Dear Education Professional;

Attached is a series of lesson plans that have been put together so that you will have material to enhance the hot air balloon presentation. Most of the plans are designed for use after the visit, but several can be used before hand to create interest and excitement.

Feel free to photocopy any or all of the plans as you see fit. Your are encouraged you to use them in any manner you want to, expanding, editing, modifying and deleting as necessary to suit your particular classroom needs and the age of the children.

Have fun!

RESOURCE SHEET

Student pilots can begin hot air balloon training at age 14 and test for their private license at age 16. A student pilot must receive at least 10 hours of flight instruction. Certain altitude, duration and soloing requirements must be documented in a log book. Then, a written, verbal and actual flight test must be passed in order to get a license. Additional experience and testing must be completed to secure a commercial license whereby the pilot can sell rides.

HOT AIR BALLOONS by Donna S. Pfautsch (Trillium Press 1993) An excellent 75 pg. book of definitions, lesson plans, experiments and resources.

Hot Air Ballooning Coloring Book by Steve Zipp (Specialty Publishing Co, 1982) Great for coloring ideas for primary students.

A few of my favorite books that travel with me and I put on display during presentations:
Hot Air Henry by Mary Calhoun (many school libraries have this)
Ballooning by Dick Wirth and Jerry Young
Mr. Mombo's Balloon Flight by Stephen Holmes
Smithsonian Book of Flight for Young People by Walter J Boyne
The Great Valentine's Day Balloon Race by Adrienne Adams
How to Fly a 747 by Ian Graham (a very cool book for kids!)
Research Balloons by Carole Briggs
Hot Air Ballooning by Terrell Publishing, Inc.
Curious George and the Hot Air Balloon by Margret and H. A. Rey
Early Flying Machines by Henry Dale

National Geographic magazines…check the spines for balloon articles. Comb thrift stores where multiple copies can be very inexpensive. There are no fewer than 8 issues with articles about various ballooning endeavors.

Time For Kids, News Scoop Edition, April 2 1999, Vol. 4, No.22 (Breitling Orbiter 3)

Research Project - One:

Using the resource list, contact of the manufacturers and the Balloon Federation of America. Collect information from these and the library regarding hot air balloons.

- Draw up a price comparison list.
- What balloon make do you think you would ultimately buy?
- Why (costs, certain design features, popularity of make, etc)?
- What would your balloon look like?
- Would you like to pursue a career as a hot air balloon pilot?
- Would you compete and/or sell rides or seek out a commercial contract? How would you decide this?
- What are some of the positive and negative aspects of becoming a balloon pilot?
- Why would you pilot balloons instead of airplanes, helicopters or gliders? Maybe you would earn several ratings so you could fly these other aircraft? Maybe you would decide to crew for a pilot instead of actually learning to fly?

Here is a list of resources that can be researched on the web for additional teaching materials, support and ideas:

Balloon Federation of America (BFA) – www.bfa.net

Aerostar http://www.aerostar.com/hotair.htm
Avian Balloon Corporation - http://www.avianballoon.com
Cameron Balloons - http://www.cameronballoons.com/
Fantasy Balloons - http://www.fantasyballoonsinc.com/
FireFly Balloons - http://www.fireflyballoons.net/
Head Balloons - http://home.att.net/~headballoons/
Kavanagh Balloons - http://www.kavanaghballoons.com.au/
Lindstrand Balloons - http://www.lindstrand.com/
Sundance Balloons - http://www.sundanceballoons.com/manufacturing.html
Ultra Magic Balloons - http://www.ultramagic.com/
Victoria Balloons - http://www.victoria-balloons.com/index.htm

Research Project – Two:

Contact a local hot air balloon pilot and interview them about the above questions. Develop other relevant factors.

Discussion:

1. What makes a hot air balloon float? What makes helium balloon float? *(Both are lighter than air).*
2. When was the first hot air balloon built? *(1783 in France)*
3. How high can balloons go*? (All the way to 77,000' or higher. Typically they fly any where from tree top height to several thousand feet.)*
4. How do you steer a hot air balloon? *(You don't! Basically, you fly on the breeze in whatever direction it is blowing. However, variations in direction at different altitudes allow for some control.)*
5. Are hot air balloons safe? *(Anytime you leave the ground in anything, there is some risk of injury or worse. But basically, balloons are safe provided the pilot uses good judgment with respect to weather, wind and power lines. Also, the Federal Aviation Administration, who regulate balloons and other aircraft, work hard to keep ballooning safe.)*
6. What are the best weather conditions in which to fly hot air balloons? (*Calm surface winds, clear days)* How do you think weather conditions effect airplanes and other types of aircraft?
7. Where are the best places to fly hot air balloons? *(Away from city congestion and power lines)* how do you think these places different for airplanes and other types of aircraft?
8. How far does a hot air balloon fly? *(It depends on how fast the wind is blowing. If the wind is moving 5 mph across the ground, then it will fly about 5 miles in an hour.   Also. Sometimes the wind is blowing faster several thousand feet up and we can go up there to get into faster wind.)*
9. How much does a hot air balloon cost? *(About $30,000 or more for a new balloon. Less for a used one.) A ride (about an hour) in a balloon costs about $175. A tethered ride might cost between $5-10 (up and down, for just a few minutes).*
10. Why do we fly hot air balloons*? (It's a beautiful and unique way to see the world and sky. We love to share it with new people (who become friends), and flying is a fun and challenging way for us to make a living.)*

Lesson Plans

Why: To Explore Low And High Pressure Air Masses

What: Science Experiment

Relatively speaking, air which is moving has low pressure. And air that is still has high pressure. This was discovered in the late 1700's by a scientist named Daniel Bernoulli. And it is because of this discovery that we can make airplane wings that actually fly. As the wing slices through the air, the air molecules moving over the top of the wing must make it to the other side at the same time as the molecules under the wing. Because the wing is curved on top, those molecules have further to go and must move faster. The combination of low pressure on top and high pressure below work together to create an upward push called "lift".

How about an experiment to prove this?

Materials List:

- 2 toy balloons, equally inflated
- 2 two strings about 1 foot long each

Tie the strings one to each balloon. Hang or hold the balloons about 1 1/4 inches apart.

Have another student blow gently between the two balloons.

The balloons should "stick" together. Remember, the pressure will be lower between the two balloons while you are blowing air through (because moving air has less pressure). The pressure on the sides of the balloons is higher because that air is not moving.

What happens when:

1. You blow even harder between the balloons?
2. You blow the balloons from the side?
3. You stop blowing altogether?

Extension: Would you think that an area of low pressure in weather report would be windy or calm? What about an approaching high pressure system?

Why: to prove that warm air takes up more space than cool air

What: science experiment

When a pilot get ready to heat the air in a hot air balloon, the balloon is not filled tightly. As we add the heat, not only does the warmer air rise, but it also expands to fill up the balloon and make it full.

Materials list:

- 2 plastic bottles (1 liter soda are perfect) with small mouth
- 4 toy balloons
- 2 deep bowls
- hot water
- ice

1. Fit one toy balloon over the mouth of one empty bottle so that it stays on.
2. Put the bottle in a bowl that is filled with hot water.
   Watch what happens after a few minutes.
3. Fit the other balloon over the mouth of the other empty bottle while you wait.
4. Place the second bottle in the other bowl that is filled with crushed ice. Wait and watch.

Draw pictures of what has happened. What can explain this action?

Additionally--blow a balloon up so that it is very hard, almost ready to pop (but not quite!!). Put it into or over a warm place (not into the oven) such as a heater vent. Watch what happens.

Blow a balloon up so that it is very hard. Measure the balloon at its widest part and make a mark there. Put it into the freezer overnight and measure it again the next day. What happened?

DISCUSSION:

You are at the mall. Big things are happening because of the holidays. Lots of food specials, big sales in the stores, and free tethered hot air balloon rides. Alas, you've lingered too long at the travel booth waiting for the free-trip-to-Hawaii drawing. Running outside to get your balloon ride, you learn that the pilot can make only one more trip because it is getting dark. Since you are with your best friend and another one of his/her good friends, you have to decide who will go up because the pilot can only take two of you (all three of you really want to go...). How will you decide (draw straws, flip coin, maybe none of you go after all)?

Additional questions:

Why won't the pilot go up after dark? (Too hard to see the ground to land safely, and by law, the balloon has to have night aircraft lighting.)

What determines how much weight (passengers) the pilot can put in the basket? (Size of balloon, density altitude) Where is that information found? (Flight Manual) What happens if the balloon is overloaded? (Over temperature maximum, ages envelope prematurely)

What is a tethered balloon? (The balloon is kept tied down with long ropes that enable it to rise 50-58 feet, but not fly away.)

Why would a pilot give rides away? (He/she may just be a nice person who likes to share hot air ballooning, or he may have a "sponsor" who is paying for the balloon rides for the benefit of good will or advertising.)

Why: To Expand General Knowledge About The History Of Flight.

What: Research Project and Timeline

Research the history of balloons and flight. Then make a time-line for display in either your classroom or the library.

Why: To enhance retention of program concepts through an exercise which uses the student's imagination and challenges comprehension.

What: compose a short story about an imaginary balloon trip you take. Base it on one or two concepts you have learned about with respect to hot air ballooning (weather, licensing, history, navigation, terrain, rallies, competition, laws, etc). If you need to, research more information about your chosen concept(s) at the library (to give your story depth and focus).

Paper Mache Hot Air Balloons

Materials List:

- strips of newspaper
- white glue diluted in water
- a toy balloon for each student
- paints
- string/yarn
- the base of a milk carton for each student

Instructions:

1. Dip strips of newspaper into diluted glue and paste onto an inflated balloon. While papering the top of the balloon, include a few inches of a long piece of string from which to hang the balloon after it dries. Make sure the piece is firmly anchored and glued in with the newspaper strips.
2. Allow balloon to dry, then paint designs.
3. Paste construction or contact paper on the sides of the milk carton base.
4. Tie the gondola (milk carton) on with 4 pieces of string after punching small holes (use hole punch) in the mouth of the balloon and sides of carton.
5. Hang up for display!!

Why: Stimulate Creative/Persuasive Thinking, Decision Making

What: Word Game

The words listed below should be considered in an aeronautical light, and the definitions as well.

Wacky words

1. Give each student 5 slips of paper and a pencil.
2. From the list below, write a word on the board.
3. Each student invents (or writes the correct) definition that he believes will convince the other players that he is right. Write both the definition and name on a slip of paper.
4. The teacher writes the correct definition on a slip of paper.
5. All slips are collected and shuffled.
6. After reading each definition, have students vote on the validity.
7. Read correct definition.

Scoring:
1 point for each vote a definition receives
2 points for each player who chooses a correct definition
3 points for each player who submits the correct definition

variometer	apex	convection	ceiling
dew point	altimeter	thermal	agl
msl	nautical mile	Montgolfiere	dirigible
venturi	gondola	chase vehicle	touch & go
envelope	navigate	burner	splash & dash

BALLOONING SONG
(SING TO THE TUNE OF SKIP TO MY LOU)

RISE, RISE LIGHTER THAN AIR,
RISE, RISE LIGHTER THAN AIR,
RISE, RISE LIGHTER THAN AIR,
COME LET'S GO BALLOONING.

FLOAT, FLOAT THROUGH THE SKY,
FLOAT, FLOAT THROUGH THE SKY,
FLOAT, FLOAT THROUGH THE SKY,
COME LET'S GO BALLOONING.

LIGHT THE BURNER, LET'S GO HIGHER.
LIGHT THE BURNER, LET'S GO HIGHER.
LIGHT THE BURNER, LET'S GO HIGHER.
COME LET'S GO BALLOONING.

PULL THE RIP CORD, READY TO LAND.
PULL THE RIP CORD, READY TO LAND.
PULL THE RIP CORD, READY TO LAND.
COME LET'S GO BALLOONING.

Why: To Discover Wind Direction, Weather Vanes
What: Science Experiment

Hot air balloon pilots do not have a steering wheel or any other mechanical means of steering their balloons. Sometimes though, the wind at several thousand feet above the ground (winds aloft) will be going a different direction than that which is blowing on the surface. With these changes of direction, the pilot is able to do some "navigating" or control to some extent where the balloon will fly and where it will land. Pilots always get weather and winds forecast before every flight so that they will have an idea of what direction and how fast the balloon will travel once launched. Remember though, it's mostly up to Mother Nature!

One way of determining which way the wind is blowing is to build a weather vane.

Materials List:

- Drinking straws
- Straight pins
- Pencils with erasures
- Feathers about 4 inches in length

1. Put a pin through the middle of a straw.
2. Push the pin down into the pencil erasure. Don't put to much downward pressure on the straw (it has to be free to move).
3. Push the feather into one end of the straw far enough so that it stays.
4. Take your weather vane outside and test it in the wind at different times. Did you notice any changes of direction during the week? Do you think these changes are related to weather systems?

Extension: chart the winds observed outside your window for a week. Use the beaufort (developed 1806) wind scale:
#0 calm--smoke rises vertically, flag hangs still
#1 light air --smoke drifts slowly, flag moves some 2-3 mph
#2 slight breeze--leaves rustle, weather vane moves 4-7 mph
#3 gentle breeze--twigs move, flags extended 8-12 mph
#4 moderate breeze--branches move, dust and paper rise 13-18 mph
#6 strong breeze--large branches sway, wires whistle 25-31 mph
#9 strong gale--branches break, roofs damaged 47-54 mph

When is it most typically windiest during the day?
What do you think would cause this?
What is the best time of day to fly hot air balloons? What would be the best speed of wind to fly in? Why?

Why: To explore the weight of air.
What: Science experiment

Did you know that the air you hold in your palm weights about 100 pounds! How can this be? How can something you can't even see weigh any thing at all? What does this mean for balloonists? Let's experiment.

Materials list:

- 2 straight pins
- l drinking straw
- 2 toy balloons
- string about l foot long
- tape

1. Push pins through both ends of a straw, the same distance from the ends (about 1/2 inch).
2. Carefully stick the mouth end (just below the rubber rings) of a toy balloon onto each pin so that the balloon stays on.
3. Tie one end of the string onto the middle of the straw. Tie the other end onto something so that straw can hang freely.
4. Move the string along the straw until the straw is perfectly balanced. Tape the string down in this spot.
5. Take the balloons off of the straight pins.
6. Blow one of the balloons up and tie it closed. Blow the other balloon up, but only about half way, tie it closed too.
7. Put the balloons back on to the pins (careful not to pop them!). What Happens??

Why: To Stimulate Creativity And Thought Processes

What: Product Advertising Campaign

Hot Air Hype

Pick a product that you would like to see represented by a hot air balloon. Design the balloon shape (remember, some pilot has to fly the thing!), maybe make up an appropriate catchy slogan, and list the places where you want to have this balloon fly. (Explain why). What people (market) would you want to see it?

Why: To Stimulate Thinking Beyond The Concepts That Are Presented In The Program.

What: Listing Items Where Balloons Are Seen

Balloons are not just seen in the sky. Because of their colors and festive nature, balloon motifs have been incorporated in toys, decorations and some very practical items.

List at least five:

for example: gift wrap paper, coffee mugs

1.

2.

3.

4.

5.

Now create two of your own:

1.

2.

Discussion:

A balloon flight can be a beautiful adventure, but why can't balloons be used for daily transportation?

(*wind direction and changes, weather, speed of flight, cost of flight, safety concerns such as launch/landing spots and power lines, legalities, social impact and public reaction, times of day that balloons fly, size and weight of balloon, etc.)*

Creative writing:

You are the first one in the field where a huge hot air balloon has landed. This was a preparatory flight for a balloon race around the world. Because you've been so helpful to the pilot, she invites you to help her with the upcoming race.

Taking the following into consideration, write a story based on the above idea.

1. Your parent's attitude (will they support your involvement or not?)
2. Your schedule (how will you juggle everything?)
3. Your responsibilities at home (will you pay your older brother to take over for you?)
4. How you feel about being involved

Also, explain what your duties will be, how and where your travels will take you. How many other balloons are involved, what is the outcome of the race?

Why: To Explore the Concept of "Lift"

What: Science Experiment

Pilots tie the balloon to the ground until they are ready to fly away. This prevents "false lift" from picking the balloon up before it is actually hot enough to fly. Much like the air passing over an airplane wing, wind flowing over the top of a balloon can actually pick it up! Since the balloon isn't actually hot enough to fly, this action often results in an uncontrolled, hard landing. Ouch!!!

Materials list:

- hair blow dryer
- sheets of 8 1/2 x 11 paper
- scissors, ruler, pencil

1. Using a long flat table as your run way, plug the hair dryer in close to one end of it. Put one sheet of paper flat on the table, a few inches from the end nearest the hair dryer.
2. Turn the hair dryer on low, and hold it a few inches above the table. Moving it around to find the right angle, the paper should then lift off and fly briefly.
3. Explore other shapes (diamond, oval, circle, etc.) To find out which shape flies best. Your flights will not be very high (1/2-1 inch) is excellent.
4. What happens if you use a crumpled piece of paper? Why?

Why: To Evaluate Program Retention

What: Follow up Questionnaire

Full of Hot Air!

Choose the most appropriate word from the list below to complete the sentences.

1. Hot Air Balloons fly because hot air ___________.
2. A balloon containing helium is a __________________________.
3. You're a balloon pilot! One of the first things to look at before you go flying is the _______________outside.
4. Describe the kind of day a balloon might fly. ______________ _______________
5. You need one to drive a car. You need one to fly balloons and airplanes. You don't need one to ride your bike.

   What is it? ___________________________

AIRPORT	RISES	THUNDERSTORMING
SUNNY	NOT TOO WINDY	HELI-COPTER
GAS BALLOON	WEATHER	LICENSE

6. If I could build a balloon its shape would look like a ___________________________.

Draw a picture of it on the back of this sheet.

Additional Projects

1. Attend a hot air balloon launch or rally (we can provide a list of events or pilots in your area. Or, check the yellow pages under "balloons, manned".)
2. Have a photo contest, or just a photo display.
3. Write a "newspaper" article on the event (number of balloons, competitions, weather conditions, etc.)
4. Video tape an interview of a pilot and share with the class.
5. Build a hot air balloon or aviation display in the library featuring the books found in the school library.
6. Invite airplane, glider or helicopter pilots to speak (from local airport, or someone's relative) for comparison's sake.

EXPERIMENTAL HOT AIR BALLOON

Materials List:

- White household glue
- 10 sheets of 30"x 18" art tissue paper per balloon
- Scissors
- poster board for pattern
- magic markers

also needed (*please use with adult supervision*):

- light aluminum pie pan
- duct tape
- charcoal
- matches
- lighter fluid
- fire extinguisher/bucket of water
- 1 gallon vegetable can, empty and clean (cafeteria)
- can opener
- 1 length of stove pipe (9' diameter)
- long handled pliers

PATTERN: make template that is 58" long, 7' wide at bottom, 18" wide at the equator", and tapers to a point at the top (resembling balloon gores).

CONSTRUCTION:

1. Group students into pairs or threes. Using glue sparingly so as not to add weight, glue two sheets together at a time, with the end result being 5 sets of 60" x 18" sheets. Pick color schemes with care!

2. Again, use glue sparingly in this next step. You might even want to practice making a thin line with the glue bottle.

   Take two long sheets from step 1, draw a thin line of glue ¼ inch from the longest edge on one sheet, going all the way from the top to the bottom. Gently press the remaining sheet onto the glue. Make sure the top and bottom edges are lined up before the sheets contact each other!

   Glue all of the sets of sheets together, allow to dry.

3. By laying the balloon pattern on the tissue sheets (one time in each set) you can outline the pattern with a marker.

4. Cut one side the outline. Then, make 1/4 inch cuts into the tissue every inch or so along the freshly cut edge.(This will help when gluing the curved edges together later.)
   Cut out the remaining side, but DO NOT make the 1/4 inch cuts
   along this edge. Do this will each of the outlines.

5. Practice this next step on some scrap tissue before attempting the real thing! Find one gore with a clipped side and another with an unclipped side. Lay the unclipped side flat and draw a

thin line of glue, 12 inches long, starting at the point of the gore. Gently press the clipped edge along the glue, matching
the edges. The 1/4 inch clips make this possible. Lay this larger section over a chair to dry.

Do the same with 2 more gores, allow to dry.

Glue the remaining single gore to one of the sets. Allow to dry.

Glue the section of two to the section of three. Allow to dry.

6. The last seam is the hardest one! Wrap the balloon around a chair or student, and carefully glue the remaining seem as in step 5. Several people may have to assist holding the balloon at this point.
7. Cut the center out of the pie pan about one inch from where it folds. The remaining seam will sit on top of the stove pipe. Attach the balloon to the pan by crimping the outer edge of the pan onto the tissue; tuck and pleat as necessary. Use duct tape to secure the edges.
8. After the last seam has dried, inspect the balloon for holes.
   Store the balloon on a bulletin board, hanging with a tack at the tip.

FLIGHT TIME!

1. Using the bottle opener, puncture holes around one edge of the 1 gallon can (for air flow to the fire).
2. Shove the stove pipe section into the can.
3. Place about 8 inches of charcoal into the bottom of the can. Using lighter fluid, ignite the charcoal.
4. Allow the flame to burn down below the top edge of the stove pipe.
5. Place a student at each seam of the balloon. Using pliers, have an adult hold the pie pan, and rest the balloon on the top of the stove pipe. Watch carefully for bunches of paper that are resisting being expanded; help as necessary. The balloon will fill well if there is little or no wind. When the balloon seems full, test its buoyancy by having the students let go.
   It stays upright; it is almost ready to fly.
6. When the balloon is fully heated, gently follow it up with your hands and give it a gently upward shove.
7. Clock and measure how long the balloon flies. Repeat as time and heat allow (provided the balloon has not burned or crashed into a tree or puddle!).

LAUNCH CREW MEMBERS:

1. Launch Directors (teacher & 1 team member), to make launch decision.
2. Fire Person, ready with extinguisher and water
3. Observer, to record flight data (height, distance, etc.)
4. Chase crew, to retrieve the balloon

EXTENSION:
While waiting for the fire to burn down before launching the balloon, experiment with marshmallows on sticks. Watch and discuss how the heat affects them. Discuss radiation, conduction, convection.