PEEK 2003 Third Grade Curriculum

Jen Lewellen & Roz Echols

Lesson 1:
Introduction to Legos and Engineering / Building a Sturdy Car

Lesson 2:
Building a Sturdy Car run by the RCX

Lesson 3:
Friction

Lesson 4:
Driving up an Incline Plane

Lesson 5:
Using Levers to Build a Catapult

Lesson 1: Lego Construction Basics

Lesson Objective: To familiarize students with Legos and how they can be used to build strong cars.

Learning Objective: To learn how to build a sturdy car with basic Lego pieces.

The Challenge: To build a car that can be dropped from the teacher's knee without breaking.

Materials:
- Lego Simple Machine kits or other Lego building pieces

Vocabulary:
- motor
- wheel
- beam
- brick
- sturdy
- bushing
- RCX
- Lego separator

Procedure: Begin by leading a discussion about engineering and Legos. Ask questions such as:
- Do you know anyone who is an engineer?
- What do you think an engineer does?
- Who has built with Legos before?
- What structures have you made?

Next, introduce the students to all the different Lego parts and their names. Ask:
- Where do you see bricks, plates, and beams being used around you in your homes or school?
- How are the Lego pieces similar or different?
- How are the pieces organized?

Engineering Challenge: After the discussion, introduce the challenge. Explain that the children will be working with partners to build sturdy cars. They may test their cars multiple times as they build to see how sturdy they are. When finished, each car will be dropped from the teacher or student's knee and should not break.

Extensions: Have children do the 'Ultimate Drop Test' to see if their structures can withstand being dropped from the teacher's waist to the floor.

Assessment: Bring the class together to discuss the various designs and what they found worked well.

- What was the biggest problem you encountered as you were building?
- What did you try? Did it help?

Troubleshooting:

Resources:

- Lego/Tufts website- www.ceeo.tufts.edu/curriculum
- Lego Dacta “Simple and Motorized Machines” Teacher Guide

Engineer: ___________________________ Date:__________
Partner: ____________________________

Building Design Sheet: A Sturdy Car

Challenge: To build a car (with a motor) that can withstand being dropped from your teacher's knee.

1. Draw your idea:

2. Write about your idea:

____

____

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____

____

3. Now share your plans with a partner.

Lesson 2: Building an RCX Car & Graphing

Lesson Objective: To familiarize students with the RCX, as well as graphing techniques.

Learning Objective: To learn construction techniques (how to build a solid car) and how to properly utilize the RCX.

The Challenge: To construct a car that incorporates the RCX and motors, and is fairly well-built (i.e. doesn't fall apart every time it is picked up); to develop a line graph based on distances that an RCX car drives in specified amounts of time.

Materials:
- Lego Simple Machine kits or other Lego building pieces
- Graph Paper
- Tape measure or measuring stick

Vocabulary:

Procedure: Begin this lesson by reviewing the time/ distance relationship in chart form. Then, as a class, create a sample line graph. Discuss what you would expect the graph to look like and bring up the concept of repeatability in testing - that each time value should give you the same or very similar distance value each time. For example, if the car drives 30 inches in 2 seconds, it should travel 30 inches the next time it runs for 2 seconds. Also, discuss how to retrieve new information from the graph you've just built. How far would the car drive in 4 seconds? 1-1/2 seconds?

Engineering Challenge/Programming:

1 – Build a Car: Instruct each student group to build a simple, strong car run by an RCX (Be sure to stress simple - no gears necessary, just wheels the motors).

2 – Calibrate the Car: Have the student groups program their cars to run for several designated times: 1 second, 2 seconds, and 3 seconds. Then instruct them to observe the distances their cars travel and develop basic line graphs plotting time against distance, checking for repeatability.

3 – Develop a Hypothesis: Challenge the students to program their cars to drive a specific distance (your choice) between two distances already plotted in the preliminary investigation. Students should extrapolate from their graphs how much time they should program their cars to run for in order to achieve the teacher's challenge distance. Because the challenge distance falls between previously plotted points, the students must learn how to retrieve new information from a line graph by tracing distance across to the graph line and following that point down to discover time.

4 – Test and Adjust the Hypothesis: Have students program their estimated times into their cars and run. Tell students to note their accuracy and

adjust their time estimates accordingly.

Extensions: Have students participate in a mini competition. Give them another challenge distance that they may not test. Tell students to estimate from their graphs the amount of time they should program their cars to run in order to achieve the teacher's new challenge distance and reprogram their cars accordingly. The groups then line their cars up on a start line for their first run. Observe which group comes closest to the challenge distance. A fun way to manage the competition is to ask each group to place a LEGO person on the finish line across from their car. Run the cars and observe which groups' people are still standing after the run.

Assessment: Hold a group discussion about forming estimates based on line graph information. Perhaps introduce some specific graph vocabulary such as axis, coordinates, and points. Share the problems and solutions encountered by each group.

Troubleshooting:

Resources:

- Lego/Tufts website- www.ceeo.tufts.edu/curriculum
- Lego Dacta "Simple and Motorized Machines" Teacher Guide

Lesson 3: Friction Exploration

Lesson Objective: To get a basic understanding of friction and how different surfaces affect the amount of friction.

Learning Objective: To learn about the effect of friction and how it varies with different surfaces.

The Challenge: To program an RCX car to drive, changing the type of tire (rubber, smooth plastic, etc.) each time, thus allowing students to see how friction varies with surface.

Materials:
- Lego pieces, especially gears and rubber tires with hubs (Note: The gears and tires should have the same diameter.)
- Smooth ramp for car to drive up
- Aluminum foil to cover ramp
- Carpet to cover ramp (optional)
- Electrical tape, or other thick tape, to mark the start and finish lines
- Tape measure, if possible

Vocabulary:

Procedure: Introduce the concept of friction to the students. Explain to them that they will be learning about friction by experimenting with the RCX cars. In order to introduce friction, you may want to have them rub their hands together and talk about resistance and resulting heat that is produced.

Engineering Challenge/Programming:

1 - Have each group build a sturdy RCX car that can have varying sizes of wheels.

2 - Instruct students to program their cars in Pilot 1 to drive for 3 seconds.

3 - Have students use gears as wheels and run their cars for the programmed amount of time. All the cars should start at the starting line on a smooth surface (i.e. a tile floor).

4 - Use tape to mark the place on the floor where each car stops and then measure the distance the car traveled using a tape measure.

5 - Have students repeat steps 3 and 4 on a carpeted surface.

6 - Instruct students to repeat steps 3-5, using rubber tires this time.

Compare and discuss the distance driven using each type of wheel. Have students make predictions about what type of wheel the RCX should have to drive up the ramp. Drive the car up the ramp using each type of wheel and see how closely the results match the students' predictions.

Extensions:

Assessment: Discuss the final results. See if students are able to apply information learned today to real-life situations. Ask questions such as:

- Why are tires on real cars made of rubber?
- What would happen when it rained if tires were made of hard plastic?
- What would happen if tires were made of gears?
- When is friction good? Ex: tires on road
- When is friction bad? Ex: Ice skates need less friction.
- What would happen if ice skates had rubber on the bottom?

Troubleshooting:

Resources:

- Lego/Tufts website- www.ceeo.tufts.edu/curriculum
    - Lego Dacta “Simple and Motorized Machines” Teacher Guide

Lesson 4: Building a car that can drive up an incline plane

Lesson Objective: To familiarize students with various gearing systems. (Note: Each car will have a different gearing system and thus be able to do different things. This should reinforce the concept of different gear ratios resulting in different actions.)

Learning Objective: To learn about gears and show what all the different combinations of gears can do for a car.

The Challenge: To construct a car that incorporates a gearing system.

Materials:
- Lego Simple Machine kits or other Lego building pieces, especially gears

Vocabulary:
- Gears

Procedure: Begin by discussing gears and providing answers to the following questions:
- What are gears? What are the important features?
- How do we use multiple gears together?
- Why are there different sizes of gears? (Here it is good to give a brief intro to the concept of torque - not the math and physics description, but a basic qualitative explanation that torque is a force acting at a distance. Doors are great examples. Have a kid try to close a door by pushing near the hinge, and then by pushing farther out. Students can also practice with a friend by holding their arms out, trying to push at different points, and seeing how easy or difficult it is to resist)
- How do we use gears for our cars? (transmission, fast/slow, power vs. speed)

After giving students some basic information on gears, ask them the following questions:
- How do you use gears to make a car move?
- How many motors do you need to make a car that drives straight?
- What about a car that turns?
- How do you build a car with gears?
- How do you mesh the gears?

You can ask the students if any of them has a bike with multiple gears, and see if they can explain to you why there are two sets of different-sized gears. How do you make a car go fast? Go up a hill?

Engineering Challenge: Assign each group a different pair of gears. There should be enough different pairs such that each car ends up with a different gear ratio driving it.

Instruct each group to build a car using their assigned gear pair. At the end of the day, set up an incline plane and a race course. Start with a car race, and see which car wins. It is VERY IMPORTANT that you frame this in the context of learning. It should not be a matter of WHO wins, but WHAT GEARS win, since we assigned the gears arbitrarily. The goal here is to see which pair of gears results in the fastest car.

For the incline plane, start with a very gentle incline and have each car drive up it. Gradually increase the slope of the incline, until the last car can no longer drive up it.

Extensions:

Assessment: Discuss which gear pair worked best and why.

- Which car drove the fastest?
- Which car could drive up the steepest incline?
- Were they the same? Why or why not?

Troubleshooting:

Resources:

- Lego/Tufts website- www.ceeo.tufts.edu/curriculum
- Lego Dacta “Simple and Motorized Machines” Teacher Guide

Lesson 5: Levers - Catapults

Lesson Objective:

Learning Objective: To learn the concept of levers and simple catapults.

The Challenge: To build a catapult that will shoot a cotton ball at least 2 meters.

Materials:
- Simple Machine kits or other Lego building pieces
- Rubber bands
- Cotton balls
- Masking tape
- Plastic spoons

(Note: Have lots of plastic spoons & cotton balls available. Spoons break easily.)

Vocabulary:

Procedure: Before beginning the lesson, set up bins of Legos, as well as extra materials - spoons, tape, cotton balls, etc. – for the children to choose from.

Begin the lesson by discussing what a lever is and how it is used. Connect the catapult use with a lever. Have sample catapults available for the children to looks at & see how they work.

Engineering Challenge: Explain to the children that they will be building catapults out of the materials given. Their structures should be able to catapult a cotton ball at least 2 meters. Students will have 30 minutes to complete the task.

After 30 minutes, get students into a large group. Have each team share its catapult and test how far it can send a cotton ball.

Extensions:

Assessment: Discuss each group’s final design, noting what aspects of each worked and what didn’t work.

Troubleshooting: Be sure to discuss with the children why they should not catapult anything heavier than a cotton ball in class. We don’t want anyone getting hurt!

Resources:
- Lego/Tufts website- www.ceeo.tufts.edu/curriculum
- Lego Dacta “Simple and Motorized Machines” Teacher Guide