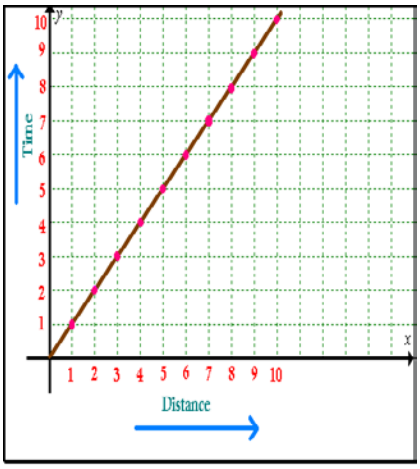
Civil Air Patrol's ACE Program

Graph the Rocket Planez

Grade 4 Additional Rocket Planez

Drug Demand Reduction Manipulative Item Lesson



Topics: space flight systems, line plots, data graphing (science, math)

Length of Lesson: 60 minutes

Objectives:

- Students will gather data points while flying the Rocket Planez.
- Students will represent and interpret data.
- Students will generate and analyze patterns.

National Standards:

Next Generation Science Standards:

- 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.
- Influence of Engineering, Technology, and Science on Society and the Natural World: Engineers improve existing technologies or develop new ones to increase their benefits, to decrease known risks, and to meet societal demands. (4-ESS3-2)

CCSS Math:

- 4.OA.C.5 Generate a number or shape pattern that follows a given rule. Identify apparent features of the pattern that were not explicit in the rule itself.

Background Information:

After 30 years of missions, NASA's Space Shuttle program was retired in 2011. Even before this retirement, NASA engineers and commercial space companies began working on new rockets powerful enough to carry out missions to the moon and beyond. Their work has been based, in part, on knowledge learned from the Apollo and shuttle programs, with innovative improvements to meet new demands.

Commercial Space Capabilities: NASA, historically the lead organization in the U.S. space race, is now working with private space companies to maximize the innovation needed to propel the U.S. space program well into the future. In pursuit of the goals of the National

Space Policy and NASA's strategic plan, NASA is continuing its efforts to foster the development of new industrial space-related capabilities that will lead to education and job growth in science and engineering and spur economic growth as capabilities for new space markets are created.

The Human Exploration and Operations Mission Directorate established the Commercial Space Capabilities Office at the Johnson Space Center in Houston to solicit and manage Space Act Agreements with U.S. private sector enterprises that wish to collaborate with NASA on the development of new space-related capabilities.

So, what does this mean? Testing design capabilities and preparing for future needs depends on modeling and analyzing the performance of various configurations of NASA's Space Launch System (SLS), as well as those of commercial or private sector companies.

- A sampling of private sector companies building new space configurations:
  Boeing Space Blue Origin Bigelow Aerospace Sierra Nevada Corporation
  SpaceX Virgin Galactic United Launch Alliance Rocket Lab Axiom Space

Offering more volume capability and energy to speed missions through space, future spacecraft and space launch systems are being designed to be flexible and evolvable, and will open new possibilities for payloads, including robotic scientific missions, to deep space locations, such as the moon, Mars, Saturn, and Jupiter. The real space race is on!

Innovation is the key to future spacecraft success. With any new and innovative space vehicle, testing and analyzing the data is of utmost importance. Determining the frequency of successes and failures will identify what innovations will work best. Failure IS an option, and, an opportunity to continue improving the configurations of space vehicles.

Using the Rocket Planez item as a means to inspire students toward innovative thinking, students will practice recording and analyzing data from test flights in today's lesson, while investigating what the future could hold for them, and, for our nation.

Materials:

- Rocket Planez (provided by CAP for the ACE program; however, orders can be placed at www.aeroracers.com)
- paper/pencils

Lesson Preparation:

1. Distribute the Rocket Planez. Students should have already built and colored/designed their Rocket Planez during ACE Academic Lesson #4, "Rocketing to the Future." If not, students should be given time to complete the build and color/design of their Rocket Planez before starting this lesson.

2. Remind (and show) students the proper way to fly the Rocket Planez.

3. Remind students of launching and safety instructions of the Rocket Planez.
   a. Wind the rubber band by spinning the propeller clockwise approximately 200 - 250 times.
   b. If the rubber band breaks, regular long rubber bands can be used.
   c. Launch vertically, providing a little boost upward upon releasing.
   d. When launching, do NOT hold the Rocket Planez below your face; looking down at it. Hold the Rocket Planez out in front of your face.
   e. Launch with the wind blowing toward your back, not your face! (No one wants Rocket Planez to fly into his/her face.)
   f. Do not run after someone else's vehicle. Retrieve your rocket plane after you have looked at your surroundings so you do not walk into someone else's vehicle being launched.

4. Rocket Planez should be put safely away so the lesson can begin.

Lesson Presentation:

1. Review historical space programs of which the students may be aware. (space shuttle, Apollo, etc.) Use program links at end of lesson, if needed.

2. Discuss any current space programs the students may have been observing. (SpaceX, NASA, Boeing, etc.) Ask if they are aware of how the configurations of space vehicles have changed through the years. (rockets have become more stable and reusable, space craft are back to the small size of the Apollo era vs the large size of the Space Shuttle era, etc.)

3. Discuss how failures while testing space vehicles can be of value. (learn from mistakes, can improve on frequency of successes vs failures) Show the video, How Not to Land an Orbital Booster!
   a. This video is funny, but it demonstrates how mistakes help to guide innovation to allow for future success.
   b. It also demonstrates how far the space program has come since the early days of launching rockets, to the current time of a rocket coming back and landing on a drone ship- ready for its next mission.

4. Tell students that they are going to be testing their Rocket Planez and collecting data, much like space program engineers and scientists do. - By collecting and organizing data, a scientist can more easily interpret what has been observed, and can then draw conclusions from the information gathered.

5. Tell the students they will be working in pairs today to track the frequency of their Rocket Planez's time in space by making a frequency table to organize the data.
   a. Show video, How to Make a Frequency Table | Statistics, Organizing Data, Frequency Distribution, to help students understand what they will be doing.
   b. Then, have students work in pairs to draw a simple frequency table on the top half of one student's paper. There should be a space at the top to write the # of seconds for 10 tries (the data set). Then, there should be three columns to make the table: # of seconds, tally, and frequency. (See sample photo at the end of the lesson.)

6. Take students to the open area to begin. In each pair, one student should have the Rocket Plane, and the other student will have the paper and pencil.

7. Students should work in pairs taking turns: one launching the Rocket Plane and the other writing the # of seconds at the top of the page. Then, they should alternate jobs until 10 launches have been completed.
   a. Students will launch their Rocket Planez and count how many seconds the plane flies in space.
   b. When it lands, students will record the number of seconds the plane flew in space on their frequency table (in the data set location).
   c. Students will repeat the launching of Rocket Planez 10 times, recording the numbers of seconds after each launching.

8. When students have launched and recorded all 10 flights, discuss with students any problems that may have occurred with launches. Also discuss successful launches and what made these work.

9. Have the students return to the classroom and continue to work in pairs on the paperwork.

10. Have students complete the frequency table's three columns on the top half of the page. Then, discuss what things they learned from the frequency column.

11. Now, have students create a line graph at the bottom half of their paper.
    a. You may want to show video "Learning About Line Graphs" for instructions, if needed.
    b. Students will use the information from the frequency table to complete this graph.
    c. The numbers along the side should be the labeled as the # of seconds listed in the frequency column of the table.
    d. The numbers along the bottom should be labeled as the frequency each # of seconds occurred.

e. As students are creating the line graph on their paper, you could make your own line graph on the board as an example. (See sample photo at end of lesson.)

12. Have students share line graphs with one another to check for understanding. Students can also share line graphs with whole group.

Summarization:
Ask students what they learned today. Ask students how collecting data assists scientists and engineers. Discuss ways that collecting data and turning it into a frequency table and line graph could be useful in their everyday life. (See suggested extensions activities for possible ideas.)

Character Connection: Remind students that in life, diligence is like an investment. A diligent person works hard in order to get the best outcome at school, at home, and in the community. Additionally, good habits, conducted with great frequency, will lead to a good outcome and a great future.

Assessment:
- teacher observation
- frequency table and line graph completion (and apparent understanding)

Resources:
- Use Create a Graph to let students explore various types of graphs, or to create their frequency graph/table online rather than on paper.
- "How We Are Going to the Moon - 4K" (video on NASA's SLS)
- Apollo Program (1961-1972)
- Space Shuttle Program (1981-2011)
- SpaceX (2011- present)

Additional activity ideas to enrich and extend the primary lesson (optional):
- Allow students to decorate their line graph using crayons or colored pencils.
- Have students create a bar graph from their frequency table.
- Have students write a paragraph about their Rocket Planez launches and what they learned from the graph results.
- Allow students to create frequency tables and line graphs with other data sets such as lunch choices made by the class for a week, attendance for a week or longer, daily weather conditions for a specified length of time, etc.

Sample Frequency Table and Line Graph Made on Student Paper for Rocket Planez Flights