Khalifa in Dubai in the United Arab Emirates. the Burj Khalifa was built in 2009 and is 828 meters high. The third tallest is the Willis Tower (formerly known as Sears Tower) in Chicago, Illinois, U.S.A., which stands at 527 m (1,729.0 ft) when measured to its pinnacle, The tallest wooden structure is the Gliwice Radio Tower in Poland, which stands at 118 meters high and was built in 1935. The chart to the right shows the height comparison between the Burj Khalifa, the CN Tower, and the Willis Tower.



In January 2010, the world's highest outdoor observation deck located in Burj Khalifa, has opened to the public. Hundreds of people, mostly families, queued up for tickets to Level 124 of Burj Khalifa – and the chance of being among the first to experience its stunning views across the city. The view is said to be similar to what you might see from an airplane. The ascent to the 124th floor is by a double-deck elevator, each deck carrying up to 14 people and travelling at 10 meters per second. In less than a minute, the elevator reaches the observation deck, the world's only public observatory at this height with an outdoor terrace. High windows circle the entire viewing platform, and visitors can scan the horizon and the distant streets below through computerized viewfinders, which also have pre-programmed day and nighttime vistas of the city and surrounding region.

Tall Tower Challenge

Student Worksheet:
Applying Technology to Solve Problems



◆ **Engineering Teamwork and Planning**

You are part of a team of engineers given the challenge of building the tallest tower you can build using only 50 straws, 50 pipe cleaners, and 25 paperclips.

You do not need to use all the materials, but your tower must support the weight of a golf ball for two minutes. The golf ball must be supported near the top of the tower, with the bottom of the ball no more than 20% below the upper height of the tower.

◆ **Planning and Design Phase**

Think about the different ways you can bend or change the shape of straws, pipe cleaners, and paper clips. You may cut these items, but cannot use tape or other materials to connect them together. In the box below, draw your plan for the tower.

Tall Tower Challenge

Student Worksheet:

◆ Construction Phase

Build your tower and test it to see if it can support the golf ball. Then, answer the questions below:

1. How similar was your design to the actual tower you built.

2. If you found you needed to make changes during the construction phase, describe why your team decided to make revisions.

3. Did you use all the parts provided to you? Were any of the parts used only to increase the height of the tower?

◆ Presentation and Measurement

Present your tower to the class and have your teacher measure the height of the tower. Bear in mind that the golf ball must be supported near the top of the tower, with the bottom of the ball no more than 20% below the upper height of the tower. If the bottom of the ball is more than 20% below the top, your tower will be disqualified. Complete the box below for your tower:

Overall height of the bottom of the ball on/in tower	Distance from bottom of golf ball to top of tower	Percentage of tower supporting golf ball.

Student Worksheet (continued):

◆ **Evaluation**

Complete the evaluation questions below:

1. Describe the shape or construction of the tower that was the tallest and won the challenge? How was this tower different from yours, if yours did not win?

2. If you had a chance to do this project again, what would your team have done differently?

3. Do you think that this activity was more rewarding to do as a team, or would you have preferred to work alone on it? Why?

4. If you could have used one additional material (tape, glue, wood sticks, foil -- as examples) which would you choose and why?

5. Do you think that once a building is designed and approved for construction that many aspects are changed during the building process? Why or why not?

6. How long do you think it will take before a building is constructed that surpasses the height of the Burj Khalifa? Where do you think it will be built? Why?

Tall Tower Challenge

For Teachers:
Alignment to Curriculum Frameworks

Note: Lesson plans in this series are aligned to one or more of the following sets of standards:

- U.S. Science Education Standards (http://www.nap.edu/catalog.php?record_id=4962)
- U.S. Next Generation Science Standards (http://www.nextgenscience.org/)
- International Technology Education Association's Standards for Technological Literacy (http://www.iteea.org/TAA/PDFs/xstnd.pdf)
- U.S. National Council of Teachers of Mathematics' Principles and Standards for School Mathematics (http://www.nctm.org/standards/content.aspx?id=16909)
- U.S. Common Core State Standards for Mathematics (http://www.corestandards.org/Math)
- Computer Science Teachers Association K-12 Computer Science Standards (http://csta.acm.org/Curriculum/sub/K12Standards.html)

◆National Science Education Standards Grades K-4 (ages 4-9)

CONTENT STANDARD A: Science as Inquiry

As a result of activities, all students should develop

- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

CONTENT STANDARD B: Physical Science

As a result of the activities, all students should develop an understanding of

- Properties of objects and materials

CONTENT STANDARD E: Science and Technology

As a result of activities, all students should develop

- Abilities of technological design
- Understanding about science and technology

CONTENT STANDARD F: Science in Personal and Social Perspectives

As a result of activities, all students should develop understanding of

- Characteristics and changes in populations
- Changes in environments
- Science and technology in local challenges

CONTENT STANDARD G: History and Nature of Science

As a result of activities, all students should develop understanding of

- Science as a human endeavor

◆National Science Education Standards Grades 5-8 (ages 10-14)

CONTENT STANDARD A: Science as Inquiry

As a result of activities, all students should develop

- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

CONTENT STANDARD B: Physical Science

As a result of their activities, all students should develop an understanding of

- Motions and forces

CONTENT STANDARD E: Science and Technology

As a result of activities in grades 5-8, all students should develop

- Abilities of technological design

CONTENT STANDARD F: Science in Personal and Social Perspectives

As a result of activities, all students should develop understanding of

- Populations, resources, and environments
- Risks and benefits
- Science and technology in society

For Teachers:
Alignment to Curriculum Frameworks (cont.)

◆National Science Education Standards Grades 5-8 (ages 10-14)

CONTENT STANDARD G: History and Nature of Science

As a result of activities, all students should develop understanding of

- History of science

◆National Science Education Standards Grades 9-12 (ages 14-18)

CONTENT STANDARD A: Science as Inquiry

As a result of activities, all students should develop

- Abilities necessary to do scientific inquiry

CONTENT STANDARD B: Physical Science

As a result of their activities, all students should develop understanding of

- Motions and forces

CONTENT STANDARD E: Science and Technology

As a result of activities, all students should develop

- Abilities of technological design
- Understandings about science and technology

CONTENT STANDARD F: Science in Personal and Social Perspectives

As a result of activities, all students should develop understanding of

- Personal and community health
- Population growth
- Environmental quality
- Science and technology in local, national, and global challenges

◆Next Generation Science Standards Grades 2-5 (Ages 7-11)

Matter and its Interactions

Students who demonstrate understanding can:

- 2-PS1-2. Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.

Motion and Stability: Forces and Interactions

- 3-PS2-1. Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.

Engineering Design

Students who demonstrate understanding can:

- 3-5-ETS1-1.Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
- 3-5-ETS1-2.Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
- 3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

For Teachers:
Alignment to Curriculum Frameworks (cont.)

◆Next Generation Science Standards Grades 6-8 (Ages 11-14)

Engineering Design

Students who demonstrate understanding can:

- MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

◆Next Generation Science Standards Grades 6-8 (Ages 11-14)

Engineering Design

- MS-ETS1-2 Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

◆Standards for Technological Literacy - All Ages

The Nature of Technology

- Standard 1: Students will develop an understanding of the characteristics and scope of technology.

Technology and Society

- Standard 4: Students will develop an understanding of the cultural, social, economic, and political effects of technology.
- Standard 5: Students will develop an understanding of the effects of technology on the environment.
- Standard 6: Students will develop an understanding of the role of society in the development and use of technology.
- Standard 7: Students will develop an understanding of the influence of technology on history.

Design

- Standard 8: Students will develop an understanding of the attributes of design.
- Standard 9: Students will develop an understanding of engineering design.
- Standard 10: Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

Abilities for a Technological World

- Standard 11: Students will develop abilities to apply the design process.

The Designed World

- Standard 20: Students will develop an understanding of and be able to select and use construction technologies.