Lesson: Up, up and away  
Length: 45 minutes  
(This is an activity that can be done to extend my last lesson plan “Simple Machines”)  

Age or Grade Intended: 4th  

Academic Standard(s):  
4.2.4 Use numerical data to describe and compare objects and events.  
4.2.5 Write descriptions of investigations, using observations and other evidence as support for explanations.  
4.6.3 Recognize that and describe how changes made to a model can help predict how the real thing can be altered.  

Performance Objective:  
Given materials, students will design rockets, with 100% accuracy.  
Given materials, the students will test rockets to determine what variables are necessary in order to optimize the system to make it function best, with 100% accuracy.  

Advanced Preparation by Teacher:  
Materials: empty film canisters (the kind with the internal sealing lid - usually clear), construction paper, Cardboard, Tape, Scissors, baking soda, vinegar, and student journals (for keeping notes)  
Teachers should determine in advance the size of the groups in which students should work. The number of groups will determine how many film canisters are needed. Film canisters are readily available, for free, from photo developing stores. It is easy to get the canisters if you request them a few days in advance. Be sure to have extra canisters available in case students want to design a different type of rocket, or make a modification to their initial design.  
Note: Rockets will be launched outside.  

Procedure: Introduction/Motivation: (ENGAGE) Begin by asking students: Have you ever seen a rocket blast off into outer space? Have you ever wondered how they make it work? What are some of the parts of a rocket? Do you think that it is important to have all those parts put together in a certain way? Discuss the students' responses with them. Then, tell students that their job is to design a rocket and to test how the parts of their rocket influence how it will fly. They will all use the same basic structure, but modifications are allowed.  

Step-by-Step Plan: (EXPLORATION) Have students go to the Space Shuttle section of the NASA Kids website. They should read the introductory section about space shuttles. Instruct students to pay close attention to the parts of the space shuttle and how they function to make a whole. Students should next read What are the different parts of the shuttle? They should study the different parts of the current NASA space shuttles. Break
students into groups (the smaller the better...it would be best if students were to work individually). Explain that they will use empty film canisters, construction paper, cardboard, tape, scissors, baking soda, and vinegar as their ingredients. Give each group a film canister. Have students set the canister so that the cover is on the bottom. Students should then roll a piece of construction paper around it so that it forms a long tube and tape it in place. Ask students as they are constructing their rocket: Do you think that we need all the materials? Why or why not? What do you think would happen if we left off the nose cone? What do you think would happen if we left off the fins? Do you think that we need the body? Next, students should cut a circle out of construction paper. They should cut a line to the center of the circle and curl the paper to make a cone shape. Have students make sure the cone fits the tube. If it doesn't, then they should adjust the size of the circle or the cone until it does. Students should tape the cone to hold it together. Make sure to remind students that the amount of tape used may impact the flight of the rocket. Students should tape their cone to the tube. If students choose, they may add four fins to the bottom of the rocket. Have students determine in advance how much vinegar and baking soda they will use as fuel. They should pack the baking soda into the canister. They may use a range of 0 to 2 teaspoons of vinegar. Have each group record these amounts in their science journals. To launch the rockets, have students take their rockets outside to an open area. They should set up the rockets at about a 45 degree angle. You might want to take time to assign a number to each of the rockets so that students can keep track of the distance traveled by each rocket in their science journals. The rockets should be launched one at a time. After each launch, measure the distance that each rocket was able to travel and have students record the distance in their science journals. (EXPLANATION) Students should compare their results with their classmates. They should look for a trend in the amount of vinegar used and the distance traveled. Ask students: Which rocket traveled the farthest? Which rocket traveled the least distance? What do you think impacted the lift off? Why do you think that? What do you think would happen if we took the best formula and increased the vinegar or baking soda? What would happen if we made the body shorter or longer? What if we decreased or increased the number of fins? Do you think that it is important to have all those parts put together in a certain way? Allow students to spend fifteen minutes revising their rockets. Say to students: Now you have had an opportunity to launch your rockets and compare data. You are allowed to make one revision to your rocket. You must record that revision. Some of the things that you may choose to do are: make the rocket body shorter or longer, change the number of fins, change the amount of vinegar, or change the amount of baking soda. 

Closure: (ELABORATION) Re-launch the rockets and compare the distance traveled. Ask students: What did you modify in the design of your rocket? Why did you make this change? Once you made your change, was the rocket the same rocket or a different one? Why or why not? What would be a new change that you would like to make to the rocket? Why?
Assessment: (EVALUATION) Say to students: *We have spent time looking at our rocket's lift off and how the design or fuel amount can impact the rocket's flight. You are to write a description that explains what you discovered to be the best design. Draw a diagram of that rocket and answer the following:* Were the parts of the rocket needed to make the rocket work? Would the individual parts be able to function alone? Why or why not? Why was the body of the rocket necessary? Why was the film canister needed? Do you think that the weather would impact the flight of your rocket? Do you think that it is important to have all those parts put together in a certain way? Why or why not? Space shuttle flights are often postponed. Why do you think it is important that all the equipment be in perfect working order?

Adaptations/Enrichment: For those individuals with learning disabilities, I feel that this will be a great hands-on activity in which they can get involved and see what is happening. I would put them into a group with an individual that is talented and gifted and discuss with the student who is talented and gifted, that they need to help them if they are having any kinds of trouble understanding the activity. Although the roles throughout the group will be equal, this will give an opportunity for the kids to interact with one another and assist each other when necessary.

Bloom’s Taxonomy: Can you recall the importance of size in relation to the space shuttle? Can you explain why the space shuttle may have blasted at different heights? Can you write an explanation as to what you observed during this activity? Can you compare the different flights of the shuttle? Can you distinguish which flight had more “fuel”? Can you propose what is necessary for a shuttle to fly?

Gardner’s Multiple Intelligences:
Linguistic Intelligence: Students are to write in their science journals and answer questions provided.
Logical-Mathematical Intelligence: Students are to use logical explanations for why the space shuttle blasted off in certain ways and how the size affected its flight.
Bodily-Kinesthetic Intelligence: Students are to physically move around to take down measurements in order to compare distances.
Interpersonal Intelligence: Students are to work in groups and communicate effectively with one another.
Intrapersonal Intelligence: Students are to branch out beyond themselves to work with other individuals. Students must understand themselves before they feel comfortable to work with others.