2019

"How It Works" After-School Club

Katharina Dvorak

NEBRASKA HONORS PROGRAM
CLC EXPANDED LEARNING OPPORTUNITY CLUBS
INFORMATION SHEET

Name of Club: How It Works

Age/Grade Level: 3rd-5th

Number of Attendees: 4-8

Goal of the Club: (learning objectives/outcomes)

This club will help students put their science learning in context by discussing how science (biology, chemistry, and physics) is important to our everyday lives.

Content Areas: (check all that apply)

☐ Arts (Visual, Music, Theater &Performance)

☐ Literacy

☒ STEM (Science, Technology, Engineering &Math)

☐ Social Studies

☐ Wellness (Physical Education, Health, Nutrition &Character Education)

Outputs or final products: (Does the club have a final product/project to showcase to community?)

Students are sent home with any crafts created each week. There is no final/cumulative project.

Introducing your Club/Activities:

Explain the purpose of the club (see above) in age-appropriate terms. Briefly discuss the scientific method: how do scientists answer questions they have about the world around them?

1. Come up with a **question**.
2. **Learn more** about the topic.
3. **Predict** what might happen (a hypothesis).
4. **Test** the prediction with an experiment.
5. **Look at the results** and see if they agree with the prediction or not.

General Directions:

These activities work best with 1 club leader per 3-4 participants.

Tips/Tricks:

Trying to discuss the concepts (rather than lecturing) is helpful, as is interspersing the educational portion with the activity (i.e. discussing how polymers work while actually making slime).

LESSON PLAN WORKSHEET

(copy table as needed)

Lesson Activity Name:	How do roads work?
Length of Activity:	60 mins
Supplies:	Cardboard, large books, toy cars, sandpaper, tape measures, coins, tape

Directions:

Vocabulary:

Energy: the ability to make things happen. Energy can't be made or destroyed, it can only change forms.

Potential energy: the energy something has that is stored to be used later.

Kinetic energy: the energy something has when it's moving.

- **Example:** When you're shooting a bow, pulling back the arrow gives the arrow potential energy. Releasing the arrow gives it kinetic energy.

Force: a push or pull that can cause an object to change where it goes.

Friction: a force that resists motion between two objects touching each other.

- **Example:** Is it easier for you to scoot across a carpeted floor or a smooth floor?

Force: a push or pull that can cause an object to change where it goes. Something with more mass will have a stronger force.

Mass: how much stuff there is in an object (on Earth, this is weight).

- **Example:** If a football quarterback is running with the ball and needs to be tackled, would you want me (short and not very strong) to tackle him or would you want (insert favorite football player) to tackle him instead?

Experiment 1 (Potential/Kinetic Energy):

1. In pairs, set up the cardboard ramp on a stack of books (make sure the books are the same height for each group).
2. Measure how far the car goes down the ramp.

Discuss: If we raise the height of the ramp, do you think the car will go a longer distance or shorter distance?

3. Raise the height of the ramp by adding another book or two (again making sure it's the same height for each group).
4. Measure how far the car goes down the ramp with the higher book.

Experiment 2 (Friction):

1. Return each ramp to the original setup.

Discuss: If we add a rough surface at the bottom of the ramp (sandpaper) do you think the car will go a longer or shorter distance? Why?

2. Place a piece of sandpaper at the bottom of the ramp.
3. Measure how far the car goes with the sandpaper.

Experiment 3 (Newton's Second Law; F=ma)

1. Return each ramp to the original setup.

Discuss: If we add mass (weight) to the cars, do you think they will go a longer distance or a shorter distance?

2. Tape coins (two quarters and a nickel) to each car to make it heavier.
3. Measure how far the car goes with the added mass.

Conclusion of the activity:

Did the results agree or disagree with what we predicted? Why did the things that happened work (i.e. discuss concepts again, explaining if necessary).

1. A car with more potential energy (higher from the ground, so gravity is pulling on it more) will go further.
2. A car that experiences friction (resists changes in motion) will not go as far.
3. A car that weighs more (has more mass) will go further because it has more force.

How does this apply to the real world? These principles (of physics) are used by the people who design roads and bridges to make them safe to drive on.

- Cars that weigh more will have more force (i.e. semi-trucks are harder to slow down and need to put on the breaks earlier than regular cars).
- Roads that have more friction make cars go slower (i.e. when friction is reduced due to snow and ice it takes more time to stop on the same road).
- Engineers construct ramps at the right height so cars have right amount of energy (but not too much) to drive safely.

Parts of activity that worked:

Students seemed to enjoy doing the experiments with the toy cars. The applicability of the experiment to their lives was good.

Parts of activity that did not work:

The first time this lesson was used, it only took 30 minutes with 3 student participants. The lesson was expanded by having students come up with their own experiments to do in the remaining time. The second time the lesson was used (with 5 student participants), the lesson took the entire club period (60 mins).

Resources: (Information for club provided by)

https://www.teachengineering.org/activities/view/nyu_frictionforce_activity1
http://www.schoolofdragons.com/resources/forces-in-motion-view

Lesson Activity Name:	How is plastic made?
Length of Activity:	50-60 minutes
Supplies:	School glue, contact solution containing sodium borate and boric acid, water, food coloring, measuring spoons, plastic cups (x2 per student), popsicle sticks (x2 per student), newspaper, aprons or trash bags to cover clothes

Vocabulary:
Chemistry: the scientific study of what things are made of and how they work
Polymer: a long chain of molecules composed of many small molecules linked together (i.e. polyvinyl alcohol, the polymer in glue)
Cross-linking: a chemical reaction that occurs to link two polymer molecules together (draw picture on the board to illustrate this)

- **Example:** When spaghetti is uncooked (straight), it slides very easily against other noodles. When spaghetti is cooked, the noodles stick together and it gets tangled up.

Concentration: the amount of substance in a solution. Chemical reactions are often dependent on concentration (i.e. how much "stuff" is available to react).

- **Example:** soda has a higher concentration of sugar than cranberry juice does, so it tastes sweeter.

Safety Precautions: students should wash hands after making the slime and the workspace should be wiped down. Students should not touch eyes, face, or mouth while making slime. None of the materials should be ingested.

Directions:
Experiment 1 (boric acid concentration):

1. Have students partner up in groups of two.
2. Pour ¼ cup of glue into each cup and give each student one cup.
3. Have each student mix in 2 teaspoons of water and ¼ teaspoon baking soda with a popsicle stick. Add food coloring if desired.
4. To one cup, have the student add 1 tablespoon of contact solution. To the other cup, have the student add 2 tablespoons of contact solution.
5. Stir mixture with popsicle stick.

Discuss:

- What are the differences you observe between your samples? How would you describe them?
- If we add more borax (which causes the molecules to cross-link), will the slime become thicker or not as thick?
- What do you think would happen if we accidentally added "too much" borax/activator?

6. Continue adding contact solution until slime is at the desired consistency. Knead with hands to fully mix.

Conclusion of the activity:
Did the results match what we predicted would happen? Can you explain why or why not?

- Adding more borax to the glue increased the concentration of borax relative to glue, allowing more cross-links to form and the viscosity of the liquid to increase.

How does this apply to the real world? These principles (of chemistry) are used by the people who create new materials (such as plastic).

- Slime can't be made as hard as plastic because the "activator" (contact solution) isn't concentrated enough (it doesn't have enough of the cross-linking molecule).
- However, plastic is manufactured by making polymers out of smaller molecules (basically, what was in the glue already).
- Cross-linking is used to make plastic more rigid (in fact, cross-linked plastics are often so hard they can't be melted down to be recycled).
- Cross-linking is used to turn rubber into tires used on bicycles and cars (vulcanization).

Parts of activity that worked:
Slime is very popular and an activity that all the kids enjoyed.

Parts of activity that did not work:
It was somewhat difficult to get the kids to pay attention (they were having too much fun with the slime!) and the polymer concept was somewhat difficult to describe at an age-appropriate level.

Resources: (Information for club provided by)

https://www.thebestideasforkids.com/how-to-make-slime-with-contact-solution/
https://www.scientificamerican.com/article/bring-science-home-playing-with-polymers/
https://www.acs.org/content/dam/acsorg/education/resources/highschool/chemmatters/articlesbytopic/solidsliquidsgases/chemmatters-dec2004-slime.pdf

Lesson Activity Name:	How do I get sick?
Length of Activity:	60 mins
Supplies:	Modeling clay, construction paper, pipe cleaners, cotton swabs, tape, scissors, ball/balloon

Vocabulary:

Parasite: an animal or plant that lives inside another animal or plant of a different type and feeds from it

- Can you think of any parasites?

Virus: a type of parasite that is a tiny particle that causes disease and can only survive if it's inside a living host

- Have you heard of any viruses?

Cell: the smallest unit of life; cells make up every part of our bodies

Directions:

Activity 1 (bacteriophage model):

1. Have students make an oval-shaped ball of modeling clay.
2. Have students twist together six pieces of pipe cleaner to make the tail and tail fibers.
3. Have students wrap a piece of paper around the tail to make the sheath.
4. Stick tail into the head of the virus to form the model of the virus.

Explain: At every level of biological organization, there is a relationship between structure (how something is made, how it looks) and function (what it does). Because of this, looking at something's structure can give us clues to how it works.

> **Discuss:** A hummingbird's beak is very long and thin. Does it look like anything you use to eat (i.e. a straw)? What might this mean for what kind of food the hummingbird eats?

Discuss: This is what a type of virus looks like (show SEM picture of bacteriophage). Viruses infect our bodies by "hijacking" cells. Let's pretend we're biologists, who discover this type of virus. We know the structure of the virus and what it's made of. How do you think it might be able to get inside, or get part of it inside, a cell to infect it? (Provide ball or balloon to have students experiment with the structure of the virus and how it might enter the cell).

Activity 2 (bacterial cell model):

1. Have students make a larger, oval-shaped ball of modeling clay.
2. Have students cut cotton swabs in half and place into the ball of clay with the cotton portion facing outward (modeling cilia).
3. Have students curl a pipe cleaner and place into the end of the clay (modeling flagellum).

Discuss: Keeping in mind the relationship between structure and function, this is what a bacterial cell looks like (show SEM picture of bacterial cell). Bacterial cells are a bit more difficult to understand based on what they look like, but do you have any guesses?

Conclusion of the activity:

- Viruses, like the one we modeled, cause us to get sick—such as when we get a cold or the flu.

- When a virus gets inside our body and starts making more of itself, our bodies decide to fight back with white blood cells ("soldier cells"). This causes the symptoms of a cold (i.e. sore throat, coughing, runny nose, fever) as your body tries to get rid of the virus.
- Vaccines work by giving you a little bit of a very weak virus that can't do a lot of harm, and your body learns to fight it off so the next time you eat the virus, your body can get rid of it more quickly.
- Bacterial infections make you sick when pathogenic (disease-causing) bacteria enter the body and start multiplying. Sometimes they release toxins that irritate the human body, but most of the time the symptoms of illness are because of the immune response.
- Antibiotics kill bacteria that are causing the disease, so the body can stop causing the symptoms of the illness.

Parts of activity that worked:
The kids seemed to enjoy the activity, and having discussions and asking the participants to predict what will happen in the activity based on previous knowledge worked well.

Parts of activity that did not work:
Initially, just using the virus lesson, the activity was too short (thus, the bacteria lesson was added as well).

Resources: (Information for club provided by)

https://science.howstuffworks.com/life/cellular-microscopic/virus-human2.htm
https://www.exploratorium.edu/snacks/viral-packaging
http://theconversation.com/what-the-flu-does-to-your-body-and-why-it-makes-you-feel-so-awful-91530

Tutorial based on:
https://i.pinimg.com/originals/48/85/ad/4885ad1f0c4a452519ddd0a25f51ef46.jpg

Lesson Activity Name:	How do my muscles work?
Length of Activity:	60 mins
Supplies:	Craft foam, string, pony beads, paper straws, tape, markers, scissors, disposable chopsticks

Vocabulary:
Tendon: the cords of tissue that attach muscles to bones
Ligament: tissue that connects bones to each other (holds together a joint)
Muscle: tissue that can contract, making different parts of the body move

Directions:

1. Have students trace their hands on a piece of craft foam and cut the shape out.

Discuss: Looking at your hands, how many bones do you think you have in your fingers? (Three in each finger, two in each thumb, one bone beyond each finger in the palm of the hand).

2. Have students cut out pieces of straw for each "bone" in the hand and tape to the craft foam in the proper place.
3. Tie a pony bead to one end of the string, and thread the opposite end through the straws for each finger, to the wrist.
4. Tie finger loops in the ends of each string, near the wrist.
5. Tape a chopstick to the back of the hand to make a handle.

Conclusion of the activity:

Arthritis: when ligaments holding joints together thin and the bones rub together, causing pain when movement occurs
Tendonitis: when tendons become irritated, usually because of doing the same type of movement over and over (i.e. Tennis elbow, pitcher's shoulder)
Tearing a ligament: when a ligament stretches or tears (i.e. a sprain)

- Depending on how severe the injury is, it may be treated with ice to reduce swelling, pain medication, splints, casts, or surgery

Muscular movement: the brain sends a signal through the spine and nervous system to the muscle in a particular area of the body, and the muscle contracts, pulling on tendons, and the bones move

Parts of activity that worked:
The kids really enjoyed the activity and it was something different. Having a less-structured approach to discussing the concepts worked well.

Parts of activity that did not work:
We went over time-wise (by about 5 minutes). The activity is complicated enough that it takes a long time to work on.

Resources: (Information for club provided by)

https://gosciencegirls.com/articulated-hand-movable-fingers-joints-tendons/?utm_content=bufferca5a4&utm_medium=social&utm_source=pinterest.com&utm_campaign=buffer