# High-Altitude Ballooning in 3rd Grade

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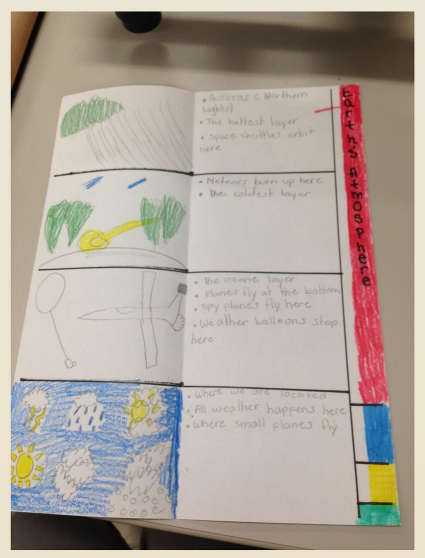
## Our Story: In the Classroom

Students were introduced to the different layers of the atmosphere and worked on skills such as map reading and giving directions. Students chose specific teams and would be training for their positions in the activities leading up to the launch. These heterogeneous teams allowed for students to take on leadership roles within the group in order to support all learners.

We began by teaching the payload set-up team about the LabQuest and how to attach the data collection sensors. The payload set-up team members were in charge of leading groups around the school building to collect data on temperature, pressure, and wind speed. This activity led to many student questions about air pressure. Using these questions to drive our discussions we introduced the idea that our ears are built-in pressure sensors. The students immediately began making connections such as the pressure change when we swim deep under water, drive up a mountain, or fly in an airplane. Students wondered what the pressure would be like in the upper atmosphere.



Students created graphic organizers about atmospheric layers and learned to use LabQuest probes.

## Preparing for Launch: Tethered Launch & Further Experimentation

The students were brought outside for a tethered balloon launch. We simulated a launch and payload retrieval by walking the balloon around the school and dropping the tracking pods in a secret spot. The tracking team used the StratoStar Dashboard software to find the hidden pods. When the location was found, the retrieval team searched the given area and returned the pods to the launch site. After a successful retrieval, we gathered at the launch site to release the balloon. As a language-arts extension, the students wrote a letter and attached their message in a bottle to the balloon.

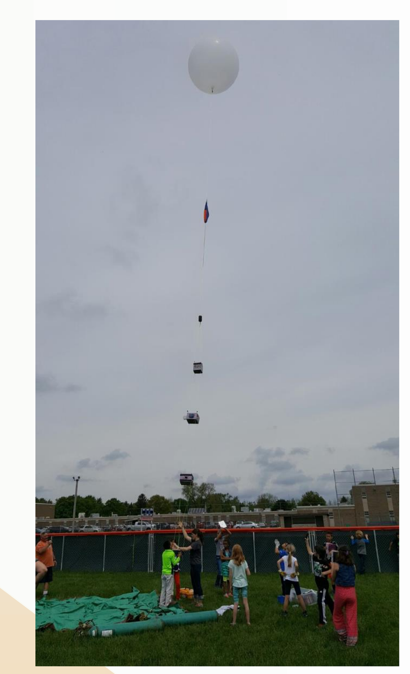
On a following day, we used a bell jar and vacuum pump to conduct various experiments on air pressure. Students recalled that the pressure didn't change much when collecting pressure data around the school and wondered what the pressure would be like when the balloon was launched. To explore air pressure changes we placed the LabQuest with the pressure sensor in the bell jar. Students were able to see the pressure dropping as air was removed from the system. Next, we explored how altering air pressure can change objects such a semi-inflated balloon, a cup of water, a chip bag, a crushed plastic water bottle, marshmallows, and bubble wrap. One at a time, the students wrote predictions about what would happen to the object as pressure decreased. They were amazed at the changes that occurred when the pressure was altered. The students used their new knowledge of how pressure affects various object as a basis for selecting materials to send up in the payload boxes.

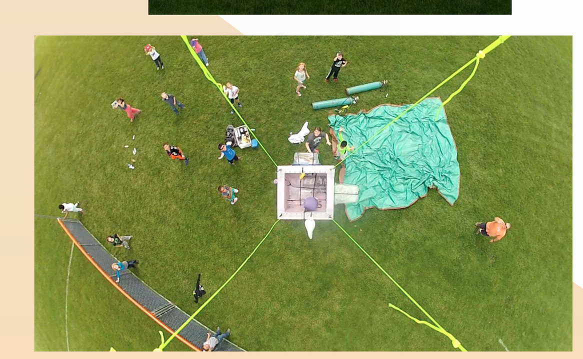
Students attaching a semi-inflated and an un-inflated balloon to their payload box.

## Launch Day

Our final preparations took place a few days before the launch. These advanced preparations were key to our successful launch. The students made predictions about what physical changes the objects would undergo, they assembled the payload boxes and made flight path predictions. Because of their previous experience with pressure during the various bell jar experiments, they were able to form evidence-based hypotheses about the objects. The students predicted that the crushed water bottle, purple balloon, air cushion, glue, and rubber glove would expand. They thought the air bubbles inside of chalk would expand causing it to break. They also predicted the flower would die more quickly than a control flower left in the classroom. Students knew that plants need air and thought the air in the upper atmosphere would be too different for the flower to survive.

The next step was to assemble the two payload boxes. The first box contained the balloons, flower, glue stick, chalk, water bottle, air cushion and latex glove. The second housed the LabQuest with the temperature, pressure, and wind speed sensors. The students worked together to secure the experiments with zip ties so that all material would be able to survive the flight. The challenge was arranging objects so that they were all visible to the GoPro that would be recording from the pod above. The students made tick marks at 1-inch intervals in order to measure the balloon's change in diameter throughout the flight. Our last task was to make predictions about the flight path. The students were given a blank map of the area. Using weather and jet stream predictions, the students drew out their predicted flight path. The students then compared their maps to the prediction from habhub.org.





The day that we had all been waiting for had finally arrived. The payload set-up team had to decide the order of the payload boxes and attach the cords accordingly. Our payload consisted of two trackers, a box with GoPros to capture video of the flight and experiments, and two boxes with the students experiments. The payload weighed 7.4 lbs.

After the boxes were correctly attached and the trackers in working order, it was time to fill the balloon. Members of payload team held their boxes and ensured that the lines did not get tangled, while the launch crew prepared the 200-gram balloon and helium tanks. When everyone was in position, a launch team member turned the valve on the regulator and the students watched with excitement as the balloon began filling with helium. Before our eyes, the balloon grew until it towered over the students. When it reached an acceptable size, we sealed the balloon to measure the lift. We decided to release some of the helium, bringing our lift down to 10 lbs and extending our flight. Finally, the balloon was ready for lift off! Slowly, the students let the balloon rise, releasing one payload box at a time. With only one final box to release, we counted down and watched in awe as the balloon ascended into the air.

## Tracking and Retrieval

The students quickly hopped back on the bus to begin tracking the balloon, while a group of adults stayed behind to clean up the launch site. Members of the tracking team looked at the computer screen to watch the path of the balloon. Using the StratoStar Dashboard, they were able to see the location of the bus and the balloon. They used their map and directional skills to navigate the bus driver on rural country roads in pursuit of the balloon. The balloon rose for 40 minutes and reached an altitude of 14,379 meters before popping and falling back to the Earth. After about an hour of tracking, we found the payload boxes resting safely in a farm field not far from the side of the road. A cheer of excitement and applause echoed through the bus congratulating our tracker team on a successful mission. When the bus came to a stop, the retrieval team safely exited the bus to gather the payload boxes with the camera crew in tow. As a team, the students examined their experiments to see if they noticed any changes. The flower seemed to curl up a bit, but other than that, the rest of the objects had no noticeable differences. The students were anxious to watch the GoPro videos to see what had occurred in flight.

## Making Sense of our Data

The following day we viewed the GoPro videos, and the students enjoyed watching themselves prepare for the launch. They saw the balloon pop and rapidly fall to the ground. We closely observed the objects in the payload box. While the purple balloon, glove, water bottle, and air cushion expanded, the glue did not. The students believed that there were tiny air bubbles inside of the glue stick that would expand, thus causing the glue to ooze out of the tube. This led to a discussion about liquids, solids, and gasses and how they react differently to pressure changes.

After downloading the altitude, pressure, and wind data from the LabQuest, we watched the videos again, this time for the purpose of measuring the diameter of the purple balloon and connecting it to the pressure and altitude data. They noticed the pattern that as the altitude increased, the pressure decreased. A few seconds after the balloon had launched, the class noted the diameter of the purple balloon. This periodic measurement continued and the students began to notice that as the altitude increased and the pressure decreased, the diameter of the purple balloon increased. However, when we reached an altitude of 13,348 meters, the diameter of the balloon had unexpectedly decreased. Based on the pattern that developed, the students knew that it would not make sense for the balloon to decrease in size since the pressure was decreasing. They formed multiple hypothesis for what could have caused this phenomenon. Some thought that a small hole had developed and accounted for the decreased diameter. Finally, the students concluded that when setting up the payload boxes, they did not take into account the expansion of the air cushion located under the balloon. This pushed the purple balloon up, thus changing the orientation of the balloon, which made the diameter appear smaller.

## Connections to the Standards

The Framework for K-12 Science Education from the National Academies Press and the Next Generation Science Standards call for multiple investigations driven by students' questions with a range of possible outcomes that collectively lead to a deep understanding of established core scientific ideas. Our balloon unit gave students the opportunity to deeply engage in the following Crosscutting Concepts and Science and Engineering Practices.

NGSS Connections:

Crosscutting Concepts: Patterns, Cause and Effect, and Stability and Change.

Science and Engineering Practices: Asking questions and defining problems, Developing and using models, Planning and carrying out investigations, Analyzing and interpreting data, Using mathematics and computational thinking, Constructing explanations, Engaging in argument from evidence, Obtaining, evaluating, and communicating information.