NanoLeap

Investigating Static Forces in Nature: The Mystery of the Gecko
Lesson 1: How Can a Gecko Walk on a Ceiling?
Engage

Student Learning Objectives:

- Make observations and interpretations of how the gecko's foot interacts with surfaces
- Formulate possible adhesive methods that might be considered for further investigations

At a Glance for the Teacher:

- Frayer Model: "What Are Your Ideas About Nanoscale Science?"
- Observations of *NanoSize Me* and *Tricky Feet* videos
- Comparison of observations and interpretations
- Observations of gecko images

Note: Some questions from the Student Journal are underlined as formative assessment checkpoints for you to check students' understanding of lesson objectives.

Estimated Time: 45–60 Minutes

Vocabulary: Adhere, Adhesion, Interaction, Interpreting, Macroscale, Mechanism, Nanoscale, Observing, Qualitative Observing, Quantitative Observing, Surface
Refer to the end of this Teacher Guide for definitions.

Materials:

- PowerPoint for Lesson 1
- Student Journal for Lesson 1
- Videos *NanoSize Me* and *Tricky Feet* found at: http://www.mcrel.org/nanoleap/multimedia/index.asp
- Computer with LCD projector
- Multiple colors of pens or pencils (optional)
- Optional: live geckos, aquarium, and crickets for an in-class introduction one week prior to the module.

Slide # Student Journal Page #	*Teacher Background Information and Pedagogy* **"Teacher Script"**
Slide 1 Introduction to NanoLeap Student Journal Page: 1–1 Student Journal Page:	Students will use a Frayer Model (Student Journal) to organize their thoughts about nanoscience. The Frayer model (Frayer, Frederick, and Klausmeier, 1969) is a word categorization activity that helps learners to develop their understanding of concepts[1]. Once students have had a chance to write down their thoughts, elicit student responses and record them on the board. Listen carefully to their answers, but do not provide feedback at this time. Acknowledge students answers by saying "Thank you for the comment." While students may not have much to report at this time, they will build upon and revise their responses in future lessons using this graphic organizer. Explain to students that throughout the module, they will be building upon what they now know to a deeper understanding of nanoscale science and technology. *1) Prior to showing the video, have students begin the Frayer Model by recording a definition of "Nanoscale Science" using their own words in the upper-left box.* **"We will begin our journey to the Nanoworld with a video. Before we do this, let's complete the chart in which you can record what you know about nanoscale science by listing examples and non-examples."** *2) Play the NanoSize Me video. During the video, students may record notes in the "Information" box of the Frayer Model. Video available at: http://www.mcrel.org/nanoleap/multimedia/index.asp. The purpose of the video is for student awareness of nanoscale science applications. It is not necessary for students to completely understand the content of each of the examples. However, some field test teachers recommended pausing the video and checking students' understanding by listening to student questions if time allows.* *3) Following the NanoSize Me video, have students modify their Frayer Model responses.* **"We will continue our journey to the Nanoworld with another video. In this module, we will be studying forces that are dominant at macro (visible world) and nanoscale (unseen world). The nanoscale is an extremely small scale, measurements can be made with the unit 'nanometer," which is one billionth of a meter."** *4) Show the thirty-second video "Tricky Feet." After showing the video, begin the script and PowerPoint slide. Video available at: http://www.mcrel.org/nanoleap/multimedia/index.asp. For the purposes of assessing prior knowledge, ask the scripted question below prior to Slide 2.* *Ask the students:*

[1] Barton, M. L., & Jordan, D. L. (2001). *Teaching reading in science: A supplement to the second edition of teaching reading in the content areas teacher's manual.* Aurora, CO: Mid-continent Research for Education and Learning.

1–2

Slide 2

Student Journal Page: 1–2

"How do you think these animals are able to crawl on walls and ceilings? *(Elicit student responses and have students record responses in their journal.)* **Scientists have been puzzled about this for hundreds of years, and only recently have they come up with possible explanations. Their new ideas came from measuring devices that can examine the gecko at a scale close to the size of individual atoms. That level is called nanoscale."**

5) Ask students to explain the characteristics of observations and interpretations. See explanations for each in the Characteristics of Observations and Interpretations. Have students complete the chart in their journal. Make sure students have included similar responses to those in the chart below. Provide some examples from everyday life in addition to the definition at the end of the Teacher Guide.

Characteristics of Observations and Interpretations—Sample Responses

Observations	Interpretations
Makes use of senses Makes use of instrumentation (when possible) Uses illustrations and labels Are statements and **not** questions Qualitative: Description of characteristics Quantitative: Numeric or measurements	Explains how/why based on what you scientifically observe May show diagrams or illustrations of how you think something works Bases explanation on scientific observation, experience, or something learned earlier (extant data) Are statements and **not** questions

6) Once the chart is completed, have the students classify the statements about the frog in their Student Journals. Emphasize the difference between qualitative and quantitative observations. Students complete the responses to the journal questions on page 1–2. **"For the picture of the frog above, label the following as observations (O), interpretations (I), or questions (Q)."**

Answer Key :
The frog is green. (O-Qualitative)
Why is the frog on the person's arm? (Q)
The frog is ready to jump. (I)
The frog is slimy. (I)
The frog has 2 eyes. (O-Quantitative)
The frog is hungry. (I)

Slide 3 Student Journal Page: 1–3	*7) Have the students make observations of the gecko images.* **"We are going to begin our investigation by making some observations of a gecko at the macroscale level. Write down as many observations as you can based on the images that you see on this slide. Look for similarities and differences among the images. Record your observations on the left side of the chart in your journal."** *Circulate around the room and assist students with questions. If students ask, state that the gecko in image 1.2 is on a vertical surface, while the geckos on images 1.1 and 1.3 are upside down on a horizontal surface. Students may have questions about the surface of image 1.3. Ask students to take a closer look at the feet on this image in order to describe the surface. This can be an interpretation listed in their journal.* *Note to teacher: The gecko is adhering to glass in image 1.3.*
Slide 4 Student Journal Page: 1–3	*8) Ask the students:* **"Now that you have made observations about the gecko and the surfaces, it is time to write down some interpretations of these images. Record your interpretations on the right side of the chart."** *The degree of inquiry from these observations and interpretations can be adjusted with the degree of response prompted by the teacher. If students do not describe the surface in their observations, you may want to ask them what kind of surfaces the gecko is adhering to.* *9) Have students work in groups to make comparisons—this can be optional if you are running out of time. If so, proceed to step 10.* *Optional:* **"Working in small groups, exchange and share your observations and interpretations with others in your group. Devise a system for keeping track of each other's responses in your Student Journals. Note any similarities."**
Optional 	*Once students have had a chance to make some individual observations, allow them to gather into a small group to compare their observations. Have the students report out using white boards with two columns: Observations and Interpretations. Spend about 5–10 minutes on this sharing out.* *Encourage students to include any new observations and interpretations made by their classmates that they themselves did not make. Provide different colored pencils or pens so that students can differentiate between their own observations and interpretations and those of their classmates. For instance, students could use one color for their own observations, and another color for their own interpretations. A third color could indicate observations made by other students, and a fourth color for others' interpretations.*

Slides 5–6 Student Journal Page: 1–4	*10) Allow students time to observe images. Then, begin debriefing students with the questions on Slides 5 and 6* 1. What do the images have in common? *Each image has a gecko that is "sticking" or "adhering" to a surface. In the second image, the gecko is hanging on the smooth underside of a piece of transparent surface. Since the surface is clear, it may not be a direct observation; however, students might interpret this.* 2. What do you observe about the surfaces and textures in these images? *In the field test, some students said that the surface appears to be "smooth," while others said "rough." Some field test students identified the substances as wood, plastic, or glass.* 3. What do you interpret about how the gecko's foot interacts with the surface? 4. What questions do you have or additional information do you need to know in order to understand what makes a gecko adhere to surfaces? *Allow students to work in their groups to make a list of topics they would need to know more about in order to understand what is happening.* **"We will be investigating many of these questions in future lessons."** *Note: You may want to use the flow chart on slide 8 to show future lesson topics related to their questions.*
Slide 6 Student Journal Page: 1–4	5. What are some possible methods for the gecko to adhere to a surface? *Possible answers from the pilot test include: suction cups, sticky feet, glue, sharp claws* 6. Describe how you made your observations in today's lesson. *Observations: a. eyes, b. visible, c. gravity* 7. What variables affect the force between the animal and the surface? *Students might state: distances apart, mass, surface-area contact, moisture, cleanliness*
Slide 7 Student Journal Page: 1–4	*11) Students might have questions about the gecko in the images. If so, you may provide information similar to what is described in the script. Debrief the groups' responses by recording them on the overhead, white/chalk board, or chart paper. These should be kept for the essay assessment at the end of the module. Student responses regarding the possible methods of gecko adhesion will vary. Some may include the following: claws, suction, friction, water, secretion (glue-like substance), Velcro-like substance on the foot, or static electricity. It is all right if students don't mention all of these at this time; however, many of these have already been considered (and evaluated) by scientists.* *At the end of each lesson, hold a short discussion with questions from the "Making Connections" slide. These questions are intended to be used by the teacher as a formative assessment and to allow students to connect key information to what was learned in previous lessons.*

	**"Geckos are small reptiles found in the tropics. They are often observed in the strangest places, because they stick to just about anything. Geckos are known for their remarkable wall-climbing ability. The method for adhesion is not well established. How do you think the gecko adheres to a vertical surface or a ceiling?"** **"Making Connections: The questions here are a chance for us to discuss what was learned during this first lesson."** 1. **"Describe one or two ideas that you learned during this lesson."** 2. **"How do you think the gecko sticks to the ceiling?"** 3. **"What should we explore next?"** (*If students suggest something outside the scope of the module, encourage them to try some of these ideas at home.*) **"In the next set of lessons, we will investigate this phenomenon to better understand how the gecko adheres to a surface."**
Slide 8 	*12)* *The pilot-test teachers highly recommend using this flow chart at the end and/or beginning of each lesson. The end of each lesson contains this flow chart that provides an opportunity to show students the "big picture" and where they are in the lesson sequence. The following color code is used:* *Yellow: Past Lessons* *Blue: Current Lesson* *Green: Next Lesson* *White: Future Lessons* **"In the next lesson, you will take a closer look into the role that the amount of contact between two surfaces is to better understand what is happening."**

Appendix: NanoLeap Physical Science Vocabulary for Lesson 1

Adhere
1. To hold fast or to stick
2. To bind to

Adhesion
1. The attraction exerted between the surfaces of objects. Can be either mechanical (e.g., suction, microinterlocking, friction) or intermolecular (e.g., electrical and magnetic)
2. Objects in contact: steady or firm attachment of objects

Interaction
1. Mutual or reciprocal action or influence (contact)
2. How one thing affects another

Interpreting
To explain or tell the meaning of

Macroscale
1. The length scale that is observable with the unaided eye
2. The description of objects and actions at a size visible to the unaided eyes

Nanoscale
1. The scale between systems of a few atoms and continuum systems
2. The description of objects and actions that occur at sizes of 1–100 nanometers (the size of a few atoms)

Observing
Using human senses and/or instruments to recognize, note, or describe a fact or occurrence, often involving measurement with instruments

Qualitative Observing
When someone describes an object or phenomenon using their own senses (e.g., seeing, hearing, smelling, touching, tasting)

Quantitative Observing
When someone measures an object or phenomenon using an instrument other than their own senses (e.g., ruler, scale, thermometer, etc.)

Surface
The exterior or boundary of an object, immediately adjacent to the air or empty space, or to another body