

Brain Safety S.T.E.M. Lesson

Wednesday, May 16, 2012

Topic: Brain Safety

Aim: Designing protection for the brain

Science – The study of the physical and natural world using systematic observation and experiment.

Technology -The study, development, and application of devices, machines, and techniques for manufacturing and productive processes.

Engineering - The application of science in the design, planning, construction, and maintenance of buildings, machines, and other manufactured things.

Math - The study of quantity, structure, space, and change.

NYS Intermediate Level Science Standards

1.2g Locomotion, necessary to escape danger, obtain food and shelter, and reproduce, is accomplished by the interaction of the skeletal and muscular systems, and coordinated by the nervous system.

1.2h The nervous and endocrine systems interact to control and coordinate the body's responses to changes in the environment, and to regulate growth, development, and reproduction. Hormones are chemicals produced by the endocrine system; hormones regulate many body functions.

Next Generation Science Standards (NGSS)

HS.LS-SFIP: Structure, Function, and Information Processing

e. Use evidence to support explanations for the relationship between a region of the brain and the primary function of that region. [Clarification Statement: Conceptual understanding that the brain is divided into several distinct regions and circuits, each of which primarily serves dedicated functions (e.g., visual perception, auditory perception, interpretation of perceptual information, guidance of motor movement, decision making about actions to take in the event of certain inputs).]

Student Learning Goals – Students will be able to:

- Explain how to keep the brain safe
- Analyze the effect of damage to certain parts of the brain

Introduction

In this design challenge lesson, students will use an egg to represent the brain. The yolk represents the brain, the whites of the egg represent the cerebral spinal fluid and the shell represents the skull. Students will design and build a "football helmet" to protect the brain at maximum impact speed and will test their design at increasing speeds.

Prior to this lesson, students have learned basic anatomy and physiology of the nervous system (brain, spinal cord, peripheral nerves, neurons, four external lobes of the brain) and have discussed how the brain can become injured and the effect of injury on the brain.

Teacher Preparation:

1. Project folders on tables
2. Prepare an area of the floor for testing, covered with tarp or butcher paper.
3. Prepare a packet of materials for each student team. Zip lock or paper bags can be used and should include a variety of inexpensive materials to use in the design of their helmet:

Bubble wrap

Paper cups

Paper clips

String

Cardboard

Straws
 Rubber bands
 Small balloons
 Sand
 Masking Tape
 Netting
 Egg carton pieces

General Materials:

eggs (2 per team)
 scissors
 poster paper
 markers
 crayons
 pencils
 rulers
 glue
 tape measurers

Students are given the following scenario:

Problem

You are a sports equipment designer for the Boogie Down Sporting Goods Company. You have been hired to design a football helmet that can protect players and withstand a maximum impact speed. The team in the firm that comes up with the most effective design will get the contract for the account.

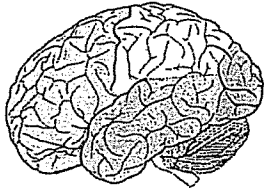
Criteria

Your design must:

- a) Stay on the brain.
- b) Keep the brain from cracking.8

Design Challenge Protocol:

Activity	Description	Time	Comments
Introduce Challenge	Problem and constraints.	5 minutes	Day 0
Brainstorm	Students work in teams to brainstorm ideas to solve problem. Brainstorming ideas are to be written down.	10 minutes	Day 1
Draw	Students create a sketch of their solution.	10 minutes	Day 1
Build/Test #1	Students build their design the test it to see if it meets the criteria.	15 minutes	Day 2
Evaluate	Students evaluate what worked and what didn't in their design	10 minutes	Day 2
Modify/Re-test	Students modify their designs and re-test	7 minutes	Day 2
Final Analysis	Students analyze the effect of their modification and discuss what other changes they would make if they had the chance. Students prepare presentations	50 minutes	Day 3
Present	Students present their work to their peers	30 minutes	Day 4



Brain Safety Design Challenge

Problem

Your team is part of the equipment designing firm, Boogie Down Sporting Goods Company. Your firm has been hired to design a football helmet that can protect players and withstand maximum impact speed. The team in the firm that comes up with the most effective design will get the contract for the account.

Your design must:

- a) Stay on the head.
- b) Keep the skull from cracking.

Remember, the team whose helmet withstands the maximum impact speed wins.

Maximum Impact Speed

Speed is determined by the following formula:

$$\text{Speed} = \text{distance}/\text{time}$$

You will determine the maximum impact speed of your helmet by performing three trials and calculating the speed for each trial.

Day 1

Brainstorm

Brainstorm with your partners:

1. What information do you need to know that will help you to be successful with your mission?
2. Write your brainstorming ideas down in on your brainstorm worksheet.

Draw

Create a labeled drawing of your solution. Be as detailed as possible in your drawings, including dimensions.

Day 2

Build and Test

Build your helmet and test by dropping your "player" from a height of 30cm.

Evaluate

1. What worked well and what didn't?

2. What do you need to change?

Revise

Modify your design based on test.

Final Test

Test your helmet with your model brain.

Day 3

Analyze

1. Was your design a success? What is your evidence?
2. What were some of the challenges in your design?
3. If you could make additional modifications, what would you change?

Summarize

Write a report about your final design, how well your design met the challenge, and what further modifications you would make.

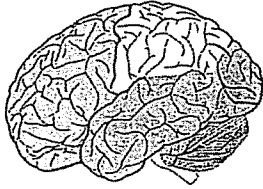
Prepare Presentation

Prepare poster presentation for your peers.

Day 4

Present

Present to your peers.



Brain Safety Design Challenge - Day 1

Problem

Your team is part of the equipment designing firm, Boogie Down Sporting Goods Company. Your firm has been hired to design a football helmet that can protect players and withstand a maximum impact speed. The team in the firm that comes up with the most effective design will get the contract for the account.

Your design must:

- a) Stay on the head.
- b) Keep the skull from cracking.

Remember, the team whose helmet withstands the maximum impact speed wins.

Using an egg as a model for the brain:

You will be using an egg as a model for the brain. The shell represents the skull, the yolk represents the brain and the white of the egg represents the fluid surrounding the brain.

Materials

You may use any of the following materials:

Bubble wrap
Paper cups
Paper clips
String
Cardboard
Straws
Rubber bands
Small balloons
Sand
Masking Tape
Netting
Egg carton pieces

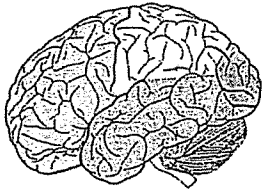
Brainstorm (10 minutes)

Use chart paper and markers to brainstorm with your partners:

1. What information do you need to know that will help you to be successful with your mission?
2. Write your brainstorming ideas down in on chart paper.

Draw (10 mins)

Create a labeled drawing of your solution. Be as detailed as possible in your drawings, including dimensions.



Brain Safety Design Challenge - Day 2

Problem

Your team is part of the equipment designing firm, Boogie Down Sporting Goods Company. Your firm has been hired to design a football helmet that can protect players and withstand a maximum impact speed. The team in the firm that comes up with the most effective design will get the contract for the account.

Your design must:

- a) Stay on the head.
- b) Keep the skull from cracking.

Remember, the team whose helmet withstands the maximum impact speed wins the account.

Step 3: Build and Test

Build your helmet and test. In the space below, describe what you did to build your design:

Step 4: Evaluate

1. What worked well and what didn't?

2. What do you need to change?

Step 5: Revise

Modify your design based on your test.

Step 6: Final Test

Test your helmet with your model brain. Complete the table below and calculate impact speed for each trial that meets the criteria.

Impact Speed:

Speed is determined by the following formula:

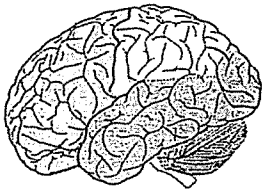
$$\text{Speed} = \text{distance}/\text{time}$$

$$v=d/t$$

You will determine the maximum impact speed of your helmet by performing three trials and calculating the speed for each trial. You may only calculate the speed if your "skull" does not crack.

Complete the following data table for each trial:

Trial Number	d (distance) cm	t (time) ms	Did your "skull" crack or break? Y/N	If No, calculate speed $V=d/t$
#1	20			
#2				
#3				



Brain Safety Design Challenge - Day 3

Problem

Your team is part of the equipment designing firm, Boogie Down Sporting Goods Company. Your firm has been hired to design a football helmet that can protect players and withstand a maximum impact speed. The team in the firm that comes up with the most effective design will get the contract for the account.

Your design must:

- a) Stay on the head.
- b) Keep the skull from cracking.

Remember, the team whose helmet withstands the maximum impact speed wins.

Step 7: Analyze

Answer the following questions:

1. Was your design a success? What is your evidence?
2. If your design was not a success, what region of the brain was damaged?
3. What functions of the body/mind would be affected by the damage?
4. What were some of the challenges in your design?
5. If you could make additional modifications, what would you change?

Step 8: Summarize

Write a three paragraph report on loose-leaf paper about the design challenge experience.

Make sure your report includes:

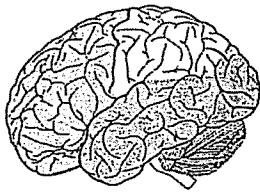
1. A full science heading (if you don't remember, look at the board).
2. An introductory paragraph describing what the problem was that you had to solve.
3. What steps you took in building your design.
4. What happened in your first test.
5. What changes you made.
6. What happened in your final test.
7. What changes you would make if you could make more modifications.
8. What regions of the "brain" were damaged (if any) in your test.
9. What the effects of the damage would be if it were a real person.
10. What you learned from the activity.

Person being graded: _____

Person grading: _____

Rubric

Category	4 - Did an Amazing Job!	3 - Did a Good Job	2 - Did an OK Job	1 - Not Such a Great Job
Report had an introductory paragraph.				
Explanation of how the design was built was clear and understandable.				
Explanation of how the design was modified after the first test was clear and understandable.				
Analysis of what further modifications they would make made sense.				
The report shows a clear understanding of how impact can damage the brain.				
The report shows a clear understanding of how damage to the brain affects function.				



Brain Safety Design Challenge - Day 4

Step 9: Present

Present to your peers.

Instructions:

1. You will have 15 minutes to complete and revise your report.
2. After your complete your revisions, each team member will have five minutes to read their report to the team.
3. Team members will have two minutes to ask clarifying questions.
4. Team members will then grade the speaker based on the rubric below.

Person being graded: _____

Person grading: _____

Rubric

Category	4 - Did an Amazing Job!	3 - Did a Good Job	2 - Did an OK Job	1 - Not Such a Great Job
Report had an introductory paragraph.				
Explanation of how the design was built was clear and understandable.				
Explanation of how the design was modified after the first test was clear and understandable.				
Analysis of what further modifications they would make made sense.				
The report shows a clear understanding of how impact can damage the brain.				
The report shows a clear understanding of how damage to the brain affects function.				

Procedure

Team Leader chooses team roles:

1. Reader
2. Recorder
3. Timekeeper

Step 1: Brainstorm

Students brainstorm solutions:

1. What information do you need to know that will help you to be successful with your mission?
2. Write your brainstorming ideas down in your notebook.

Step 2: Draw

Students create a labeled drawing of their solution using as much detail as possible (with labels and dimensions).

Step 3: Test

Students build their helmets and test with their model brain.

Step 4: Evaluate

Students evaluate their designs:

1. What worked well and what didn't?
2. What do you need to change?

Step 5: Revise

Students modify their design based on test.

Step 6: Final Test

Students test their helmet with a model brain and complete the table below to calculate impact speed.

Impact Speed:

Speed is determined by the following formula:

$$\text{Speed} = \text{distance}/\text{time}$$
$$v=d/t$$

You will determine the maximum impact speed of your helmet by performing three trials and calculating the speed for each trial. You may only calculate the speed if your "skull" does not crack.

Complete the following data table for each trial:

Trial Number	d (distance)	t (time)	Did your "skull" crack or break? Y/N	If No, calculate speed $V=d/t$
#1				
#2				
#3				

Step 7: Analyze

Students answer the following questions:

1. Was your design a success? What is your evidence?
2. If your design was not a success, what region of the brain was damaged?
3. What functions of the body/mind would be affected by the damage?
4. What were some of the challenges in your design?
5. If you could make additional modifications, what would you change?

Step 8: Summarize

Students write a report about their final design, how well their design met the challenge, and what further modifications they would make.

Step 9: Present

Students present their designs to their peers in the form of a report with peer evaluations.

Resources

<http://thefunworks.edc.org/SPTUI--FunWorks/funworks/accessible.php?class=5#career31>

Score Sheet: Helmet Design Challenge

4 Superior
 3 Very Good
 2 Good
 1 Needs Improvement

Group: _____

Period: _____

GROUP EVALUATION

Objective	Score				Comment
	Needs Improvement	Good	Very Good	Superior	
Results: 1 meter drop	1	2	3	4	
Poster:					
Design explanation	1	2	3	4	
Marketing	1	2	3	4	
Illustration with labels	1	2	3	4	
Design changes explanation	1	2	3	4	
Results: 2 meter drop	1	2	3	4	
Egg can see/move/could play a sport wearing helmet	1	2	3	4	
Helmet can be removed easily	1	2	3	4	
Creative use of materials....looks like a helmet rather than a pile of stuffing.	1	2	3	4	

Helmet Design Challenge

Directions: Write (word process) a three paragraph report about the design challenge experience. Make sure your report includes:

1. A full science heading in upper right corner.
2. An introductory paragraph describing what the problem was that you had to solve.
3. What steps your team took in building your design.
4. What happened in the first test?
5. Describe the changes you made.
6. What happened in the final test.
7. What changes would you make if you could make more modifications.
8. What regions of the brain were damaged (if any) in your test.
9. What the effects of the damage would be if it were a real person (you may have to research the answer for this).
10. What you learned from the activity.

Helmet Design Challenge

Directions: Write (word process) a three paragraph report about the design challenge experience. Make sure your report includes:

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