Lifeguard Chair

Grade Level:	**Total Time Required:**
3 - 6	Three to five 30 minute class sessions

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Original source: This lesson is an adaptation of a design lesson introduced by *Engineering is Elementary* called "Tower Power."

Lesson Objectives:

In this lesson, students will participate in the engineering design process.

Students will be able to:

1. Identify the problem to be solved.
2. Identify the essential elements of the design brief including the constraints, criteria, client, client's needs, and end user.
3. Generate individual and team solutions.
4. Develop and document a plan for a possible prototype.
5. Construct and test the performance of the team's prototype.
6. Evaluate and test the design using measurement (i.e., height of the chair and time to hold the required mass).
7. Evaluate whether the solution met the client's needs (and/or goal).
8. Identify the different forces working on the structure (i.e., chair) including forces such as gravity and compression.

Indiana Standards:

3-5.E.1 Identify a simple problem with the design of an object that reflects a need or a want. Include criteria for success and constraints on materials, time, or cost.

Next Generation Science Standards:

3-5.ETS1-1 Identify a simple problem with the design of an object that reflects a need or a want. Include criteria for success and constraints on materials, time, or cost.

Science/Engineering Practices
1. Asking questions (for science) and defining problems (for engineering)
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence

Crosscutting Concepts
2. Cause and effect: Mechanism and explanation.
3. Scale, proportion, and quantity.

Common Core Mathematics:

Not applicable.

Common Core English and Language Arts:

Not applicable

Concepts and Vocabulary

Term	*Defined by a scientist or engineer*	*Defined by student*
Force	Any push or pull.	A push against something
Compression	A type of force acting on a structure. To compress, to squish or shorten the length of an object or structure. Opposite of tension or tensional stress.	Squish
Constraints	A limitation or restriction.	Rules you must follow
Criteria	Guidelines or specifications a "designer" must meet.	
Client	The individual(s) who has a problem, need, or goal that must be met or solved.	
End user	The individual(s) who will benefit or use the solution to the problem.	
Prototype	A first or preliminary model of something.	

Equipment, Materials, and Tools

Materials		
Index cards (3 x 5) [one package of cards per team]	Masking tape [one yard of tape per team]	Small stuffed animal to represent the life guard

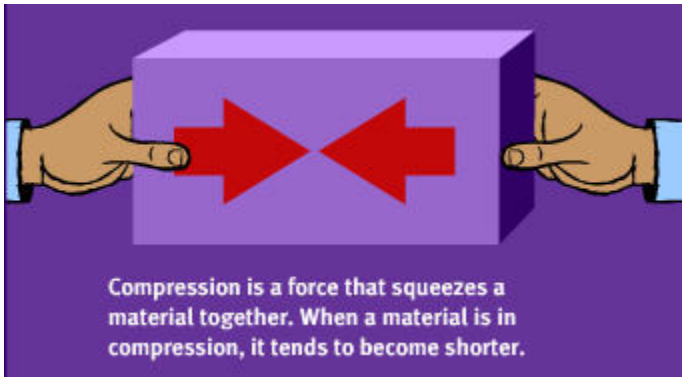
Tools		
Scissors	Meter Ruler	Stopwatch

Safety Guidelines: Monitor students when using scissors

Science Content - Basics

Compression:

In physics, compression is the magnitude of the *pushing force* exerted on another object. It is the opposite of tension.



http://www.pbs.org/wgbh/buildingbig/lab/forces.html

Synopsis of Engineering Design Activity

Problem:	Town Safety Inspector has ordered that lifeguard chairs be constructed so the swimming pool is up to public safety code.
Goal:	To design and construct lifeguard chair models in time for the grand-opening ceremony.
Who is the client:	Safe Stands Company
End-User:	A lifeguard
What is the design:	Design and construct lifeguard chair models
Criteria:	• Chair must be at least 35 cm tall • Cards can be folded but not torn • No piece of tape can be longer than 5 cm • Chair cannot be taped to the floor or any other object or surface • Chair must be in one piece • Chair must support the 'lifeguard' for 20 seconds in an upright position
Constraints:	• Only use the materials provided (note cards & tape) • Chair must be completed in 15 minutes

Lesson Plan #1
Guiding Question – Can you help local authorities meet the Town Safety Inspector's needs?

Time: One 30 minute class session

Procedure:

1. Distribute the design brief (see last page of this lesson plan).

2. Explain to students that they will work in teams of three or four to come up with the solution to this problem.

3. Read the design brief aloud with the class. Encourage students to highlight, circle or underline terms that are new or unfamiliar to them.

4. Ask students the following questions:
   - *What is the problem?*
   - *What is the goal?*
   - *Who is the client?*
   - *Who is the end user?*
   - *What is/are the criteria?*
   - *What are the constraints?*

5. Discuss with students what materials will be made available. Show them the index cards and masking tape.

6. Encourage students to use the next 10 minutes to draw a sketch of what they would like their chair to look like using the cards (Individual planning). Emphasize with students the importance of labeling their drawings/sketches such that a second grader could review the sketch and make a copy or replica of their design using the cards and tape provided.

7. Wrap up the lesson by asking students to share their plans and discussing one new thing they learned today.

Lesson Plan #2
Guiding Question – What is your team's plan?

Time: One 30 minute class sessions

Procedure:

1. Today students will meet with their team members and share their plans (Team planning). Encourage students to take the next 10 minutes to listen to one another's plan and making note of one or two features you like of each member's plan.

   Remind students to revisit the original design brief. Reiterate with students what the problem is; who the client is; the constraints; and the end user. Be sure to show students the materials they have available.

   Show students how they will test the prototypes of their chairs by holding up the stuffed animal and explaining that this will serve as your "lifeguard."

   Ask students:
   - *How will we know which design is the best?*
     The design/prototype that is 35 cm in height, using the required number of cards and tape, holds the lifeguard for 20 seconds, and does not collapse.

   - *What are the criteria?*
     See list

2. Encourage students to now talk with their team members and decide on one team's plan. Members can approach this phase in one of the following ways:
   - Vote on one plan
   - Identify one feature from each team member's plan and incorporate each feature into one team plan
   - Identify common features among all of the plans and incorporate all of the features into one team plan

3. Ask the students:
   - *What are some of the ideas your team discussed?*
   - *What materials will you need?*
   - *What will your team measure the chair and determine whether or not you met the client's needs?*

4. Check each team's plan to make certain their sketches are all the same; their sketches are clearly labeled; and the materials are used appropriately. Check "ok" on the plan and instruct each team to move forward with constructing their prototypes. Remind students they have only 15 minutes to construct their designs (constraint).

5. Once the team has completed construction of their prototype, ask the following questions:
    - *What is your team's solution to the problem?*
    - *Does your solution match the team's plan (sketch)?*
    - *How will you test your prototype?*

Lesson Plan #3
Guiding Question – How does your prototype perform?

Time: One 30 minute class session

1. Today each team will test its prototype.

2. Identify an area at the front or center of the classroom where everyone can see. Have a meter stick or ruler on hand (to measure each prototype) and a stopwatch.

3. Encourage one team at a time to test their prototype. Maintain a class data table to record each team's performance (optional).

Criteria	***Team 1***	***Team 2***	***Team 3***	***Team 4***
Height of chair (35 cm or higher)	35	37	35	33
Met the criterion for # of cards used	x	x		x
Met the criterion for amount of tape used	x			x
Met 20 seconds	x	x	x	

4. Ask students:
   - *Which team designs met the client's needs?*
   - *What made their designs "good"?*
   - *Which designs did not work as well?*
   - *If you had a chance to do this again, what is one thing you would change?*

Assessment

The following are possible sources of formative and summative assessment:

Formative:

- Check students' notebooks for the overall quality in their sketches.
- Engage students in a class discussion about the key elements of a design brief. Note how students respond to your questions.

Summative:

- Collect students' notebooks and assess their final designs based on: 1) sketch (to scale); 2) labeling; and 3) identification of materials.
- Encourage students to prepare reflections in their experiences with working on a team and/or constructing their prototypes.

Lesson Extensions and Resources

Design Activity

Student Resource

Science Learning through Engineering Design

Local authorities have recently decided to open a privately owned swimming pool to the public. A grand-opening ceremony is currently being planned and the Town Safety Inspector has ordered that lifeguard chairs be constructed so the swimming pool is up to public safety code. These new lifeguard chairs must be completed before the pool can be opened to the public.

You have just been hired by the Safe Stands Company to design and construct lifeguard chair models in time for the grand-opening ceremony. The chairs must be sturdy enough for the lifeguards to sit on and must be tall enough for them to patrol everyone at the pool.

Criteria

- Chair must be at least 35 cm tall
- Cards can be folded but not torn
- No piece of tape can be longer than 5 cm
- Chair cannot be taped to the floor or any other object or surface
- Chair must be in one piece
- Chair must support the 'lifeguard' for 20 seconds in an upright position

Constraints

- Only use the materials provided (note cards & tape)
- Chair must be completed in 15 minutes