3M Young Scientist Lab

Classroom Activity | Grades 3-5

How Strong Is It?

GUIDING QUESTION

What are the adhesive properties of sticky notes and what variables influence how much weight a sticky note is able to hold?

LEARNING OBJECTIVES

Students will be able to:

- work with other students to discover some adhesive properties of sticky notes.
- test sticky notes for their adhesive strength.
- interpret student-collected data in order to draw conclusions.

OVERVIEW

Students use sticky notes often, but they rarely think about them in terms of using them to learn inquiry skills. Sticky notes readily stick to most surfaces and require a small, but measurable, force to remove them. In this lesson, students will work in small groups to gather quantitative data about the amount of force needed to pull a sticky note from the surface of a CD along the plane of the CD. They will initially be offered the chance to explore the adhesion conditions and properties of the sticky notes in an open inquiry setting. Later, in a more directed inquiry approach, students will focus on two variables that affect the degree of adhesion on a sticky note, the force used to attach the sticky notes to the CD and the surface area of the adhesive part of the sticky note that is attached to the CD. Students will continue their inquiry at home by involving their parents/guardians in additional investigations of sticky notes in everyday situations around the house.

NEXT GENERATION SCIENCE STANDARDS

- PS1.A: Structure and Properties of Matter
    - Measurements of a variety of properties can be used to identify materials. (Boundary: At this grade level, mass and weight are not distinguished, and no attempt is made to define the unseen particles or explain the atomic-scale mechanism of evaporation and condensation.) (5-PS1-3)

- PS2.B: Types of Interactions
  - Objects in contact exert forces on each other. (3-PS2-1).
- ETS1.B: Developing Possible Solutions
  - Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions. (3-5-ETS1-2)
  - At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. (3-5-ETS1-2)
  - Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved. (3-5-ETS1-3)
  - Testing a solution involves investigating how well it performs under a range of likely conditions. (secondary to 4-ESS3-2)
- ETS1.C: Optimizing the Design Solution
  - Different solutions need to be tested in order to determine which of them solves the problem, given the criteria and constraints. (3-5-ETS1-3)(secondary to 3-PS4-3)

LESSON TIME FRAME

Two Sessions:

- One 40-minute session to engage students
- One 50-minute session for students to carry out the investigation

BACKGROUND INFORMATION

Materials such as masking tape, scotch tape, glues and sticky notes that adhere to surfaces work because of the adhesive forces between two surfaces. Students make use of such items in their everyday lives and by investigating some of their properties of adhesion, these items can be used to develop and practice student inquiry skills in a fun manner.

Students learn inquiry skills through curiosity, asking questions about the world around them, making observations and gathering data, and working to make sense of this data.

MATERIALS

Teacher Materials/Prep

- Home Connection Resource
- Pad of sticky notes
- White board or chart paper
- Marker

- Print copies out copies of:
  - How Strong is it? Data Collection Student Capture Sheet
  - Home Connections (for students to take home)
- Print copies and cut out
  - Five Finger Summary Capture Sheet

Materials per Student Group

- Sticky notes: four 3”x3” squares*
- CD**
- Masking tape: several 4 inch sections
- String: 2 feet long
- Scissors
- Paperclip
- Weights***
- Vertical surface such as a door, wall, or side of a desk or table
- How Strong is it? Data Collection Student Capture Sheet
- Pencil

* It is recommended you use Post-it® Notes for their stronger adhesive properties. If these are unavailable, generic sticky notes will work as well.

** Any CD will work; students could be encouraged to bring in unused CDs from home.

*** Examples include batteries, heavy washers, full boxes of paper clips, etc. Provide extra string and masking tape to make loops so the weights can be hooked over the paper clip. Groups could share these weights if necessary. You could have some students make these ahead of time. You might want to test the setup as described below in order to choose weights that are heavy enough to actually pull the CD from the sticky note.

CLASSROOM ACTIVITY

Day 1

Engage

1. Ask students how they got to school today. Find out the different methods and write the name of each method on the board (e.g. walk, bus, car, bicycle, other). Produce a pad of sticky notes and ask how many students walked to school. Write the number of students who walked on a sticky note and stick the Note to the board next to the word “walk.” Do the same for the other methods.

2. Suggest to students that sticky notes are an easy and convenient way to record and display information like this. Ask students if they've ever thought about why sticky notes stick to things like blackboards. In the ensuing brief discussion, focus more on the amount of adhesion or stickiness between the sticky notes and the board than on the molecular mechanism of the adhesion.
3. Pull off a sticky note from your pad and hand one to each student.
4. Tell students you would like them to explore the stickiness of their sticky note for any surface of their choosing. Allow as much freedom for this initial exploration within the classroom as you feel comfortable.
5. After students have had sufficient time for this activity, gather them together to share and discuss their discoveries. Did they discover what, if any, factors might affect how hard it is to pull a sticky note off of a surface?
6. Make a list of their suggestions on the board or chart paper to refer to later. Since investigating some of these factors is the goal of this lesson, encourage students to brainstorm how they might determine the force or amount of stickiness between a sticky note and a surface.

Day 2

Explore

1. Tell students you are going to provide them with some materials and give them the chance to measure the force of stickiness between a sticky note and a surface. Refer to the list you made of their suggestions of factors that might affect the stickiness and if "surface area" and "how hard you press" are not on the list, add them. Those will be the two factors or variables they will investigate.

***Teacher Note:** If you have not used the term "variable" with your students before, use this opportunity to introduce the concept, provide some examples including the two here, and discuss the role of variables in a scientific investigation. Otherwise, it would be appropriate to review the concept now.

2. Show the students the image below.

3. Demonstrate how to attach a paperclip to a string and tie the other end of the string to a CD.
    a. Pull the knots tight so they don't come undone.
    b. Using masking tape, tape the non-stick edge of the sticky note to a vertical surface, i.e. essentially upside down, with the sticky side towards the vertical surface.
    c. Allow room below for the weights to hang down just off the floor.
    d. Next slide the CD with string and empty paperclip attached up under the sticky note so the entire adhesive portion of the Note will make contact with the CD.
    e. Lightly press the sticky note against the CD so that when you let go of the CD and string, it does not fall.
    f. Demonstrate how when you pull down on the string with enough force, the CD will suddenly pull away from the sticky note.
    g. Reattach the CD to the sticky note and demonstrate how the string can exert a force on the CD when you add weights to the paperclip one at a time. You might stop after adding one or two weights so as to leave the surprise of the weights falling to the students when they are doing this.
4. Show students how they are to change the values of the two variables for this investigation:
    a. The amount of force used to stick the sticky note to the CD.
    b. The surface area of the adhesive part of the sticky note.

***Teacher Note:** The size or value of the first variable is difficult to quantify, whereas the second variable is easily quantifiable and can be tied to a math lesson on surface area if appropriate for your students.

5. As you again press on the sticky note to stick it to the CD, demonstrate how you can press gently, with a moderate force, and finally with a large force.

***Teacher Note:** These then will be the three values of the "force" variable: soft, medium, and hard. They are subjective terms and therefore not standard; i.e. not easily comparable from one group to another. You might use this concern to suggest that within each group, the same student should be the one to press the sticky note to the CD each time. This will minimize changing the value of force due to different students and keep the value the same as much as possible from one trial to the next. It also is a talking point to emphasize the importance of trying to keep all variables in an investigation the same except for the variable deliberately being changed.

6. To illustrate the second variable, make a large sketch on the board of the back of a sticky note, highlighting the part or area that contains the adhesive. Depending on the math experience of your students, tailor your presentation to their understanding of the area of an object. If your students have had little exposure to finding the area, you could simply call the amount of adhesive on the back of one sticky note, "one unit." Students could then cut the sticky note in half vertically to produce a note with one half a unit of adhesive and in quarters for a note with one-fourth a unit of adhesive. If your students are capable of measuring and calculating area, let them quantify area this way.
7. Hand out one How Strong Is It? Data Collection Student Capture Sheet to each student and go over it with the class. Identify and modify the units as necessary.
8. Before distributing the materials, have students make predictions about the outcomes they expect concerning both variables. This could either be done individually or in their assigned groups.
9. Distribute materials and let students begin; assist as needed.
10. When the groups have collected their data and cleaned up their materials, encourage them to examine their data to look for cause/effect relationships and to revisit their predictions. Can they explain their data? Did they discover any logical trends and patterns in their data? Can they extend their data to higher or lower values than what they tested?

Explain

1. Gather students together to summarize and discuss their results and conclusions. Use the following questions as discussion points.
    a. Can students develop hypotheses to explain their data?
    b. What parts of their procedures could they improve upon?
    c. Can students articulate a model or comparison to explain their results?
    d. Can students make a bar graph to communicate their findings to others?

Extend

1. Generally, the principle underlying this investigation involves fasteners or ways to hold two materials together. Challenge students to apply their findings to other situations.
2. With your supervision, some students might want to investigate the effect of heating (with a hair dryer) on the sticky notes' ability to stick to a surface and hold up weight.
3. What factor does time play on sticky notes' ability to hold up weight? How long can a sticky note stick to a CD before losing its grip?

Evaluate

***Teacher Note:** Have students answer the following questions on a piece of paper or in their science journal.

1. Which two variables did you investigate when you worked with the sticky notes?
2. What did the weights represent in this investigation?
3. Summarize what you found out about each of the two variables as they influenced the ability of a sticky note to stick to a surface.

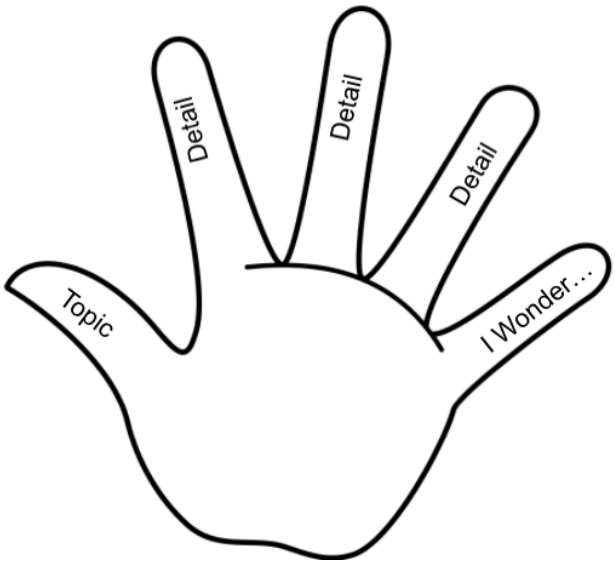
Teacher Scoring Key for Evaluate

1. We investigated the effect of how hard you pressed on the sticky note on how much weight the sticky notes could hold. We also looked at how the surface area of the sticky part of the sticky note affected how much weight it could hold.
2. The weights we used provided a force to pull the CD away from the sticky notes.
3. As we pressed harder on the sticky notes, it could hold up more weight. The larger the surface area of the sticky notes sticking to the CD, the more weight it could hold.

REFLECTION

Students will reflect on their learning by completing the Five Finger Summary. Print off the Five Finger Summary Resource, cut them up, and distribute one to each student. Alternatively, students may trace their hand on a piece of paper or in their science journal.

Students will fill in each finger as shown below:



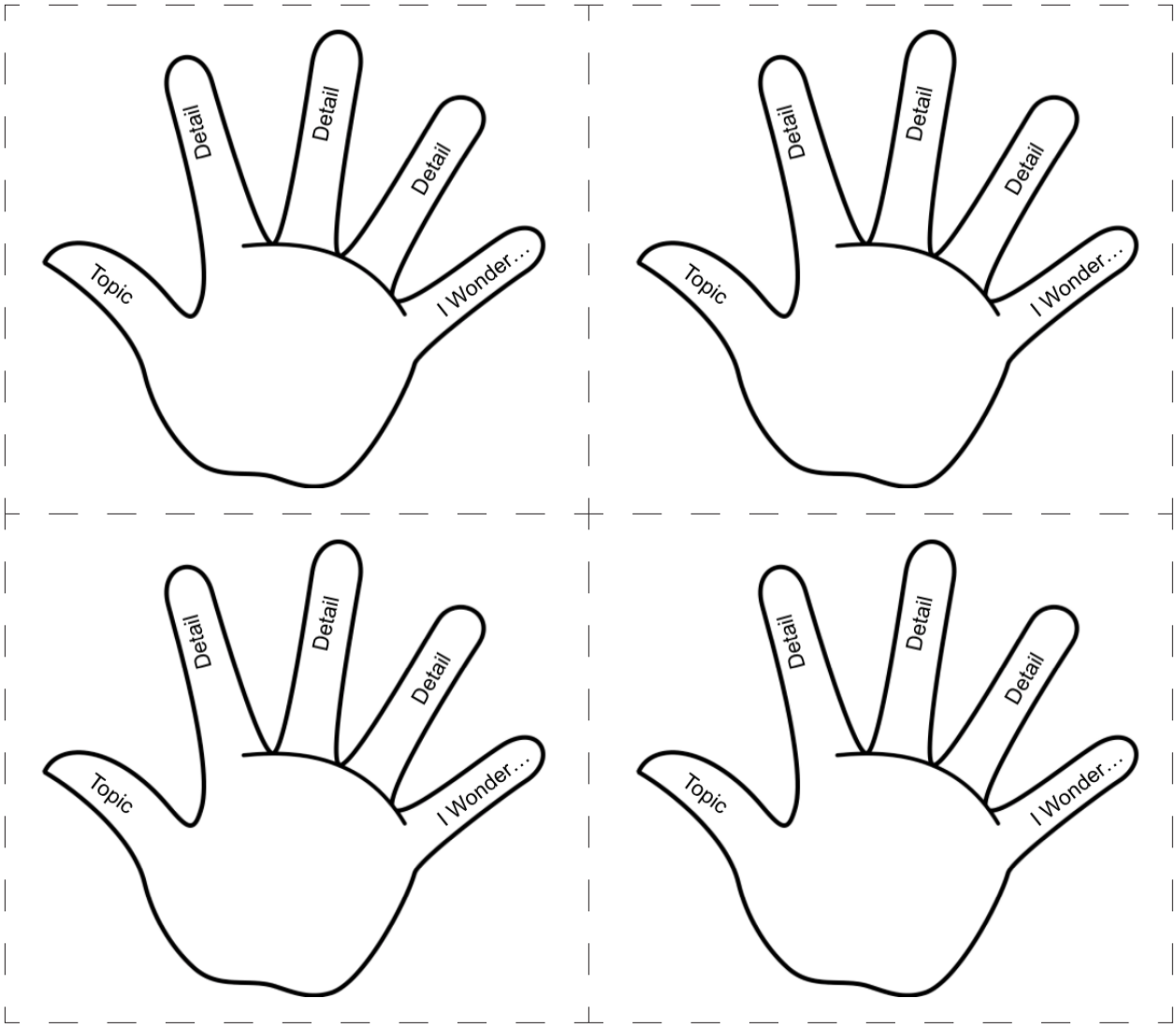
Weight Held vs. Force Applied

How Hard the Sticky Note is Pressed	Amount of Weight the Sticky Note Holds
soft	
medium	
hard	

Weight Held vs. Force Applied

How Hard the Sticky Note is Pressed	Amount of Weight the Sticky Note Holds

FIVE FINGER SUMMARY



HOW STRONG IS IT? ACTIVITY IMAGE

HOME CONNECTIONS

Parent/Guardian Background Information:

Materials such as masking tape, scotch tape, glues, and sticky notes that adhere to surfaces work because of the adhesive forces between two surfaces. Students make use of such items in their everyday lives and by investigating some of their properties of adhesion, these items can be used to develop and practice student inquiry skills in a fun manner. Students learn inquiry skills through curiosity, asking questions about the world around them, making observations and gathering data, and working to make sense of this data. Practicing these skills at home will greatly benefit your young scientist in countless ways.

Activities to do with your young scientist:

1. Weight It Down Activity: If you have an old CD, some string and weights, and sticky notes, have your young scientist demonstrate how they conducted their investigation at school. You could discuss what they found out and try to duplicate those findings at home.
2. Surface Area Activity: One of the factors or variables your young scientist investigated at school had to do with surface area; specifically, how much area on the back of the sticky note was covered with adhesive. Practice finding and comparing the area with items found around the home such as place mats, pictures, rugs, newspaper, etc. Area can be calculated using this equation: A = length (x) height.
3. Real-Life Area Activity: Can you and your young scientist find situations around the home where area is a factor in performance? For example: Snowshoes or skis? Holding a heavy object on the refrigerator with fewer or more magnets?
4. The Surface Matters Activity: Investigate what effect the type of surface has on a sticky note's ability to stick to that surface. Is there any way you and your young scientist could assign a number to the ability of the note to stick? For example: create a stickiness scale of 1-5 and determine the criteria for each number.