Lesson 3- Planes vs. Parachutes: A Data Analysis

Objectives:

- Students will distinguish between qualitative and quantitative data they have collected from the previous week's lesson on flying machines and from this week's lesson on parachutes.
- Students will determine the rate of speed each airplane traveled by manipulating the equation Rate = Distance/Time with the raw data in order to produce interpretive results.
- Students will interpret the various results from producing each airplane's rate in order to determine which plane traveled the furthest, the fastest, and which plane remained in flight the longest and why.
- Students will work in small groups to determine which type of graphic representation they would like to create in order to illustrate the data collected and make appropriate conclusions based off of their results.
- Students will manipulate different provided materials to construct a testable parachute in order to produce a variety of data results.
- Students will predict how long their parachutes will remain in flight after release.
- Students will use a constant weight supported by their parachute and drop their parachutes at the same height to time the length of flight until they hit the ground with a stopwatch.
- Students will investigate online possible construction revisions they can make in order to improve the quality of their original parachutes.
- After making their revisions, students can do a second test to compare and contrast their first set of data to the second in order to interpret results.
- Students will use concepts of drag and lift to explain how flight occurs in order to compare and contrast qualities of flight between their paper airplanes and parachutes by compiling a Venn diagram.

Standards:

Nature of Science:

- Grades 4, 5: Make predictions and formulate testable questions.
- Grades 4, 5, 6: Test predictions with multiple trials
- Grades 4, 5: Keep accurate records in a notebook during investigations and communicate findings to others using graphs, charts, maps and models through oral and written reports.
- Grades 4, 5, 6: Compare the results of an investigation with the prediction.

Core Standard:

Design a moving system and measure its motion**.**

- 4.4.1 Investigate transportation systems and devices that operate on or in land, water, air and space and recognize the forces (lift, drag, friction, thrust, and gravity) that affect their motion.
- 4.4.2 Make appropriate measurements to compare the speeds of objects in terms of distance traveled in a given amount of time or time required to travel a given distance.

Teacher Content Knowledge:

- The first man to come up with the thought of man flying was Abbas Ibn Firnas. He played an important role with the invention of the flying machine.
- Abbas was known as the "man who jumped off the earth" when he came up with the idea of a flying machine and tested it. He studied the birds and covered himself in bird feathers, attached wings made of bamboo sticks and feathers, and jumped off of a cliff managing to fly at a significant height for a considerable amount of time.
- While Abbas was noted for inventing the idea of the "wings" of a plane and that keeping man in air, it was much later before the concept of thrust, or an engine, was created to help make a more intricate flying machine.
- There are 4 main aspects that allow planes today to fly. Thrust from the engine causes lift of the airplane and makes it possible to allow the plane to elevate. The weight of the airplane is gravity's pull back towards earth, which is why the wings of the plane are necessary for lift to keep it in air. Essentially, planes fly best when the thrust is greater than the drag (allowing it to move forward) and the lift greater than the weight (allowing it to move upward).
    - 4 essential aspects – thrust, lift, weight, and drag
    - Without any of these 4 components, flying would be difficult if not impossible.
- Parachutes have large surface areas, which cause more drag when descending. The reason drag is greater with a parachute is because the material is light and has a large surface area to catch more air. This helps a person or thing land safely by decreasing the rate of decent.
- Parachutes following the Law of Gravity, which states that what goes up must come down. Gravity pulls everything to the center of the earth so the same concept that allows us to walk on the ground is the concept that allows parachutes to work as they were designed.
- The initial purpose of parachutes was to save people from emergency situations in flying machines, such as airplanes.
- Parachutes have had many purposes since their creation. They play roles in dropping food and supplies into war zones or other areas not easily accessible by land, as safety devices for emergencies in the air, as well as for recreational use.
- The best way to organize and present scientific data is through charts and graphs. There are many kinds of charts and graphs to use when presenting data.
    - Graphs include: bar, line, pictograph, and scatterplots.
    - The best graph or chart to use depends on one's data and what he/she is trying to convey to the audience.

- "Inventions in the Islamic World." *metaexistance.org*. N.p., n.d. Web. 9 Feb 2011. <http://metaexistence.org/inventions.htm>.
- "Abbas Ibn Firnas." *YouTube*. Web. 9 Feb 2011. <http://www.youtube.com/watch?v=oB-9l9vXBHM>.
- "F4U Corsair - How Do Airplanes Fly?." *Connectkids*. N.p., 2010. Web. 9 Feb 2011. <http://www.ct.gov/kids/cwp/view.asp?a=2731&q=330926>.
- "How Does a Parachute Work." *Buzzle.com*. N.p., 2011. Web. 14 Feb 2011. <http://www.buzzle.com/articles/how-does-a-parachute-work.html>.
- "Science Buddies." *Data Analysis and Graphs*. N.p., 2011. Web. 16 Feb 2011. <http://www.sciencebuddies.org/science-fair-projects/project_data_analysis.shtml>.

Materials:

- 12 medium sized washers
- 12 small washers
- 15 pennies
- 15 paper clips
- 7 stopwatches
- 7 calculators
- 2 Spools of string or yarn
- 6 rolls of masking tape
- 16 coffee filters
- 8 pairs of scissors
- 6 meter sticks
- 6 hole punches
- 16 pieces of tissue paper
- 20 pieces of construction paper (color does not matter)
- 20 pieces of lined notebook paper
- 20 pieces of computer printer paper
- 3 yards of light-weight fabric
- Student access to the 4 classroom computers

**Note: We are continuing this week's lesson by building upon the data of the prior week's lesson regarding flying machines. A new, complete, five E model about the parachute will follow immediately after a condensed five E completing the ideologies of the paper airplanes.*

Engage 1:

- Remind students of last week's lesson by asking them: What did we do last week? What did you remember the most? What types of data did we collect?
- Display the raw data from last week's lesson of each student's distance traveled in meters and time spent in flight, measured in seconds, for both the first and second trials. (5 minutes at most)

Explore 1: (20-25 minutes)

- Invite the students to examine the raw data from last week. Ask them to think about what we can find out using the data we already have collected.
    - How can we present this data to someone who was not present at our last Saturday Science, in order to have them understand what we did in our experiment?
- Here, it is important that students raise the issues of which plane traveled the furthest and least furthest in distance and which plane had the longest and shortest flight time in order to explore which plane had the fastest and slowest overall velocity.
    - Students of this age will hopefully inquire about finding out which plane had the fastest and slowest time (velocity). If not, use appropriate probing questions based off of students' discussion comments in order raise the issue.
- Introduce the equation to find the plane's velocity: Rate (meters/second) = Distance (meters) / Time (seconds)
    - Reinforce this idea by asking students what information that could acquire with this equation and how they could use the data we have to do so.
- Ask students what types of graphs or tables they have constructed before and what sort of data their visual representations illustrated. List their comments on the board for all to see.
- Invite students to work in their table groups in order to select a type of graph or table to create, and choose what parts of the data they wish to include in their visual representation. Remind students to think about the different qualities we measured and the data we discussed today.
    - Students will brainstorm ideas and make necessary calculations in their journal in order to organize their thoughts and data.
    - Groups will be given a poster board and markers when their brainstorming and planning is complete in order to make a visual representation of their data.

Explain 1: (10-15 minutes)

- Each group will present their poster to the class explaining:
    - How they selected that type of graph or table and why?
    - What type of calculations did they need to do in order to complete the table and why? (If applicable)
    - What does their graph or table illustrate?
    - What type of inferences or interpretations can they make from their visual representation?

Elaborate 1: (15 minutes)

- Project Page 75 of The Teacher's Pack from http://www.muslimheritage.com/feedbackuploads/1001iTeachersPacksHiRes.pdf
- Pass out copies for the students to examine:

- What do they notice?
- Ask the students if they think there is data on worksheet
- What types of data have they learned or heard about?
- How is this information different than what was collected from week 2? (Flash the original data tables back up on the projector for the students to compare).
- Ask students if they have heard of qualitative and quantitative data before. Without saying anything out loud, instruct the students to predict in their journals what they think the difference is.
- Display the definitions of qualitative data verses quantitative data on the board using → http://www.regentsprep.org/Regents/math/ALGEBRA/AD1/qualquant.htm
- After reviewing the examples, ask the students to compare what they learned to their predictions. How have they changed? How have they remained the same? Revise in their journals.
- Then, determine what type of data we collected from last week and what type of data is illustrated in worksheet pg. 75. Compare and contrast.

Evaluate 1:

- The evaluation of the first 5 E's is embedded throughout the discussion with the children, observations of their group explore time, and presentation of their posters along with accuracy of rationale.

Engage 2:

- Students will start off by writing in their journals on what they know about parachutes and how they think they will work. They will be given a minute to look at the materials they will use and then answer the question, "What qualities or characteristics do you think make a parachute stable while in flight? How can we investigate these ideas in the world around us?"
- Student name cards are placed on the benches before they come into the classroom, so that we can predetermine groups that we feel will be most productive while working together.
- As a class we will ask the students if they feel the parachute is a form of transportation. Why or why not?

Explore 2:

- Have the students gather into investigation pairs. Lay out the various types of papers and cloths for the students to openly choose which ones they want to work with in order to create a testable model parachute. They are required to use 4 washers connected to the bottom of the string to represent a constant weight of a "person."
- Allow students to spend 15-20 minutes collaborating together to design and create two testable parachutes.

- During this time of open inquiry, walk around the room and help facilitate their thinking and model building strategies using appropriate probing questions.
- Once students have two parachutes they feel are their best products, gather the attention of the class to establish some safety rules before dropping their parachutes. Because we will be dropping the parachutes off the second story balcony, we will make clear to not to drop any other objects, besides the parachutes, when told. Also, the observers at the bottom need to be at a safe distance so that any falling objects do not hurt them. One partner will be on the ground while the other will be dropping the parachute from above.
- The students will be actively involved by observing what their parachutes are doing while they floating in the in the air. They will also use a stopwatch to take time of how long their parachute remained in the air and will record the information in their journal. This should take about 15 minutes.
- After each group tests their original parachute design, they will be directed to brainstorm with their partner for about 10 minutes about how they could manipulate their parachutes with the materials given to revise their original designs.
- Students will then utilize the lab's computers to access a few websites investigating concepts how a parachute works. This creates additional potential ideas for students as to how to improve the quality of their original parachutes. Students will browse the provided websites for about 10 minutes. Remind students to bring their journals in order to take investigative notes.
    - http://headrush.discovery.com/videos/head-rush-terminal-velocity.html
    - http://www.ehow.com/how-does_4564095_a-parachute-work.html
    - http://www.youtube.com/watch?v=S6aJ9DSYOHk
    - http://www.youtube.com/watch?v=ur40O6nQHsw&feature=related
- Students will then be instructed to return to their lab stations in order to access the available materials to manipulate or revise the construction of their parachutes if they so choose. It is important to remind students to take what they learned from the video and from the resources online and apply them to their original test results. This process should consume about 10-12 minutes.
- Do not by any means construct a model parachutes for the students if they are having difficulties. Instead use appropriate probing questions to stimulate student thinking about the forces from the video and how adding different objects, or how different types of paper or materials may affect the air resistance
- Once again have students take turns dropping their revised model parachutes. Students will record their new data findings in their journals, documenting the exact changes made to each parachute. This should take about 15 minutes.

Explain 2:

- Have students return to their lab stations and establish an open forum of discussion. Probe the students to think about how they can used the data they collected to form inferences about varying construction techniques. Come to a consensus and create a data table on the board with the students' data.

- Allow students to share what materials they chose and why, how their original parachutes flew, what revisions they made to their parachutes and why, and finally how their revised parachutes fell to the ground.
- Remind students to be constantly thinking about the two forces from the video and how those affected their parachutes fall. If necessary replay the video to refresh students' memory.
- Invite students to select their "best" parachute flown in a class contest to see whose parachute floated the most smoothly (no rocking or spinning) and what parachute floated the slowest. Allow for predictions and inferences to be discussed.
- Encourage students to think about what methods of the scientific process they used in their investigations today.

Elaborate 2:

- Revisit the original journal/driving questions written on the board, "What qualities or characteristics do you think make a parachute stable while in flight? How can we investigate these ideas in the world around us?"
- Invite students to spend 5 minutes revising their original predictions to formulate new inferences based off of the data collected from their experiments.
- Discuss students' revised thoughts and prompt them to explain why their answers did or did not change.

Evaluate 2:

- Formative assessment will be achieved during the students' exploration and explanation time. We will be walking around the room making sure students are productively working together in order for everyone's ideas to be heard and tested. Also, we will be asking students probing questions based off of what they are doing in order to stimulate their thinking about manipulating materials to make different airplane models. We will be able to reveal students' understanding of what qualities and characteristics made their model planes fly best or caused areas of difficulty during our open forum of sharing and data collection.

Handouts/Journal Entry: (Summary)

In the first 5E lesson:

- Students will brainstorm ideas and make necessary calculations in their journal in order to organize their thoughts and data.
- Students will predict in their journals what they think the difference between qualitative and quantitative data means. Then students will have a chance to revise their predictions in their journal after whole-group discussion.

In the 2nd 5E lesson:

- Students will answer in their journals the question, “What qualities or characteristics do you think make a parachute stable while in flight? How can we investigate these ideas in the world around us?”
- Students will record in their journal the amount of time their parachutes remained in flight.
- Students will record ideas in their journal as to how to make revisions to their original parachutes to improve their overall flight.
- Students will record their new data findings in their journals, documenting the exact changes made to each parachute.
- Students will revisit the original journal/driving questions written on the board, “What qualities or characteristics do you think make a parachute stable while in flight? How can we investigate these ideas in the world around us?”

Attached is a copy of the worksheet page 75 from
<http://www.muslimheritage.com/feedbackuploads/1001iTeachersPacksHiRes.pdf>

Learning from the birds

How does flight work? Flying requires a balance between forces. The glider's weight is pulling it downwards. When it moves, air flowing over the wings creates 'lift'. This upwards force balances the weight and keeps the glider up.

I know a lot about bird flight. Can I use this knowledge and design a glider that will land more safely?

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Sequence the cards to describe how birds control their landing speed

1 They drop their legs and tails down. Their wings open and this creates more drag.

2 When birds take off they need as much lift as possible.

3 In flight, birds use their streamlined shape to create as little drag as possible.

4 Just above their perch, their lift also drops to nothing they fall the last few centimetres.

5 Low drag means birds can fly fast to catch prey or escape predators.

6 Birds are clever. Just as they land they crate a 'stall' situation.

7 Birds control the amount of drag from their wings by spreading out their tail.

8 Birds create extra lift by turning the bottom of their wings into the air.

9 When birds are about to land they need to reduce their speed.