1. Gather materials.
   • LineChaserz Cars (enough for each group to have one, when your class is divided into groups of 5 students; for a class of 20, that would be 4 cars)
   • LineChaserz Activity Backgrounds (enough for each group to have one)
   • Pad of large, blank, white paper
   • Assorted markers
   • Small pieces of paper that can be used to cover sensors
   • Scotch tape
   • Assignment handout/worksheet packet

2. Demonstrate a Line Chaserz Car, then explain the premise of the activity to the class.
   An example demonstration:
   Draw a line on a large piece of blank white paper, with a black marker. Turn on the car, and have it follow the line several times. Flip the car over, and show the two red LEDs and two IR emitter/detector pairs. Explain that when the car is turned on, the LEDs shine light under the car. The IR emitter also sends out a light, but one we can’t see. The color of the reflected light that is detected by the IR detector tells the car if it’s over the line or not.
   An example script:
   “Today we are going to be scientists. I want each of you to brainstorm an idea for an experiment you could conduct in class today using a Line Chaserz car, and these available materials” [show available materials] “Then you will be put into groups, I will let you know which group you are in. In your groups you will try each of your experiments. You will get a worksheet packet to use while you brainstorm and try out your experiments. Make sure you fill out your worksheet packet as you go. If you need any help, let me know and I will be glad to help you.”

3. Pass out the worksheet packet.

4. Give time to brainstorm.

5. Divide the class into groups. Aim for 5 students per group, or smaller.

6. Distribute a set of materials to each group.

7. Allow students to conduct their experiments. Offer help when required or requested.

8. After a group has completed all 5 experiments, encourage them to complete the final page of the worksheet packet. Offer help when required or requested.

9. After all groups have finished their worksheet packet, initiate a discussion with the class regarding how the conclusions they have drawn from their experiments relate to concepts of energy and geometry, make inferences on how the experiments conducted were simulations- and the value of simulations, and the multitude of ways the activity is related to careers.
   Example questions you can ask:
   • What did you find out about Line Chaserz cars?
   • What does that tell us about the sensors the car uses?
   • What other kind of sensors can you think of?
   • What kind of jobs use sensors?
   • Lets think of your experiments as simulations. Do you think real cars could work like the Line Chaserz? Why?
   • What kind of paths could your Line Chaserz follow? Are there paths the Line Chaserz can’t follow? Why do you think that is?

10. Have class clean up.
Scientific Method and Simulations: The LineChaserz Activity
inspired by NCWIT's Outreach-in-a-Box:Discovering IT

Planning Overview

Student’s Prior Knowledge
Scientific Method, Energy and Circuits, Energy as Light, Basic Geometry, & Simulations

Academic and Career Plan Objectives

- EC1. Understand the concepts of job and career
- EC3. Understand the relationship of individual effort, hard work, and persistence to achievement
- EC4. Understand the importance of teamwork in working towards a common goal
- EC5. Demonstrate the decision making process
- EC7. Recognize the benefits of both individual initiative and teamwork
- EC8. Recognize that the changing workplace requires lifelong learning
- MC6. Demonstrate employability skills such as individual initiative, teamwork, problems solving, organization, and communication

Teacher Objectives & SOLs

*Scientific Investigation, Reasoning, and Logic*
- 4.1 The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which
  a) distinctions are made among observations, conclusions, inferences, and predictions; g) constants in an experimental situations are identified; hypotheses are developed as a cause and effect relationship; and m) current applications are used to reinforce science concepts (particularly *Force, Motion, and Energy* 4.2 & 4.3, and *Geometry* 4.10).
- 5.1 The student will demonstrate and understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which
  d) hypothesis are formed from testable questions; f) constants in an experimental situation are identified; i) inferences are made and conclusions are drawn; and k) current applications are used to reinforce science concepts (particularly *Force, Motion, and Energy* 4.2 & 4.3, and *Geometry* 4.10).

*Basic Operations and Concepts*
- C/T 3-5.1 Demonstrate an operational knowledge of various technologies. b) Communicate about technology with appropriate technology. Use basic technology vocabulary in daily practice.

*Thinking Skills, Problem Solving, and Decision Making*
- C/T 3-5.9 Use models and simulations to understand complex systems and processes. a) Understand the use of simulations in learning. Enhance understanding of concepts and skills by explaining how a simulation differs from and is similar to real life. b) Use simulation to understand complex concepts. Enhance understanding of concepts and skills by using simulations.

What careers are related to these objectives?
Focus on any career that requires scientific investigations, simulations, sensors, and information technology. Engineers, Electronics Technicians, and Computer Scientists are a few examples!

Arts Processes this Activity Utilizes
These processes are not only essential to the arts, but to a variety of careers and pillars of character.

- Problem Solving
- Design
- Creativity
- Collaboration
- Reflection
- Attention to Detail
- Conceptualization
- Meaning Building
- Interpretation
- Dialogue

Created by Virginia Career VIEW - Virginia Tech School of Education  www.vacareerview.org  800-542-5870
Instructional Goal

Who?
• Students in a range of grades. Third through Fifth grades are emphasized in the SOLs, but the lesson can be utilized with students of any age-group, so long as they possess an appropriate understanding of prerequisite concepts (see student's prior knowledge section).

What?
Individually
• Design an experiment to be undertaken by the group
In Small Groups
• Conduct experiments
• Discuss hypotheses, observations, conclusions and inferences for each experiment
• Discuss conclusions and inferences drawn from all conducted experiments
As a Class
• Discuss group findings and their relationship to concepts of energy (particularly circuits and light), geometry, simulations, and careers

When & Where?
• During class time

With What?
• LineChaserz Cars
• LineChaserz Activity Background
• Pad of large, blank, white paper
• Assorted markers
• Small pieces of paper that can be used to cover sensors
• Scotch tape
• Assignment handout

Performance Objectives

1. After a brief demonstration of a LineChaserz Car, each student will design one experiment they would like to conduct with a Car and the available materials. In the process of designing their experiment, each student will record the question they wish to answer, the constant variable(s) in the experiment, the changing variable, and their hypothesis, which can be tested, and is based on a cause and effect relationship between the variables.

2. In small groups of up to 5 individuals, each group member will take a turn explaining their experiment. For each experiment presented, the will develop and record a group hypothesis, or prediction, and conduct the experiment. All observations will be recorded, and the group will record the conclusion they have drawn from the experiment. Any inferences made about the success of future experiments, based on their observations, should be recorded as well.

3. After conduct all of the experiments, the group should discuss what inferences and conclusions can be drawn from the collective data. Any inferences and conclusions drawn should be recorded.

4. After all the groups have finished their experiments, the class should come together as a whole to discuss the findings and conclusions developed. As facilitated by the instructor, students should participate in a discussion on how the conclusions drawn relate to concepts of energy and geometry, make inferences on how the experiments conducted were simulations- and the value of simulations, and the multitude of ways the activity is related to careers.
**Experiment Brainstorming**

Scientists use **scientific experiments** to discover and build information about something they are interested in. Experiments start with a question scientists don’t already know the answer to.

What question do you have about Line Chaserz cars, that you want try to answer with your experiment:

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

**Variables** are items, factors, or conditions that can change. In an experiment trying to determine cause and effect, there are three types of variables: **independent**, **dependent**, and **controlled** variables.

**Independent variables** are changed by the scientist, to see what happens to the **dependent variables**. To determine cause and effect an experiment should only have one independent variable.

**Dependent variables** change based on changes to the independent variable. Scientists observe the dependent variable to collect data, and decide on the results of their experiment.

**Controlled variables** remain **constant** through the experiment. Controlled variables help scientists make sure the effect on the dependent variable was a result of the independent variable.

What variable are you going to change during your experiment? ________________

What variable(s) do you expect to change as a result of the changes you make to your independent variable?

__________________________________________________________________________

__________________________________________________________________________

What variable(s) are going to remain constant throughout your experiment?

__________________________________________________________________________

__________________________________________________________________________

What do you hypothesize will happen to your dependent variables when you change the independent variable?

__________________________________________________________________________

__________________________________________________________________________
Experiment Summary

Experiment 1
Independent variable: __________________________
Dependent variable(s): __________________________
Controlled variable(s): __________________________
Group hypothesis: ________________________________

Draw a table to record your results.

What can you conclude from these results? ________________________________

Do the conclusions of this experiment change how you think future experiments with the Line Chaserz car will work? Why? ________________________________
Experiment Summary

Experiment 2
Independent variable: __________________________________________________________________________
Dependent variable(s): __________________________________________________________________________
Controlled variable(s): __________________________________________________________________________

Group hypothesis: ________________________________________________________________________________

Draw a table to record your results.

What can you conclude from these results? _______________________________________________________________________
_______________________________________________________________________________________________
_______________________________________________________________________________________________
_______________________________________________________________________________________________
_______________________________________________________________________________________________

Do the conclusions of this experiment change how you think future experiments with the Line Chaserz car will work? Why? _______________________________________________________________________
_______________________________________________________________________________________________
_______________________________________________________________________________________________
_______________________________________________________________________________________________
_______________________________________________________________________________________________
Experiment Summary

Experiment 3

Independent variable: ____________________________

Dependent variable(s): ____________________________

Controlled variable(s): ____________________________

Group hypothesis: ________________________________

Draw a table to record your results.

What can you conclude from these results? ______________________________

____________________________________________________________________

____________________________________________________________________

____________________________________________________________________

Do the conclusions of this experiment change how you think future experiments with the Line Chaserz car will work? Why? ______________________________

____________________________________________________________________

____________________________________________________________________

____________________________________________________________________
Experiment Summary

**Experiment 4**

Independent variable: ____________________________________________________________

Dependent variable(s): __________________________________________________________

Controlled variable(s): __________________________________________________________

Group hypothesis: ______________________________________________________________

Draw a table to record your results.

What can you conclude from these results? __________________________________________

________________________________________

________________________________________

________________________________________

________________________________________

Do the conclusions of this experiment change how you think future experiments with the Line Chaserz car will work? Why? ________________________________

________________________________________

________________________________________

________________________________________

________________________________________

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Experiment Summary

Experiment 5

Independent variable: _______________________________________________________

Dependent variable(s): ______________________________________________________

Controlled variable(s): ______________________________________________________

Group hypothesis: __________________________________________________________________

Draw a table to record your results.

What can you conclude from these results? __________________________________________

______________________________________________________________________________

______________________________________________________________________________

______________________________________________________________________________

Do the conclusions of this experiment change how you think future experiments with the Line Chaserz car will work? Why? __________________________________________________________________

______________________________________________________________________________

______________________________________________________________________________

______________________________________________________________________________
Final Thoughts on the Experiments

Think about all the experiments your group has conducted, and all the results you collected.
What did you learn about the Line Chaserz care from your experiments?

Line Chaserz are mechanical computing devices, that use light, infrared emitters, infrared sensors, and a short computer program to work. The circuit in the car uses the information from the sensors to follow the line.

Think about what you learned about Line Chaserz.
What could that tell you about how the electricity and circuit in the car works?

What could that tell you about sensors?

What other ways can you use the information you learned about how Line Chaserz work?
**Science Standards of Learning Grades 4 and 5**

**Scientific Investigation, Reasoning, and Logic**

4.1 The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which
   a) distinctions are made among observations, conclusions, inferences, and predictions;
   g) constants in an experimental situation are identified;
   h) hypotheses are developed as cause and effect relationships;
   m) current applications are used to reinforce science concepts.

5.1 The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which
   d) hypotheses are formed from testable questions;
   f) constants in an experimental situation are identified;
   i) inferences are made and conclusions are drawn;
   k) current applications are used to reinforce science concepts.

**Force, Motion, and Energy**

4.2 The student will investigate and understand characteristics and interactions of moving objects. Key concepts include
   a) motion is described by an object’s direction and speed;
   d) moving objects have kinetic energy.

4.3 The student will investigate and understand the characteristics of electricity. Key concepts include
   d) the ability of electrical energy to be transformed into light and motion, and to produce heat;

**Mathematics Standards of Learning Grades 4 and 5**

**Geometry**

4.10 The student will
   a) identify and describe representations of points, lines, line segments, rays, and angles, including endpoints and vertices;

**Computer Technology Standards of Learning Grades 3-5**

**Basic Operations and Concepts**

C/T 3-5.1 Demonstrate an operational knowledge of various technologies.
   B. Communicate about technology with appropriate terminology.
      • Use basic technology vocabulary in daily practice.

**Thinking Skills, Problem Solving, and Decision Making**

C/T 3-5.9 Use models and simulations to understand complex systems and processes.
   A. Understand the use of simulations in learning.
      • Enhance understanding of concepts and skills by explaining how a simulation differs from and is similar to real life.
   B. Use simulations to understand complex concepts.
      • Enhance understanding of concepts and skills by using simulations.