Spring 5-10-2014

Let's Talk Science

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LET’S TALK SCIENCE!

By

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Submitted in Partial Fulfillment of the Requirements for Graduation with Honors from the South Carolina Honors College

May 2014

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# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>TABLE OF CONTENTS</td>
<td>1</td>
</tr>
<tr>
<td>THESIS SUMMARY</td>
<td>2</td>
</tr>
<tr>
<td>EXPERIMENTS</td>
<td>4</td>
</tr>
<tr>
<td>Experiment 1: Liquid Rainbow</td>
<td>5</td>
</tr>
<tr>
<td>Experiment 2: Fire-Fighting Foam</td>
<td>11</td>
</tr>
<tr>
<td>Experiment 3: DNA Extraction</td>
<td>15</td>
</tr>
<tr>
<td>Experiment 4: Cabbage Chemistry</td>
<td>19</td>
</tr>
<tr>
<td>Experiment 5: Film Canister Rocket</td>
<td>27</td>
</tr>
<tr>
<td>Experiment 6: Fingerprints</td>
<td>34</td>
</tr>
<tr>
<td>Experiment 7: Tie-Dye Milk</td>
<td>41</td>
</tr>
<tr>
<td>Experiment 8: Yeast Balloon</td>
<td>46</td>
</tr>
<tr>
<td>Experiment 9: Bending Water</td>
<td>53</td>
</tr>
<tr>
<td>Experiment 10: How My Lungs Work</td>
<td>58</td>
</tr>
<tr>
<td>IMPACT</td>
<td>68</td>
</tr>
<tr>
<td>Response from Waverly After-School Program</td>
<td>69</td>
</tr>
<tr>
<td>Response from St. Lawrence Place</td>
<td>70</td>
</tr>
<tr>
<td>Final Reflection: Krupesh</td>
<td>71</td>
</tr>
<tr>
<td>Final Reflection: Courtney</td>
<td>73</td>
</tr>
<tr>
<td>Final Reflection: Savannah</td>
<td>76</td>
</tr>
<tr>
<td>ACKNOWLEDGEMENTS</td>
<td>78</td>
</tr>
<tr>
<td>WORKS CITED</td>
<td>79</td>
</tr>
</tbody>
</table>
THESIS SUMMARY

The focus of our senior thesis, “Let's Talk Science!”, was to increase the exposure of elementary school-aged students to science. In particular, we focused on increasing the students’ opportunity to experience fun science experiments that still presented a strong take-home lesson. In doing this, our goal was to increase the students’ interest in science, technology, engineering, and math (STEM) careers.

We coordinated our outreach program with the Waverly After-School Program, a student organization that operates through the University of South Carolina Honors College in Columbia, South Carolina. Through the Waverly After-School Program, we were able to carry out our senior thesis experiments with St. Lawrence Place. St. Lawrence Place is a facility for families as they make their way from homelessness to home. Many of the families residing at St. Lawrence Place have young children; these children need somewhere to spend their afternoons while their parents are at work. St. Lawrence Place has an activities center that the children visit after they arrive home from school. This grants the children the opportunity to complete their homework and have fun with their peers. Waverly is directly involved in this after-school center; volunteers from the program work with students each day, helping them with homework and reading.

Our goal for developing this science outreach program was to show these kids how fun and exciting science can be, as well as teaching them important scientific concepts. The strategy for the program was initially to visit twice a week (Mondays and Wednesdays) for eight weeks for a total of sixteen different experiments. After three experiments, it was suggested that, instead of doing two different experiments with all of the kids (about 25 in total) in one week, we should divide the kids into two groups (a
Monday group and a Wednesday group) and do the same experiment on both Monday and Wednesday. This changed our strategy for the program; instead of doing sixteen different experiments, we would only perform ten. This was a wonderful change to the program as we were able to better assist the kids with their experiments, and it allowed us to have an active discussion about the topic of that day’s experiment. Throughout the course of the program, we asked the kids to write in their laboratory notebooks. This was a great element of the program, because it allowed the kids to process the topics discussed and then put them down in writing.

It was our hope that, by working with the kids for eight weeks, we would spark an interest in STEM-related careers. After we finished our thesis, we reflected on our personal experiences. Furthermore, we asked those that supported us, our partners at Waverly and St. Lawrence Place, to reflect on their experience. While we cannot confirm that we made a student want to become a doctor, we hope that we had a positive impact on the children’s interest in science.
EXPERIMENTS

This portion contains protocols, photos, lab notebook samples, and reflections to the ten experiments that we completed with the children attending Waverly After-School Program at St. Lawrence place. The first three experiments were done only one day with the complete group of children attending the Waverly After-School program. The following seven experiments were done twice per week, with half of the children participating each day, with one exception; Experiment 7 was only completed on Monday, as the students had a Halloween activity on the Wednesday of that week.
EXPERIMENT 1: LIQUID RAINBOW

Objective: Look at density by making a mixture of two different density liquids.

Introduction: Density is what allows you to float on water; it’s also what allows paper to float and rocks to sink. Rocks are denser than water, meaning there is more matter, or “stuff”, in rocks than in water. Every kind of object has a unique density.

The leaders are going to make a rainbow using density of seven liquids. The heaviest liquids will be most dense, and they will sink to the bottom. The lightest liquids will be less dense, and will settle towards the top. The students will then make their own jar with two liquids to understand density while having a durable product.

Duration: 1 hour

Make a Hypothesis: Our liquids are corn syrup, dish soap, water, olive oil, and rubbing alcohol. Which will be the densest? The least dense?

Supplies:
- ½ cup corn syrup
- ½ cup blue dish soap
- ½ cup water
- ½ cup olive oil
- ½ cup rubbing alcohol
- 20 mason jars
- Food coloring (red, blue, green)

Rainbow Directions:
1. Purple: mix corn syrup, 1 drop red food coloring, and 1 drop blue food coloring
2. Pour into jar
3. Blue: pour ½ cup blue dish soap into side of jar
4. Green: mix water with 2 drops green food coloring
5. Pour down side of jar
6. Yellow: pour ½ cup olive oil down side of jar
7. Red: mix rubbing alcohol with 2 drops red food coloring
8. Pour down side of jar
9. Observe

Two Liquid Directions:
1. Add one cup of water to the jar.
2. Add one cup of vegetable oil to the jar.
3. Shake it up, let it settle, and see what happens.

Observations:
1. What was denser?
2. What was less dense?
Conclusions:
Why do you think corn syrup is the densest in the rainbow? Why do you think rubbing alcohol is the least dense in the rainbow? Which of your liquids (water or vegetable oil) was denser? Did your hypothesis match what you observed?

Figure 1: The above picture displays two excerpts from the laboratory notebooks kept by the participants.
Figure 2: The picture above shows the final set up as depicted by a participant showing the varying densities of oil and water.
Reflection: Courtney

Our first day at Waverly went very well! The kids were very excited to do an experiment, and their enthusiasm made the experiment go smoothly. We completed a density-based experiment with the children. The afternoon began with us setting up; the kids continued to work on homework while we did this. Once we had everything set up, we showed the kids our density rainbow. We then asked what students knew the term density. Two children had heard of the word, and one of the children knew enough to explain it to the group. He said he had already completed this experiment at school. We explained to the children that, in our rainbow, the densest liquid was at the bottom and the least dense liquid was at the top. We explained that density was based on amount of substance per volume, and more dense solutions had more substance in it.

Then the kids began their experiment. Each student came up to our station, and they picked a color of water. They had the option of green, blue, or yellow. We also allowed them to mix colors. After their water was colored and they mixed the food coloring up, we poured vegetable oil into the Mason jar. As we poured, we asked the students what they expected to happen; about half said that the water would be on top. The other half thought that the oil would be on top. As the oil settled on top of the water, we asked why this was the case. They understood that oil was less dense than water, and were able to explain it to each other.

Our first experiment went as planned. It is important that we continue to do experiments that cater to all age groups, as we had students ranging from elementary to middle school.
**Reflection: Savannah**

Today we performed our first experiment with the kids, and it went as best as possible! We worked with about 25 kids in total, and overall I’d say their behavior was good. They were excited from the moment we walked in the door with bags of stuff. It took a few minutes to set up the experiment, but once things were rolling, everything went smoothly. We started out by showing the kids our rainbow density column. They were amazed by the column of stacked colored fluids and wanted to know how we did it! Before having them come up to the table to start the experiment, we asked if anyone knew what the word density meant. A few of the older kids seemed to have heard of the word and one boy explained that if something were denser then it would be heavier. He mentioned that he had seen something similar to this before, so we asked him where the densest liquid would be in the column. He replied by saying that the densest liquid is the one on the very bottom of the column. We told him that he was correct and explained that density is how we created our rainbow. We put the densest liquid on the bottom and the least dense liquid on the top. We then explained to the students in further detail the meaning of density.

The kids could hardly wait to make their own density columns. Instead of having them do four or five layered density columns we simplified the experiment and just had them do two layers. We figured this would be a good idea since it was the first experiment and we weren’t sure how much assistance the kids would need. We called the students up to the table in groups of four or five and they picked a color of water (blue, green, or yellow). Then we assisted the students by pouring the vegetable oil on top of the water. Prior to pouring the oil in their jars we would ask the student which liquid would
be on top: the water or the oil. Most of the students thought that the water would be on top. They thought that, because the oil was more viscous, it might be denser. Once the oil was poured into their mason jars the students were able to observe that the water was actually denser than the oil, because the water was below the oil. The students that thought water was less dense were quite surprised at this result.

Overall the first experiment went very well and the kids were great! We learned a lot about the kids and I think that today confirmed how important is it to take into consideration the ages of the kids and their ability levels.
EXPERIMENT 2: FIRE-FIGHTING FOAM

Objective: To understand the properties of colloids in relation to extinguishing fires.

Introduction: A colloid is a substance that is dispersed throughout another substance, but is not dissolved. Foam is a colloidal gas phase dispersed between a liquid phase. Common examples of colloidal foams include the lather created by shampoo, sea foam, and marshmallows.

We will learn the properties of colloids, specifically foam that is used to stop fires. In this lab we will produce a foam of carbon dioxide gas in water.

Duration: 30 minutes

Supplies (per student):
- 2 plastic cups, 1 spoon
- 100 mL of vinegar
- 100 mL of water
- ½ spoon of baking soda
- Food coloring of choice
- 1 drop of liquid dish soap

Directions:
1. In a cup, add 1 drop of liquid dish soap to vinegar and stir gently until it is thoroughly mixed.
2. In a separate cup, mix water and baking soda until the solid dissolves.
3. Dump the contents of the cup with the water into the cup containing the vinegar and observe.

Observations:
1. What happened when you added the food coloring to the water?
2. What happened when you combined the contents of the two cups?

Conclusion:
Why are foams like this particularly good at putting out fires?
1 - The foam serves as a physical barrier that prevents air (oxygen) from reaching the flame.
2 - The carbon dioxide dispersed within the foam doesn’t allow for combustion since it is heavier than air.
Figure 3: The figure above shows an excerpt from a participant’s notebook for the fire-fighting experiment.

Figure 4: The figure below displays the set up as depicted by a participant.
Reflection: Krupesh

The fire-fighting foam experiment that we conducted today was one that I had researched. The experiment was fairly straightforward as far as the preparation was concerned. All we had to do was combine a baking soda and water solution with a vinegar and soap solution to produce the fire-fighting foam.

Even though this was only the second week, the kids were starting to remember our faces as the “ones who do science” people. At any rate, although the experiment was fairly straight-forward in its procedure, the concepts that it was designed to teach were a little bit more convoluted and difficult to convey thoroughly to the kids. I think we made the error of allowing the kids to conduct the experiment before explaining the reasons for doing this particular experiment.

As a result, the kids were excited to create the foam, but I’m not sure how much of the science they really learned. I think this will be something to keep in mind for future experiments. Perhaps it would be wise to explain the concepts to the kids before conducting the experiment just to make sure that they are not too distracted by the “product” to focus on the science behind it!
Reflection: Courtney

The experiment today was one of Krupesh’s: fire-fighting foam. The foam was made in a similar fashion to a baking soda volcano, though there were a few differences. Rather than using just baking soda and vinegar, we diluted the baking soda in water and mixed the vinegar with dish soap.

The kids were eager to see us again; they remembered that we were the fun science people. We provided each child with two cups, one with the baking soda water and one with vinegar and dish soap. Krupesh explained the premise of the experiment, and we allowed the students to make their foam. When the kids mixed the solutions, the foam produced elicited several “oohs!” They asked if they were able to keep the foam, and we had to let them know that, unfortunately, we had to clean it up and take the supplies home with us.

I didn’t think this experiment went as well as the first one. In the case of the first experiment, the kids learned quite a bit about density. In this case, I think the kids were so excited to make cool foam that they didn’t care to understand why the foam was being produced. It will be very important in the future to explain why the experiment is happening and how that is important before we actually allow the kids to carry out the experiment. I feel that this is the best way to implement learning into the fun of the experiments.
EXPERIMENT 3: DNA EXTRACTION

**Objective:** To explain the concept and roles of DNA. To observe the properties of such an important molecule.

**Introduction:** A cell is the building block of life! There are approximately 2.5 billion cells in just one of your hands! That means if a cell were the size of a single grain of sand, your hand would have to be as big as a school bus! Each cell in our body has a specific job. Just like people do. There are over 200 different types of cells in our bodies. That means there are over 200 different jobs. How does a cell know what job to do? They are told what job they are to do by a special molecule called DNA. Each cell in your body contains DNA. In fact, DNA is found in all living things. Not all DNA is the same though! The DNA that is in a plant is going to be different than the DNA inside of you. DNA is what determines your hair color, whether you are tall or short, and many other things that make you...you!

**Duration:** 30 Minutes

**Supplies:**
- 1/2 cup of split peas (100ml)
- 1/8 teaspoon table salt (less than 1ml)
- 1 cup cold water (200ml)
- 2 tablespoons liquid hand soap (about 30ml)
- Blender
- Plastic Cups
- Fork
- Strainer
- Isopropyl Alcohol (70% or 95%)

**Procedure:**
1. In the blender, combine the following:
   a. 1/2 cup of split peas (100ml)
   b. 1/8 teaspoon table salt (less than 1ml)
   c. 1 cup cold water (200ml)
2. Blend on high for 15 seconds.
3. Pour the contents of the blender through a strainer to obtain the liquid mixture.
4. Add 2 tablespoons of liquid hand soap to the pea mixture and swirl to mix.
5. Let the mixture sit for 5 minutes.
6. Pour the mixture into individual cups until they are about 1/3 full.
7. Tilt the cups slightly and pour along the side of the cup so that it forms a layer on top of the pea mixture.
8. Clumps of white strings should begin to form at the intersection of the two layers (DNA!).
9. Swirl the fork around to pick up the DNA for observation.
**Observations:**
What happened when you added the alcohol?
How many layers formed?
What does the DNA look like?

**Conclusion:**
How does the extraction of DNA work?

DNA is a long stringy molecule. When you add alcohol to the salted DNA, the DNA precipitates, or comes out of the water. Because alcohol is less dense than water, the alcohol sits on top. The DNA should be able to be found at the intersection of the two layers.

Figure 5: Experimental setup created by a participant showing the final set up of the cup containing the DNA at the top.
Reflection: Krupesh

The experiment we did today was one of the ones researched and prepared by Savannah. She did a really thorough job of preparing all the solutions and other ingredients that we would need to complete this particular experiment. Extracting DNA from peas was indeed a lot of fun!

We started by explaining the concepts of cells and working our way down to the specifics of DNA. This proved to be a little bit tricky, especially for the younger group of kids. They had a harder time visualizing the ideas we were trying to convey. However, I think they were able to understand the generalities of what was going on and why we were doing the experiment. The older group, on the other hand, was much more receptive to this experiment! They were excited and participated a decent amount before and during the experiment.

Some of them had already learned in school what DNA was, but didn’t fully grasp the importance of the molecule, so being able to visualize it really helped clarify their understanding and gave them more appreciation for the science behind it.
Reflection: Savannah

Today’s experiment was discovering the storage molecule of our genetic information, DNA! Most of the kids seemed at least somewhat familiar with the term DNA and knew that we all have DNA. The older kids contributed to the discussion by mentioning that DNA is found in our cells. I think that the kids really liked the idea of extracting DNA from the peas, but were slightly disappointed that they weren’t able to blend the split peas themselves. Fortunately the kids were able to add the isopropyl alcohol themselves. This experiment taught us to pick experiments that the kids could do with as little help from us as possible. I think kids like to feel independent and that showed today in this experiment.

This experiment was also somewhat difficult to do with all of the kids because they all wanted to do it at once. Many of the kids wanted to drink the split pea mixture after they had added the isopropyl alcohol so we had to make sure that they didn’t do so. I think the kids really enjoyed this experiment because it helped materialize a concept that many of them were familiar from school and other sources. After all, most people know basically what DNA is but can’t describe what it looks like.
EXPERIMENT 4: CABBAGE CHEMISTRY

Objective: Compare acids and bases

Introduction: Acids and bases are solutions that you can find anywhere, including your fridge and your cleaning supplies. An acid has a pH below 7; oranges and lemons are acidic. A base has a pH above 7; cleaning supplies are usually basic. A neutral solution, like water, has a pH of 7.

You can test if something is an acid or a base using a chemical indicator. We are going to use cabbage, which contains a chemical indicator, to see if soda, cleaning supplies, juice, and other liquids are acidic or basic. You can tell by color change of the liquid: red means the liquid is acidic, purple means that the liquid is neutral, and green means that the liquid is basic.

Make a Hypothesis: What solutions do you think will be acidic? Basic?

Duration: 1 hour

Supplies:
- Cabbage
- Boiling pot of water
- Strainer
- Small white Dixie cups
- Medicine dropper
- A series of household items to test the pH of:
  - Fruit juice: lemon, orange
  - Lemon-lime soda
  - Vinegar
  - Baking soda solution
  - Dish soap

Directions:
1. The leaders will grate a small red cabbage, put it in boiling water, and let it steep to room temperature ahead of the experiment.
2. Fill half a dixie cup with the cabbage solution.
3. Add drops of each solution until you see a change in color.
4. Record if the solution is acidic, basic, or neutral.
5. What happens?

Observations:
1. What colors did you see?
2. Which solutions were acidic? Basic?
3. What was the most acidic? Most basic?
4. What other things would you like to test?
Conclusion:
What’s going on? What did you think of when you heard “acid” before? What do you think now? Remember, acids and bases can be strong, so always be careful when you hear those words!

Figure 6: A diagram of the experimental set up created by a participant.

Figure 7: The picture above shows three liquids with varying pH; pink is acidic, purple is neutral, and blue is basic.
Reflection Day 1: Krupesh

The format of our experiments has changed a little bit starting this week. The folks at St. Lawrence Place have decided that it would be more manageable for them to break up the kids into two groups. As a result, we will be doing the same experiment on both days of the week starting this week with half of the group on each day.

The experiment today was Cabbage Chemistry, which turned out to be a really interesting. We took advantage of a chemical indicator naturally present in cabbage to determine the acidity of certain solutions. The indicator turns red if the solution is acidic and blue if the solution is basic. Its neutral color is purple.

I thought the kids really participated very well in this experiment! They were active in responding to our initial questions regarding acids and bases before we actually started the experiment. Most of the children were also quick to make predictions on which solutions they thought were acids and which they thought were bases.

Each participant received two cups and got to choose from a variety of standard solutions to test their predictions. Some of the younger students had a harder time making their predictions but the older ones seemed to get the hang of it, which is a good sign! I am starting to see that some of these kids are beginning to enjoy and even look forward to our visits on a regular basis and are gaining valuable knowledge that will help them in school down the road.
Reflection Day 1: Courtney

Starting this week, the students will be split into two groups, a Monday group and a Wednesday group, and each experiment will be repeated with both groups. The experiment for today, which will be the same experiment for Wednesday, was my favorite so far.

The experiment for today was “Cabbage Chemistry.” Red cabbage can be used to indicate pH of solutions, or how acidic or basic a solution is. There is a chemical indicator in red cabbage that will turn red in an acidic solution and will turn blue in a basic solution. The cabbage for the experiment was ripped up and steeped in boiling water ahead of time. When Krupesh and I arrived at St. Lawrence Place, we asked the kids in the Monday group if they knew what the word “acid” meant. Some of the children said that acid was in their stomachs, and it made their stomach hurt. We explained that they were correct that acid was in the stomach, and it was used to break down food. We then asked what “base” meant, and no one knew. They asked if it was like a base in baseball. We taught them that a base was kind of the opposite of an acid, and a lot of cleaning supplies are bases.

Each student received two cups of cabbage juice. They were given six options of liquids that they could check the acidity of: orange juice, lemon juice, vinegar, soda, baking soda, and dish soap. We asked the students prior to adding their choices what they expected. For the most part, the students were correct about the acids and bases; they were only incorrect in the case of vinegar. They discovered that red meant acid and blue meant base. We were further able to compare the intensity of the colors. We added the same amount of lemon juice and soda to two cups and asked which was more acidic.
The students agreed that lemon juice was more acidic because the solution was a brighter red.

Overall, this experiment was my favorite so far. I felt that the students took away something concrete from the experiment. They knew that acids and bases were different, and had examples of both. They also knew that it is possible to tell if something is an acid or a base by color. This will come in handy once they reach high school science. This experiment will be repeated on Wednesday, where I hope to see the same “aha!” moment with the kids.
Reflection Day 2: Courtney

This experiment followed the same protocol as Monday. The kids were given two cups of cabbage juice and asked to test the pH of six different liquids. For the most part, the process was carried out in exactly the same way as Monday. However, there was one stark difference: the kids in the second group were much less interested in the experiment than the kids in the Monday group.

A few of the kids were very excited to do the experiment. They listened well and actually learned what an acid and a base were. Unfortunately, this was greatly overshadowed by three of the boys who were not at all interested in the experiment. They were too busy fighting and horsing around with each other to take anything away from the experiment. When they finished their experiment, which I imagine they learned little from, I asked them if I could clean up the cups of cabbage juice. One yelled “no” and tried to walk away with the cups. I promptly removed the cups from his hands and poured them out. He looked at me and said, “You’re mean. Don’t come back here.” I hope that he changes his mind by next week, because I don’t want him missing out on the rest of our experiments because I took his cups away.

On a brighter note, one of our older girls from Monday, Zaria, was so interested in the experiment that she came back to do it on Wednesday. She chose two different liquids and tested the pH. She then noticed a very exciting find. She mixed lemon juice and dish soap and found that the pH of the mix was still considered acidic. She asked why, and Savannah explained to her that the total pH was still acidic. I joked with her that she should be a chemist. She asked what that meant, and I shared with her that
chemists are the people that do what we did for their career. She smiled at the thought of that and said that it sounded like a fun career. I think we may have had a breakthrough.
Reflection Day 2: Savannah

Today’s experiment was really colorful and exciting! We used red cabbage as a pH indicator. Each of the students was given two cups of cabbage juice for their pH testing. This allowed them to test the pH of two different common household items. Items such as orange juice and vinegar were used. The majority of the kids did not seem very interested in this experiment until they realized that the liquids, once added, caused the juice to turn from a purple to either a blue or pink. If the juice turned pink this meant that the liquid added was an acid. If the juice turned blue this meant that the liquid added was a base. The students found that orange juice was an acid and baking soda was a base.

One student in particular, Zaria, seemed very interested in this experiment. Most of the students tested their two chosen household items and then went to go play with the other kids. Zaria chose to stay at the experiment table to watch the other kids doing their tests even after she finished hers. Then once the other kids had finished she started asking some really in-depth questions about the experiment. She had noticed while playing around with her cups (one blue because it’s a base and one pink because it’s an acid) that when she mixed the two together the result was pink instead of purple. She asked me why this was and I told her that it was because her acid was a very strong acid and her base was a weaker base. When her weak based was added to her strong acid the result was a weaker acid and thus her cups still had pink liquid. She found this very curious and told us how fun this experiment was for her. I think that it really made us feel like what we were doing was making a difference.
EXPERIMENT 5: FILM CANISTER ROCKET

Objective: Learn how real rockets are propelled by pressure.

Introduction: Rockets need a way to get to space and move through space. Rockets use pressure created by burning rocket fuel to power the rocket forward. We will use Alka-Seltzer tablets, to make pressure by carbon dioxide.

Make a Hypothesis: What do you think will happen? What is our “fuel”?

Duration: 45 minutes

Supplies:
- 14 Film canisters (order)
- 7 Alka-Seltzer tablets
- Water
- Safety goggles

Directions:
1. Break an Alka-Seltzer tablet in half
2. Put a teaspoon of water into the canister
3. DO THIS QUICKLY: Drop the tablet half into the canister and seal it with the cap, then set it down cap side down
4. Step back!!
5. Watch your rocket fly

Observations:
1. What is our fuel?
2. How could we improve our rocket?
3. What gas builds up?

Conclusion:
What made our rockets fly? How do you think this works with real rockets?
Figure 8: Sample diagram drawn by a participant showing the experimental setup for the canister rocket.
Reflection Day 1: Krupesh

We performed the film-canister rocket experiment today. I have been excited to do this experiment all along because it strikes a chord with childhood. Also, we are “blowing up” something today, which is something everyone can appreciate, regardless of age.

More importantly, I’ve noticed that a few of the students are starting to separate themselves somewhat with an extra interest in science. One such student who seems to be very excited and is looking forward to us coming in every week is Zaria. She is one of the older kids at the center, is quite mature for her age, and is showing a special interest in science.

The film-canister rocket experiment is designed to demonstrate the effects of pressure. This is done by adding an Alka-Seltzer tablet to some water in a film-canister; the resulting carbon dioxide produced from the reaction will increase the pressure in the closed canister and eventually “pop” when the pressure exceeds a certain limit. We placed the canisters upside down (with the cap on the ground), which resulted in the canister being “popped off”.

Overall, I think the experiment today went very well! A few of the kids, including Zaria, are showing great interest and curiosity in the science we are doing and I’m looking forward to completing the rest of our experiments with this group!
Reflection Day 1: Courtney

Today’s experiment was a fun choice. When Krupesh and I arrived, the students were excited to see us, and immediately began asking us what we were doing. Krupesh and I got everything set up, and the Monday group was called up. They picked up their lab notebooks and we went outside.

Today’s experiment was all about pressure. We began the day by asking the students what pressure was. One student, Zaria, explained that pressure occurred when you pressed your hand into a tabletop. We took that example and supplemented it with other examples. To connect pressure to today’s experiment, I mentioned a balloon. An empty balloon doesn’t have pressure pressing on it, but a blown-up balloon does. The students were able to understand this example quite well.

From there, we began the experiment: the film canister rocket. Placing an Alka-Seltzer tablet in a film canister with water will produce carbon dioxide (CO$_2$) gas. The CO$_2$ gas will build up in the canister, but it will not be able to escape the canister due to the sealed lid. This will increase the pressure until the canister eventually pops apart. To simulate a rocket, the canister can be placed on the group cap-down. The cap will be left behind and the remainder of the canister will shoot into the air.

We allowed the kids to add the Alka-Seltzer tablets themselves, though Krupesh and I placed the canisters on the group and made sure the students stayed back. The kids were able to accurately correlate the pressure from the produced CO$_2$ with the launch of the “rocket”.

Two great things happened today. The first occurred when we were outside. The kids asked us what would happen if we put multiple tablets in the film canisters together.
They hypothesized that it would produce more pressure and elicit a bigger launch. Krupesh and I decided to let them test their hypothesis. The students discovered that adding another tablet had the opposite effect; the extra weight held the canister down. The other great thing that happened was that Zaria, our older student in the group and one who has a great interest in science, drew us a picture. Overall, this experiment was fun, simple, and gave the kids a good idea of what pressure can do.
Reflection Day 2: Krupesh

This week was my turn to attend the center on both days! However, this session with the students seemed to be less successful than our session on Monday. We performed the film-canister rocket experiment again today with the other half of the students.

The group we had today was a little bit tougher than usual to get under control. They seemed to be really excited that we were going outside, but at the same time they all had extra energy for whatever reason.

At any rate, we were able to explain the concepts for the day to the group before heading outside to do the actual experiment. Although it looked like the kids were out of control, they were all super enthusiastic for the experiment itself! We went through the same procedure as we did on Monday with the other half, and this group seemed to appreciate it just as much, if not more.

Towards the end of the day today, the kids had trouble staying seated at a safe distance while we waited for the film canister to shoot up like a rocket. I had to repeatedly tell a few of the students to stay seated, which naturally led to them being upset with me. I believe one of them even went as far as to draw a picture of me telling all of them to “sit down”. Safety, especially of the children, is always the number one priority, so I have no problem being the tough one of the group if I have to. All in all, though, I would still say the experiment was a success; all the kids seemed to understand the concept of pressure and were of course enthralled by the film-canister “popping off” repeatedly.
Reflection Day 2: Savannah

Today was the perfect fall day, so the kids loved doing this outdoor experiment. The experiment was based on the reaction between Alka-Seltzer and water. When water and Alka-Seltzer react they produce the gas carbon dioxide (CO₂). This gas would build up in the empty film canister causing an increase in the pressure. The increase in pressure drives the film canister up in the air causing it to fly like a rocket. The kids were all very eager to do this experiment as it involves an “explosion” reaction and a “rocket” (I mean who doesn’t love rockets?), but we needed them to do it one at a time for safety reasons. I think the kids’ excitement got the better of them on this particular day, as they were very difficult to control. We would ask them to sit down, and they would for about two seconds, and then they would get right back up. I think it was curiosity more than an attempt to misbehave. We did ask that the younger kids go first as we have found that they have a harder time waiting their turn. This seemed to be sufficient solution, but the kids were still rowdy. In fact, Krupesh had to tell them to sit on their bottoms so much that one of the oldest kids in the group drew a picture of an angry Krupesh barking out instructions. We took this into consideration when dealing with the kids in further experiments, as we don’t want to come across as mean. Safety is important, however, and if ensuring their safety means repeatedly telling them to remain seated, then that is what we will do.
EXPERIMENT 6: FINGERPRINTS

Objective: Learn about the shape of fingerprints, and figure out what kind of print you have!

Introduction:
You have lots of ways to tell people who you are. You have a name, an address, a phone number, and maybe a school ID. You usually share those things with someone. But you also have one kind of identification that no one else can have. Your fingerprints are an ID that only YOU have. You can have 4 kinds of fingerprints. They are:

![Different types of fingerprints](image)

Figure 9: Different types of fingerprints that are present in the population.

Let’s see what your prints look like!

Make a Hypothesis: What kind of prints do you think you have for each finger? Do you think identical twins have the same fingerprints?

Duration: 30 minutes

Supplies:
- 30 index cards
- 5 ink pads
Directions:
1. Divide your index card into 2 rows (fold hotdog style)
2. Divide it into 10 squares (fold 4 folds)
3. Label them like this:

<table>
<thead>
<tr>
<th>R Thumb</th>
<th>R Index</th>
<th>R Middle</th>
<th>R Ring</th>
<th>R Pinky</th>
</tr>
</thead>
<tbody>
<tr>
<td>L Thumb</td>
<td>L Index</td>
<td>L Middle</td>
<td>L Ring</td>
<td>L Pinky</td>
</tr>
</tbody>
</table>

4. Put your right thumb into the inkpad, and then place your right thumb where it says “R Thumb”. Press straight down and pick up straight so you don’t smear.
5. Repeat for all 10 fingers.
6. Compare to our picture to see what kind of fingerprints you have for each finger!

Observations:
1. What kinds of fingerprints do you have?
2. Are all of your prints the same?
3. Do twins have the same prints?
4. How are fingerprints used in the real world?

Conclusion:
Each person has different fingerprints. They are ONLY yours. Even identical twins have different fingerprints. Why? You get your fingerprints before you’re born. They’re caused by how your skin grows as you grow. This is why everyone has different fingerprints - everyone grows differently!
Figure 10: Different types of fingerprints that were observed and tested along with the respective finger that was used.
Reflection Day 1: Krupesh

Today’s “experiment” was slightly unconventional. Instead of doing a wet lab of sorts, we thought about doing something a little bit more low key to switch it up for a change. As a result, we decided to explore the idea behind fingerprints.

There were a few who disagreed with us when we told them that fingerprints were totally unique for each individual, regardless of whether or not they are twins, triplets, etc. We then went on to explain to the kids that each person acquires their fingerprints during birth, and that they are totally unique to how you develop before birth.

We then proceeded to explore the different types of fingerprints that are common, including the arch, loop, double loop, and simple loop. It seemed as though all the kids were excited to get started with the inkpads, because I kept noticing most of them eagerly eyeing the inkpad sitting on the table waiting to be used.

Conducting the experiment was fairly entertaining because it was interesting to see the kids trying to form the perfect impression of their prints onto the notecards. They then compared their own prints with each other and proceeded to answer a few questions we had posed for them to make sure that they understood the concept of a unique identification marker. Overall, this was a fun and unique experiment we could do to provide an application for science that the kids could relate to!
Reflection Day 1: Courtney

Today’s experiment was not much of an “experiment.” Rather, we wanted to expose the kids to applications of science. Therefore, we decided to show the kids an application of fingerprinting.

Krupesh and I began by explaining identification. Most of the kids came up with an example of ID, ranging from a drivers license to a Piggly Wiggly card. After that, we asked them if they knew of an absolutely unique ID. They guessed fingerprints from the supplies we had on the table. We then explained that every person has a unique fingerprint. A few students were quick to disagree with us, telling us that twins have the same fingerprints. Krupesh shared with them that even twins have different fingerprints. We explained to the kids that each person gets their fingerprints based on the way that they develop before birth. Then we got to work.

The students quickly went for the inkpads. They each put their thumb in lightly and transferred the ink to their notecard. After the students had all ten fingers on their index card and they cleaned their fingers up, we discussed the types of fingerprints. Each student received a picture of the four types of prints: whorl, arch, simple loop, and double loop. They compared their prints to the types of prints. The students then answered a few questions, including “are all of your prints the same?” and “what are some applications of fingerprinting?” Overall, it was a simple, albeit slightly messy, science activity with real world application.
**Reflection Day 2: Courtney**

We repeated the fingerprint experiment today. I actually think we were more prepared today than we were on Monday. We learned to hide the supplies for the experiment before the kids arrived at the table. Also, we prepped the index cards ahead of time, with extras, for the kids to make their fingerprint card.

The kids arrived at the table and we asked them the same questions as the Monday group. They provided similar answers. When we were doing the fingerprints, the kids had a difficult time waiting, and began trying to get ink on each other. We had to step in and tell the kids to stop. Each student did his or her fingerprints, and they compared them to the fingerprint types we provided. These students also answered their follow-up questions. They were able to understand that each finger had a different print, and that each person had a different set of prints. When we asked the students if twins had the same fingerprints at the end, they agreed that they did not.

Savannah and I agreed it is in our best interest to focus on experiments that the kids could do themselves without making a mess in the future; they seem receptive to easy experiments, and it seems like too much show, mess, or conceptual information deter them away from the science. It became such a struggle to keep the ink off of the students and off of us that we were unable to really explain what we were doing and why it is important.
Reflection Day 2: Savannah

Today’s experiment was good in theory but difficult to execute. The idea of the experiment was to have the kids stamp their fingerprints onto a notecard so they could observe the unique characteristics present in each. We had learned from the first day that there was a particular way that the students must stamp their fingerprints onto the notecard for a clear image to be created. We instructed each of the students to not press down too firmly on the inkpad or the notecard or else they won’t be able to see the individual lines in their fingerprints. The strategy on this experiment was to do one finger at a time for everyone. That way we didn’t have students waiting while we helped others stamp both of their hands at once. This was a pretty good strategy, as it kept the students from getting too impatient, but we still had issues with students wiping ink on each other and making a mess. Additionally, some students were clearly not listening to our instructions before the experiment, as they pressed down too hard on the inkpad and the notecard so their fingerprint lines were not visible for them to analyze. Most of the students did pretty well on at least a few of their fingers so they had something to analyze. Some kids seemed extremely interested in identifying what type of fingerprints they had, but others didn’t seem to care at all. We discussed with the students before and after the experiment about the uniqueness of fingerprints and how fingerprints might be useful. Several students knew that sometimes fingerprints were used to identify people in mysteries or crimes. I was pretty pleased with their ability to connect the experiment with real world situations. I think that this experiment might best be done in very small groups so that the students pay close attention and stay under control.
EXPERIMENT 7: TIE-DYED MILK

Objective: Explain what an atom is.

Introduction: An atom is the smallest part of a chemical. Atoms make up molecules. Atoms and molecules are so small that you can’t see them. Molecules can stick together by cohesion. Milk is made of many types of molecules, including fat molecules. Fat molecules are broken by dish soap, and this makes them move. We can see how adding dish soap to milk moves fat molecules. To see it easier, we are going to add food coloring to the milk and watch it move.

Duration: 30 minutes

Supplies: • 1 shallow, clear dish per student
• 1 gallon of whole milk
• 1 pack of food coloring (four colors)
• 1 bottle of clear liquid dish soap
• 1 package of toothpicks

Directions: 1. Pour room temperature milk into the dish until it is about ½” deep.
2. Add one drop of each food coloring, spread out from each other.
3. Dip a toothpick into the dish soap, and then touch the toothpick to the milk to see what happens.

Observations: 1. What happens to the food coloring when you put it in the milk? Why?
2. What happens when you add the drop of soap?
3. What direction does the food coloring move in when you add the soap?
4. Does the movement keep going? If not, when does it stop?

Conclusion: What happened when you added the dish soap to the milk? Why do you think it happened? The breaking down of the milk’s fat molecules allows the food coloring to be moved around. Why do you think the movement stopped?
Reflection: Courtney

Today we completed an experiment I first learned about while in high school. This experiment is called “tie-dyed milk”. In the experiment, milk is poured into a bowl. Then, drops of food coloring are added to the milk. The end of a toothpick is covered in
dish soap, and that is placed in the milk and food coloring bowl. Due to surface tension being broken, the milk will move, carrying the dish soap with it. Though we were unable to explain surface tension to the kids, we were able to work on a very fundamental concept, the atom.

The kids, as usual, were excited to see us. Also as usual, the first thing that they did was stick their fingers in the milk. Despite our repeated warnings that touching would lead to exclusion, the kids continued to act up. We were eventually able to get started. We began by asking the kids, “What is an atom?” Zaria, one of the older girls, said it was a family on television (referring to *The Addams Family*). We agreed with her, and then told them the definition of an atom. We explained that an atom was the smallest unit of matter. We followed that up by saying that everything was made out of atoms, including the air, water, and the kids themselves.

We then got started with the experiment. The kids enjoyed seeing the colors move, but then became distracted with manually mixing the colors. Again, it seemed like the experiment proved more interesting than the concept behind it. When asked what the experiment was showing, only a few kids knew the word “atom.” However, when writing up the experiment in their lab notebooks, a few students asked how to spell the word, so they did make a connection.

We finished up the day by passing out t-shirts to the Monday group. This was a big hit. Again, I would like to thank the South Carolina Honors College, Rebecca Sanders, and River Printing LLC for the beautiful shirts!
Reflection: Savannah

Today, the experiment was called “tie-dyed milk”. The students were very enthusiastic about the experiment, as they quickly observed that it had to do with milk and food coloring. As soon as we walked in the door the students were asking if they could drink the milk. We, of course, told them no, that it was for the experiment! The students quickly found their lab notebooks and asked if they could help set up. The food coloring is added to the milk. A toothpick dipped in soap is used to break the surface tension, resulting in bursts of movement and swirls of color. The students enjoyed this experiment, but we weren’t sure exactly how much they were getting from it. The main idea of surface tension was still a little hard for them to grasp, but hopefully they got something out of it. Of course, the kids wanted to put several drops of each food coloring we had into their milk. Then they proceeded to use the toothpick we gave them to mix all of the colors together. Most of the kids were mixing theirs on purpose, but I have to say sometimes it happened on accident. Once the colors mixed it was difficult to see the results of the experiment. Even the slightest nudge of the Styrofoam bowl caused the experiment to become difficult to see. I think that this experiment might have been a little too advanced and difficult for the students, not because of the actual procedure but simply because the learning point was hard for them to grasp, and the experiment was very sensitive. It’s hard for 5 and 6 year olds to sit still and even when they were trying to do it right, sometimes it still had problems. Overall the kids did enjoy the experiment though, and hopefully it will be something they can remember and think about more as they get older.
EXPERIMENT 8: YEAST BALLOON

Objective: Discover the world of microorganisms.

Introduction:
Yeast is a fungus. A fungus is one of the many times of microorganisms that live in our world. Yeast, like humans, need food to survive. Yeast also need to “breathe” like humans, and release carbon dioxide. We can blow up a balloon with the carbon dioxide that the yeast produce.

Make a Hypothesis: What “yeast food” (sugar, honey, corn syrup) helps the yeast create the most gas?

Duration: 1 hour

Supplies:
- 3 packets of yeast
- 3 soda bottles
- Warm water (enough for 1 inch per soda bottle)
- 3 small balloons
- 1 teaspoon of sugar
- 1 teaspoon of honey
- 1 teaspoon of maple syrup

Directions:
1. Fill up the soda bottle with 1 inch of warm water
2. Add the entire yeast packet to the water and swirl - this is what brings the yeast to life!
3. Add the sugar, corn syrup, or honey and swirl the bottle around
4. Stretch out the balloon
5. Place the balloon over the mouth of the bottle
6. Watch for 20 min as the balloon fills up!

Observations:
1. What is filling the balloon? Can you see the yeast making the gas?
2. Which “yeast food” fills the balloon the fastest?

Conclusion:
Yeast, like humans, need to eat. What food helps the yeast make the most gas? Yeast is one of many types of microorganism. What other microorganisms have you heard of?
Figure 12: Beginning of the Experiment; the balloons were deflated.

Figure 13: Post Experiment; the balloons are mostly filled due to carbon dioxide production by yeast.
Reflection Day 1: Courtney

Today’s experiment was “yeast balloon.” When I tried this experiment prior to today, I knew it would be a hit. The purpose of this experiment was to explain the idea of a microorganism – a living creature too small to be seen.

We began the day by asking the kids some basic terms. First we asked what “organism” meant. We heard everything from “water” to “living being.” Zaria, one of our older students, covered that one. When we asked what “micro” meant, most of them knew it meant something very tiny. When we asked what a “microorganism” was, most students were able to put the pieces together.

We then explained that yeast was a microorganism. They disagreed with us because yeast doesn’t move. We explained that things don’t have to move to be an organism, giving the example of plants.

To begin our experiment, we filled a plastic bottle with one inch of water, then added one teaspoon of sugar, honey, or corn syrup for yeast “food.” Then we added 1/3 packet of yeast and put a balloon on top. As the yeast settled and the balloons began to fill, we told the students that, like us, yeast need to “breathe.” We are proving that yeast is living because the gas each yeast organism releases will blow up a balloon. As they filled, we asked the students which balloon they thought would fill up the fastest. The group was split fairly evenly, 1/3 supporting each “food.” The ones that didn’t support honey said it was because honey poured too slowly.

The balloons filled up quickly, with corn syrup blowing up the balloon the fastest. The sugar took a much longer amount of time. We asked for a hypothesis as to why this was the case, and prompted the students by suggesting they examine the three “foods”
more closely. The students were in unison that it could be because the sugar was solid, while the other two “foods” were liquids.

The students wrote and drew their observations in their notebooks, and we cleaned up and passed out the remainder of the Monday’s group shirts.
Reflection Day 1: Savannah

As soon as we brought out the balloons the kids were immediately eager to see what this experiment would entail. We began by asking the students some questions about what it meant to be living. The older kids in particular seemed to really help us out in this department. These students were able to really help us by suggesting things they had heard before either in class or elsewhere. While the older kids were the only ones that really seemed to be able to describe the term “organism” really well, even the younger kids seemed to know what “micro” meant without much help.

This experiment was really fun because we turned it into a race. We explained to the students how the microorganisms in the bottle would use the food in the bottle to perform a process called fermentation that would result in gas production (hence how the balloon would get inflated). The students had to each pick a food that they thought the yeast would like the best and thus produce the most gas to fill up the balloon the fastest. The group was split pretty evenly in which type of food they thought would fill the balloon up the fastest. In the end, the corn syrup appeared to fill the balloon the quickest with the honey as a close second. The sugar came in last and the students hypothesized that it was because the other two were liquids. This was a great observation on the part of the students and one that we were very happy to hear. By this point in the program, it was great to start hearing the student making suggestions about why things were happening and to answer their questions about why certain results came about.
**Reflection Day 2: Krupesh**

This week we conducted an experiment called the “yeast balloon.” This was the second day of the week for this experiment, so the kids who had yet to do this experiment already had an idea of what was supposed to happen and were super excited as a result!

We started by relaying the concepts for today’s experiments to them, which revolved around microorganisms and their role. A handful of the younger students proceeded to confuse this word with microscope, which took a little bit of practice to remove from their system!

Everyone by now is in-tune with the idea of formulating hypotheses for the experiments that we do, and today was no different in that regard. Most of the students picked one of the conditions that they thought the yeast would like the most. They picked sugar more than any other condition. When they realized that the corn syrup ran away with the competition, they realized that the condition most liked by yeast also depended on the state of matter that their food was presented in.

Overall, today was super fun because we got to give the children their shirts! Thanks to Ms. Rebecca Sanders’ contact at River Printing LLC, we were able to give each participant his or her very own shirt. All of the children really like their shirt and some of them even proceeded to put it on immediately!
Reflection Day 2: Courtney

This experiment was a repeat of Monday’s “yeast balloon.” Like the Monday group, the kids were certainly excited to get to work. They greeted us as we arrived and quickly gathered around.

We began by asking the students the same questions we asked the Monday students: “What is an organism?”, “What does ‘micro’ mean?”, and “What do you think a microorganism is?”. The kids seemed to be less receptive to the terms than the Monday group. When I explained “micro” means something very small, like when you use a microscope to look at small things, the kids became fixated on the word microscope. Anytime I asked them what our big word of the day was, they told me “microscope” instead of “microorganism.”

The students had very different guesses from the Monday group as far as which “food” the yeast would like best. The Monday group was varied in their answers. The Wednesday group was fairly set on sugar, because it was the most familiar to them. No one picked corn syrup, the eventual winner. When the students realized that they made the wrong hypothesis, they were not happy. However, when asking them why they thought sugar was the least successful yeast “food,” most of them caught on that it was because sugar was a solid, while honey and corn syrup were liquids.

We finished off the day by giving the Wednesday group their shirts. Like the Monday group, they were very excited to receive their very own t-shirt. Again, we are grateful to the South Carolina Honors College, Rebecca Sanders, and River Printing LLC for the t-shirts.
EXPERIMENT 9: BENDING WATER

Objective: To learn the concept of static electricity and use it to understand its effect on other polar molecules.

Introduction: Static electricity is the accumulation of electrical charge on an object. The charge is created when two objects are rubbed against one another. In our experiment, these objects will be your hair and a nylon comb. Altering the charge on an object will affect its electrical properties. In our experiment, the hair and comb acquire opposite charges when rubbed against each other and change the charges in the water when brought near the stream.

Make a hypothesis: What do you think will happen when a charged nylon comb is brought sufficiently close to a stream of water?

Duration: 30 minutes

Supplies:
• 1 nylon comb per participant
• A steady stream of water

Directions:
1. Have each participant rub the comb through their hair. It is not necessary to actually “comb” your hair; simply rubbing the comb will be sufficient to change the charges.
2. Set up a steady stream of water, preferably form a faucet or bottle of some sort
3. Bring the charged comb near the stream of water.
4. Observe and record what happens.

Observations:
1. What is happening to the water when the comb is near it?
2. How does the amount of bending change when the water flow is higher vs. when it is lower?

Conclusions:
Static electricity is all around us and can be harnessed very easily. What other forms of static electricity do you come in contact with on a regular basis? (Hint: think about the winter!)
Reflection Day 1: Krupesh

Today’s experiment was a very simple and straightforward one. However, it touched on what I thought was an interesting and engaging topic: electricity! Specifically, static electricity!

The set up today simply required the students to rub a comb through their hair to create some static electricity, after which they were to bring the comb near the stream of water to observe what happened. We supplied a stream of water from a water bottle that I had filled up. I used a slightly unscrewed lid to create a small, but steady stream of water and Savannah used her comb to show the kids how it was done.

Upon seeing her comb bend the water, everyone became super excited to give it a try! We had to briefly manage the kids and break them into separate lines by age so that they wouldn’t crowd the stream of water all at once, since this led to a little bit of pushing and shoving, and consequently breaking the stream of water with their combs.

Furthermore, the weather was not up to par today for this experiment, making it slightly difficult of the stream of water to bend an aggressive amount when the comb was brought near it.

All in all, today was a fairly productive day of experimenting! The kids seemed to grasp the concept of static electricity and polarity of substances fairly well, even though this is a topic that isn’t fully covered until college!
Reflection Day 1: Savannah

The experiment today was called “Bending Water”. The experiment uses static electricity to cause the water to move. Each of the students were given a comb and instructed to rub the comb in their hair (to create the static electricity). Then the students were asked to hold their ‘charged’ comb right beside the constant stream of water (Krupesh was pouring water out of a liter bottle). The students observed as I demonstrated this experiment with my comb. The water moved back and forth a little bit. The students then wanted to try it out for themselves. While some students were able to replicate the results that I had gotten, many were not able to replicate them to the same level. We suspect it was related to the humidity level of the air. The kids were all able to see what was supposed to happen, and we discussed the expected results with them. They did learn key words, such as charge and repulsion. A few kids recorded these words, and their understanding of the concepts is evident in their drawings. I think this experiment offered some insight into a different property of water that children often don’t know a whole lot about. Despite the fact that the polar characteristic of water is a topic not fully developed until introductory college chemistry, the students were already grasping the basics.
Reflection Day 2: Krupesh

Today was the second day of us conducting the bending water experiment at St. Lawrence Place. Initially, the kids were not very excited about the experiment that they were set up to do based on what they had heard from their peers from Monday. However, I think they all came around once they saw the cool phenomenon of static electricity.

Today’s discussion about the concepts behind this experiment was much smoother than the one we had on Monday. The kids seemed to understand the concepts fairly well and were just as excited as the other group to begin playing with the stream of water. This led to a few behavioral problems again, but nothing that we couldn’t handle. Also, the weather cooperated with us today and the humidity was more suitable for us to effectively conduct this experiment. The stream of water was bending more visibly than it did on Monday.

Overall, this experiment was fairly straightforward, but conveyed some potentially difficult concepts to understand. However, I think all the students did an incredible job of grasping the concepts of static electricity, polarity, etc. given their level of current understanding and the fact that most of these topics aren’t tackled until high school or even college.
Reflection Day 2: Savannah

The second day of this experiment the results were much better than what we had on the first day. We began the discussion by asking the students what the word ‘charge’ meant. One student said that the word ‘charge’ makes her think of charging a phone battery. We explained the relation between her definition of charge and the charge we were studying in the experiment. Just like on the first day, we demonstrated how the experiment worked. This time when the students attempted it for themselves they were easily able to replicate the expected results. The suspected reason for this was the better weather conditions for this experiment.

The kids did enjoy the fact that they were able to perform this experiment completely on their own. There were some behavioral problems when it came to having to wait while others were doing the experiment. Since we only had one bottle of water to create the constant stream of water to bend, only one person could really go at a time. We decided to do the experiment outside because we could have the water just pour on the ground. On one hand this made the experiment easier, but it also made the kids behavior a little harder to control. Overall I believe that the students were successfully able to grasp important concepts like charge and repulsion.
EXPERIMENT 10: HOW MY LUNGS WORK

Objective: Explain how the lungs work via negative pressure

Introduction:
Your body needs oxygen to be able to work. Oxygen is found in the air, and it enters your body every time you breathe. Oxygen gets into your body through your lungs. You have two lungs, one on the right side of your body, and one on your left. Let’s see how you get air into your lungs!

We will look at how air moves from spaces that have more air to spaces that have less air by making a model lung.

Make a Hypothesis: How does breathing get air into your lungs?

Duration: 50 minutes

Supplies:
- 20 empty, clean 1 liter soda bottles
- Thumbtack to pierce the bottles
- 5 sets of scissors
- 40 balloons
- 20 rubber bands
- 20 straws
- Clay

Directions:
1. The leaders will pierce the base of the bottle with the thumbtack and cut the base of the bottle off with scissors.
2. The leaders will tie a knot in the neck of a balloon.
3. The leaders will cut the other end of the balloon off and stretch the balloon over the base of the bottle.
4. Insert a straw into the neck of a second balloon, wrapping a rubber band around it without crushing the straw.
5. Push the balloon end of the straw into the neck of the bottle, leaving the straw poking out of the top. Seal the straw onto the bottle with clay.
6. Pull down the knot at the bottom balloon.
7. What happens?

Observations:
1. What part of the plastic lung is just like your lung? Your throat? Your diaphragm muscle?
2. Why does pulling the bottom balloon fill the balloon lung with air?
Conclusion:
What’s going on? Pulling on the outer balloon makes more space inside the bottle, decreasing pressure. Air moves into this bigger, low-pressure space through the straw, filling up the inner balloon. When you let go, the air leaves and the balloon deflates. This is called “negative-pressure breathing”.

Figure 14: The picture above shows samples of the “lungs”. The balloons inside the bottle represent the lungs and the balloons at the bottom represent the diaphragm.
Reflection Day 1: Krupesh

Today’s experiment was, in my opinion, the neatest experiment we have done this entire semester. It required a little bit of technical knowhow to create a makeshift organ, but at the same time was tremendously fun. The experiment was called “How My Lungs Work.”

We created a lung model using a plastic bottle, balloons wrapped around a straw with the help of a rubber band, and sealed with the help of modeling clay. The kids were all extremely excited to not only learn how their lungs work, but to also build a model. I’ve found in my time here that kids are very hands-on and seem to retain information a lot better when they are tasked with creating their own model or other learning tool.

At any rate, the experiment was a blazing success, and I think the kids really appreciated learning the basics of how the diaphragm moves to allow your lungs to fill up with air.

The kids were eager to ask us if they could keep their own lungs, since they each handpicked the color of their balloons as well as their modeling clay. There was an outburst of excitement when we encouraged them to keep the models and to go home and show their parents whey they did today after school. This experiment proved to be a really rewarding one, in my opinion!
Reflection Day 1: Courtney

Today’s experiment was “How My Lungs Work,” an exploration of the organ as well as an explanation of negative pressure breathing. The students made a lung using a bottle, two balloons, a straw, rubber bands, and clay. The bottom of the bottle was cut off, and a tied rubber band was cut and wrapped around the bottom, modeling the diaphragm. A balloon was rubber banded with a straw inside, representing the lung and trachea. This was placed in the neck of the bottle, opposite the other balloon. The straw was sealed to the bottle with modeling clay. When the students pulled down on the bottom balloon’s knot, the other balloon (the lung) inflated.

I liked this experiment when I researched it, and I was very excited to try it with the kids. They seemed to catch onto the idea of a lung well. We began the experiment by asking the kids to be aware of their breathing as they inhaled and exhaled. We explained that there is a muscle called the diaphragm that pulls down when you inhale, allowing your lungs to fill up with air.

When we arrived at St. Lawrence Place, the younger students were outside, while the older students completed a story project inside with another group. We decided that we would return on Wednesday to finish the experiment with the older ones. As we completed the experiment, it became apparent that we should have kept a single color throughout the experiment. The young ones were more focused on the colors they received than what they were making. Ideally, the older students will be more focused on the experiment rather than the supplies. Overall, though, I believe that the kids really took away an understanding of how the lung and diaphragm work. They were able to
take their experiments home, so we are hoping they will continue to study it and teach others.
Reflection Day 1: Savannah

Today we did an experiment with the kids that explains the way that our lungs work. The kids were immediately excited about today’s experiment as it contained colored balloons and modeling clay. We decided to take this experiment outside as another group was working with the older kids in the activity center. Once outside we asked the kids to consciously think about their breathing. We asked them to take deep slow breaths in and out. We discussed some basic mechanics of breathing with them while using buzzwords such as inhale, exhale, and diaphragm. Most of the kids were not familiar with the word diaphragm at the beginning of this experiment.

Once the introduction for the experiment had been given, we handed out a bottle with a balloon covering their cut off bottoms to each of the kids. We asked them to not squeeze the bottle as doing so would cause the balloon to pop off and the experiment wouldn’t work properly. As we were helping some of the kids, the other kids were playing with their bottles and popped their balloons off, but luckily we had prepared several extra bottles. The kids were then asked to pick a balloon, a rubber band, a colored straw and a small piece of modeling clay. We stuck the straw in the balloon and attached them together by tying on the rubber band. Then we stuck the straw in the bottle. Then we helped them fasten their straw to their bottle using the modeling clay. The modeling clay had to make sure the bottle was air tight, minus the ends of the straw. Now the experiment was finished and the kids could expand the balloon inside of the bottle by pulling down on the balloon on the bottom of the bottle. The balloon on the bottom of the bottle represented the diaphragm in our chest cavities.
The students seemed to really enjoy this experiment and were eager to take home their model lungs.
Reflection Day 2: Krupesh

We came back again this week to finish up our lungs experiment with the second half of the kids at St. Lawrence Place. They all had seen their friends in the Monday group playing with balloons at one point or another and were even more excited to be able to get their chance at doing the same!

This group was comprised almost exclusively of the older kids, so we were able to explain the concepts even faster before starting the experiment. We used this as an opportunity to add a little bit of extra information on negative pressure breathing, something that would not have been as useful with the Monday group of kids who are fairly young.

All in all, this experiment was even more successful today than it was on Monday because the older group seemed to get an even better appreciation for the concepts and for the work we all put in to make the experiment happen.

Unfortunately, today was also our last day at St. Lawrence Place for the semester. Most of the kids knew that and some were visibly disappointed about us not coming back to do science with them the following week. I think this is an encouraging sign for the sort of impact we were able to have on these kids and I hope they will continue pursuing science going forward in their schooling.
Reflection Day 2: Courtney

Today was our final day of going to St. Lawrence Place. We finished the same experiment, “How My Lungs Work,” with the older kids in the program. We worked with six students today, and we were able to explain the function of the lung in more depth.

The experiment followed the same protocol. However, we explained the physics behind breathing as well as labeling the parts of our lung model. We introduced negative-pressure breathing, and explained that the contraction of the diaphragm increases the volume of the chest cavity. They understood that an increased volume resulted in decreased pressure, and air moved in.

The great part about working with the older students is the questions that they ask. Zaria asked us what allows you to breathe deeper. She correctly hypothesized that you pull your diaphragm down more. We had other students ask why we needed to seal the bottle with clay, giving us an opportunity to discuss the pressure difference inside and outside of the bottle.

We gave all of the leftover supplies we had to St. Lawrence Place. We hope that they will have the opportunity to benefit from our project beyond the Mondays and Wednesdays that we spent there. The past nine weeks have provided me with a great insight into science outreach, and I believe we impacted the students; it appears that science is now less of an abstract show. The students learned by doing, and we were able to tie in key terms with fun experiments.
Reflection Day 2: Savannah

Today was the last experiment of our program with the kids at St. Lawrence place. We did the lung experiment again but this time it was with the older kids which had been taking part in a writing program on Monday. The kids in this group were extremely curious as to what we were doing with bottles and balloons. When we asked them about how the lungs worked they were able to give us answers that were fairly in-depth. We asked if they were familiar with the concept of a diaphragm. Most of them had heard of the word but couldn’t quite tell us what it did.

Prior to beginning the experiment we asked the kids to inhale and exhale slowly several times. We brought up our buzzwords: inhale, exhale, and diaphragm. Since this group was older we delved a little deeper into the mechanics of breathing. We mentioned how pulling down the diaphragm creates a larger space which leads to negative pressure. This allows us to breathe air into our lungs. When the diaphragm returns to its original position it forces air out of our lungs.

We then proceeded to hand out the experiment materials and assist the kids when needed. It was nice to have such a small group today so that we could really work with the kids. This was a great experiment because the kids love anything that they can build and then take home. I think that this experiment also drove the point that our lungs and diaphragm are tools that allow us to breathe. Overall this experiment was a great way to close out a great couple of weeks!
IMPACT

The purpose of our senior thesis was to expose students participating in the Waverly After-School program to Science, Technology, Engineering, and Math (STEM) related careers. We asked the president of the Waverly After-School Program, Addison, the director of the Waverly After-School Program, Sandra, and the director of the St. Lawrence Place Children’s Program, Gerald, to provide their reflections on our thesis. Furthermore, each of us completed our own reflection of this experience and the impact our project had on the students and on ourselves.
Waverly After-School Program (Addison and Sandra):

During fall 2013, “Let’s Talk Science!” provided the children of St. Lawrence Place with an unprecedented exposure to the principles of science. Once a week, this initiative facilitated opportunities for students to immerse themselves in science and provided students with the chance to connect with undergraduate students majoring in the sciences. The encouragement of “Let’s Talk Science!” members led many students at St. Lawrence Place to express an earnest desire to pursue a career in the sciences. Through the “Let’s Talk Science!” initiative, the students living at St. Lawrence Place became aware of the employment opportunities that exist in the field of science. Additionally, students gained the self-efficacy necessary to pursue knowledge of science. “Let’s Talk Science!” initiated and funded an effort to provide the students of St. Lawrence Place with a shirt. The students have expressed a great deal of pride in the shirts and a select group of older students continue to use the shirts as a platform to talk to their teachers and supervisors about their continued interest in the field of science. The “Let’s Talk Science!” initiative had a tremendous impact on the children at St. Lawrence Place. The initiative also provided the inspiration for the Waverly After-School Program to seek partnerships with students interested in imparting knowledge of one particular field to the community. After recognizing the benefit of single subject instruction provided after school while partnering with “Let’s Talk Science!”, the Waverly After-School Program has been able to provide the children at St. Lawrence Place the opportunity to participate in art initiatives. “Let’s Talk Science!” has certainly left a lasting impression upon both the Waverly After-School Program and the students at St. Lawrence Place.
February 7, 2014

To whom it may concern:

My name is Gerald Davis Jr., the Children’s Program Coordinator here at St. Lawrence Place, a transitional housing program for homeless families in which our families can stay for up to two years. It gives me a great honor and an appreciation of thanks for the continued efforts to educate our children given to us by “Let’s Talk Science!” a project/program of the University of South Carolina. “Let’s Talk Science!” hosted by Krupesh Dave, Courtney Malo, and Savannah Savage has been a great example for our children as they have educated them on different type of science experiments that our children are receiving beyond the classroom. We are now noticing a great deal of excitement in the art of science. “Let’s Talk Science” has educated our children in Finger Prints, How My Lungs Work, Liquid Rainbow, Tie Dyed Milk, and many more experiments. All of these activities have been done on our Mondays and Wednesday using 2 groups of children ages 5-12.

Signed,

Gerald Davis Jr.

Children’s Program Coordinator
**Final Reflection: Krupesh**

Completing our senior thesis was one of the coolest experiences I have ever had! I thoroughly enjoyed every aspect of the project, from coming up with the experiments to executing them, to reflecting on our experiences. I was able to learn so much about several qualities that are harder to develop than initially meets the eye.

One such quality was teamwork. I had the pleasure of working alongside Courtney Malo and Savannah Savage, both of whom are at least as excited as me when it comes to all things science. The three of us had to work as a collective unit to accomplish all the experiments in a timely manner, while making sure that it was an enjoyable learning experience for the kids. The collaboration required us to meet regularly at the beginning and then stay in constant communication with each other throughout the thesis to ensure proper completion. I am very glad I had the opportunity to complete this thesis with them and can honestly say I wouldn’t want to do it with anyone else!

However, the kids at St. Lawrence Place taught me even more valuable lessons. Chief among these lessons is patience. I learned that just because I understand any given concept doesn’t mean that others will be able to grasp it as quickly as I did, particularly children. It was interesting how I had to change the way I explained concepts to the kids in order to make sure that they had a reasonable understanding of the material we were covering that day or week.

Completing this thesis was fun from start to finish. The kids made every moment of it enjoyable. This included all the times we got to bond with them when we weren’t even doing anything science-related. For example, I had a great time just throwing the football around with the kids before and sometimes even after we were done with our
science experiments. They really seemed to enjoy this because it provided them with a little extra variety in their day. Similarly, Savannah and Courtney were also active with the children outside of our thesis and also had similar experiences.

Throughout my experience with this senior thesis, I learned the importance of a basic science education. Courtney, Savannah, and I were able to notice several gaps in knowledge of the children at St. Lawrence Place throughout our semester with them and are hopeful that we were able to fill some of them during our time there. Plus, kids are natural scientists with their curiosity, which made conducting these experiments that much more fun!

This natural curiosity was so inspiring that it would make you forget for a second that these kids come from families that have been through a lot, which is why there are at St. Lawrence Place to begin with. I am thoroughly humbled to have the opportunity to provide a welcomed distraction for these kids and hope that it was worth their time, because it was definitely worth every bit of my time.

Last, but not least, conducting my senior thesis would not have been possible without the help and unwavering support of our director Dr. Bert Ely, our second Ms. Rebecca Sanders, and everyone else associated with the South Carolina Honors College. Furthermore, I would like to thank the Waverly After-School Program and, most importantly, St. Lawrence Place for allowing me to pursue one of my goals of sharing and improving the knowledge of concepts in the STEM fields. It is my sincere hope that I was able to spark an interest in the children to learn something new, because I know for a fact that they taught me several valuable lessons that I will surely carry with me forever.
Final Reflection: Courtney

The experience I had while completing our senior thesis project at St. Lawrence Place was eye-opening. I learned a great deal about the students I interacted with, the necessity of science outreach programs, and the beauty of programs like St. Lawrence place and Waverly After-School Program.

The students Savannah, Krupesh, and I worked with were some of the silliest and brightest kids I have ever met. They were able to make anything fun, even homework, which made our job much easier. A few of the students developed a closer relationship with us, giving us the opportunity to both teach them further and tease them a little bit. One student in particular, Zaria, stood out to me. Zaria was clearly an incredibly bright girl, and she was one reason I was so grateful that we made the choice to do a science outreach program for our thesis. In particular, she enjoyed our “Cabbage Chemistry” experiment. She was so interested in it that she came back on Wednesday to do it again, even though she could have gone and played with the other kids. Talking to her as she did it, she made several hypotheses that were completely accurate, and she had the opportunity to test them as well. I jokingly told her that she should be a chemist, since she enjoyed the experiment so much. She asked what that was, and we told her it was someone that worked in a lab doing almost what she was doing right now every day. She said that would actually be fun. I am hoping that our program impacted her enough that she continues loving science, even if she does not become a chemist.

Science outreach programs are a necessity for students today. Learning about science in a classroom only provides students with abstract concepts and complicated terms. While this applies to visual, auditory, and read-write learners, it leaves kinesthetic
learners lacking. Furthermore, a diagram in a textbook about lung function does not interest students nearly as much as making their own lung model. Science labs, and science outreach programs for after-school groups, are one of the few ways to make science interesting and concrete to students. I made a point to ask a very basic question at the beginning of every experiment that I took part in, and I made sure to reiterate the question at the end. Almost every time, the students were able to answer the question at the end, indicating that the students understood the concept behind the experiment we completed. Had we just been talking at the students, rather than interacting with them, they may have lost interest and would not have been able to answer my question.

One of the most moving parts of the thesis was the situation that these students were in. St. Lawrence Place’s motto is “getting families from homelessness to home.” The children we worked with are from families that were homeless. Even in grim circumstances, these kids were sweet, happy, and optimistic. I was amazed at their attitude toward everything they experienced; you could never tell that these kids were experiencing a tough time with their family. I am so grateful that programs like St. Lawrence Place and Waverly After-School program exist, so that these brilliant children and their families can have every opportunity available to them. I hope to continue to volunteer with these types of programs, because I have seen firsthand the impact they can have on the families. Whether the students we worked with follow STEM related careers or not, Savannah, Krupesh, and I can be certain that the students came away from our program with some fun memories, a few experiments, and a t-shirt. Thank you to St. Lawrence Place, Waverly After-School Program, the South Carolina Honors College, River Printing LLC, Rebecca Sanders, and Dr. Bert Ely for their support in our project.
The past ten weeks have been an educational and fun experience for both the students and us; we certainly had the chance to talk science!
Final Reflection: Savannah

The eight weeks spent with the kids at St. Lawrence place were a wonderful experience in every way.

From the very beginning it was evident that the kids were natural scientists. They were very curious about how things worked and why they got the results that they did. When we first thought of this idea, we thought of it as going to work with these kids to turn them into little scientists, but it became immediately clear that with most of the children our job was to feed this natural curiosity instead of forcing it upon them. Over the course of the program the kids developed a keen sense of what it meant to form a testable hypothesis. In the early stages of the program the kids might ask a few questions about why something worked, but didn’t really act on them. By the end of the program, the students would take their questions and turn them into testable hypotheses. The first time this happened was during the “Cabbage Chemistry” experiment; the experiment comprised of us allotting each of the kids two cups in which they could pick two of the acid and base solutions we had set out for them. Following the experiment, a young girl named Zaria began to ask questions aloud about other possible combinations than the two she had already tried. She then decided to ask us for permission to test out her hypothesis with the leftover supplies. We were overjoyed seeing her expand beyond the experiment that we had set out for her and the other kids.

Additionally, the program taught the three of us a lot about working with kids and fostering their natural inner scientists. We learned that working in smaller groups allowed us to better help the kids and answer any questions they might have about the topic of the experiment. We also all learned how to properly reinforce the key learning points of the
experiment and to plan experiments that the kids could mostly do on their own. The kids enjoyed doing these experiments themselves because it instilled in them a sense of independence and allowed them to more freely discover their own sense of curiosity. We also learned how to accommodate kids with different learning styles and levels. I think in the beginning we would present the experiment in a more uniform fashion, but by the end we were familiar enough with the kids to at least partially understand their learning style and level. Understanding the kids and where they were at really helped us with planning our experiments because we were able to pick and choose the ones that best suited the kids. I think planning the experiments ahead of time (we planned out most of the experiments during the summer prior to our time spent with the kids during the fall semester) was a great idea; however, when we began to get to know some of the kids, we realized that some of experiments we had picked out were better than others.

Our main goal when creating the “Let’s Talk Science!” outreach program was to instill in these kids a greater understanding and interest in STEM related fields. I think that goal was definitely accomplished. I think that this program taught the kids and all of us important lessons that we can take with us into our future endeavors.
ACKNOWLEDGMENTS

We are very grateful for all of assistance we have received throughout our senior thesis process. First, we must thank the Waverly After-School Program and St. Lawrence Place for providing us with the space, time, and resources to help us finish our thesis. We are grateful to River Printing, LLC, for producing fun T-Shirts for the students that participated. A huge thank you to the South Carolina Honors College for the opportunity to use our thesis as an outreach experience, Rebecca Sanders for helping us shape our idea and for being our second reader, and Dr. Bert Ely for answering our continuous stream of questions and being the ideal thesis director. Finally, we are so thankful for the children that participated in our thesis; their bright and curious minds made all of the preparation and planning worth it.
REFERENCES


