Next Gen **PET**

Teaching and Learning Extension H

Facilitating Investigations - Preparation for Lesson 5

Purpose and Materials Needed

This activity includes the following sections.

1. Video Analysis Guide. This includes instructions for how to access the video, an overview of the Engineering is Elementary unit *A Long Way Down: Designing Parachutes* and questions to guide your observations.
2. Transcript of video
3. Reading about NGSS Practice 3: Facilitating Investigations

Video Analysis Guide

The video you will watch in this activity comes from a unit in the Engineering is Elementary (EiE) curriculum called "A Long Way Down: Designing Parachutes." In this unit, elementary school children learn about drag (air resistance) and apply this knowledge to designing a parachute that will land a payload on a planet that has an atmosphere that is thinner than Earth's atmosphere. The unit contains four lessons:

- *Lesson 1*: The children read a story about a boy who is faced with the engineering challenge of designing a parachute that can land a large fruit on the ground from the height of a forest tree.
- *Lesson 2*: Children learn about temperature, atmospheres, and surfaces of planets and imagine how spacecraft might be designed.
- *Lesson 3*: Children learn about air resistance and test three variables.
- *Lesson 4*: Students design and test parachutes.

More information can be found at: [A Long Way Down: Designing Parachutes]
Note that you need an account to access the online materials.

Analyzing the video

In the video you will be watching, children will be engaged in an engineering design challenge. [In Extension I, you may be guiding students through a modified version of this investigation.]

The overarching (engineering) challenge is to design a parachute that will land a payload softly on the surface of the planet. This engineering problem led to identifying three variables: 1) canopy material, 2) canopy size, and 3) length of suspension line.

Watch the video *Slow and Steady Wins the Race*. (Click the link to open the video in a browser.)

The transcript is at the end of this activity. First, however, read the chart for student expectations for this practice at the end of this activity. Keep these expectations in mind as you watch the video.

While you watch this video, make notes of what kinds of activities the students are doing and what the teacher is doing to **facilitate** the students' investigations. Write your observations in the following table.

Time	Students Actions	Teacher Actions

What were some things you noticed the students doing?

What were some things you noticed the teacher doing?

EiE Parachutes Lesson 3: Slow and Steady Wins the Race Transcript

This transcript is for a video that is part of the online resources for the Engineering is Elementary (EiE) curriculum. The video can be found online at:

https://youtu.be/NH8tFtN95sQ

Whole Class Discussion

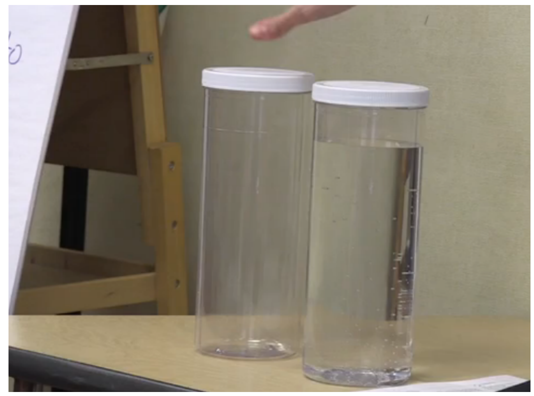
[00:20.00] Teacher: So, let's start by thinking a little bit about yesterday. We want to reflect back. What steps of the engineering design process did we use yesterday? Matthew.
[00:31.00] Matthew: Ask and imagine.
[00:34.00] Teacher: Yeah, we did the ask and imagine yesterday. We're going to move on and we're going to continue thinking about asking and we're going to continue thinking about imagining with this lesson. We're going to be going off of this question. This is kind of our key question to be thinking about throughout the day today. So, who wants to read it?
[00:51:00] Student: How do thickness of an atmosphere and the design of a parachute affect the speed of a falling parachute, páraquedas?
[01:03:00] Teacher: Okay, let's just hear a few ideas. Let's just go with the first part. How does thickness of an atmosphere affect the falling of a parachute? Jonathan.
[01:11:00] Jonathan: It just makes the parachute float in space 'cause the atmosphere is not like pushing it down. It's just like going everywhere, it's not like pushing it down.
[01:25:00] Teacher: Are you talking about like if it was on the moon where there is no atmosphere, it would just kind of go off into space?
[01:28:00] Jonathan: Yeah.
[01:32:00] Teacher: Okay so, on Earth we have an atmosphere and on other planets there is a thicker or thinner atmosphere from what we saw. Venus has a much thicker atmosphere than Earth. If we were to drop a parachute down on Venus, would it go slower or would it go quicker than if it was on Earth? Obdi, what are you saying?

[01:51:00] Obdi: Slower.

[01:52:00] Teacher: It is going to drop slower 'cause it's thicker. There's more particles for it to push out of the way, right? Let's do this. We're going to go and we're going to kind of look at another example of the thickness and thin atmospheres okay? And how things might fall in that. So, I want you to quietly push in your chairs and go sit on the rug.

Jar Demo

Student explaining why a parachute would fall faster in air than in water



Two jars of different atmospheres

[02:09:00] ((Students sitting on rug))

[02:10:00] Teacher: I have two different jars, okay. What do you notice about the jars? What do you notice and what's in them? Logan?

[02:15:00] Logan: One is empty and one has water in it.

[02:19:00] Teacher: Okay, one has water in it. Is this one empty though? (pointing to the jar without water).

[02:22:00] Class: No.

[02:23:00] Teacher: What is in it?

[02:23:00] Class: Air.

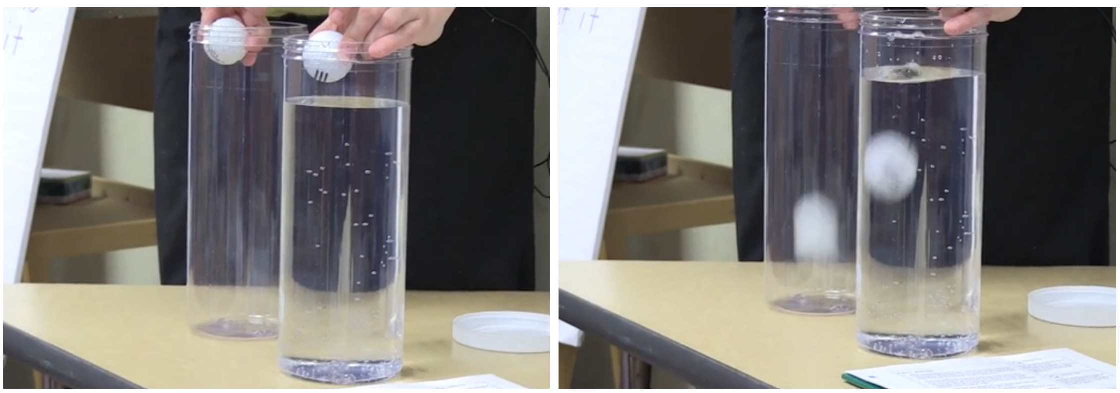
[02:24:00] Teacher: Air is in it. That's a really good thing to keep thinking about. There are particles floating around in there and so which one do you think is going to be our thinner atmosphere?

[02:34:00] Student: The one with the air.

[02:37:00] Teacher: The one with the air? The one without the water? Why do you think that?

[02:29:00] Student: Because, like you said, if we drop a parachute over here since this is filled with air it would kind of go faster like it's thinner or something. I don't really know how to explain it.

[02:56:00]Teacher: So you think if something were to drop in here [pointing at jar with air], it would go faster than if you were to drop something in here [pointing to jar with water]? Okay, predict. [holding one ball over each]. Which one is going to hit first?
[03:02:00]Class: The air one.
[03:04:00] Teacher: Okay ready, count down for me.
[03:06:00] Class: Three, two, one, drop.
[03:11:00] Teacher: Which one fell first?
[03:13:00] Class: The air.
[03:17:00] Teacher: I mean, not which one fell first, which one got down to the bottom first?
[03:17:00] Class and teacher: The air.


Class demo testing the difference in drop rates for thicker and thinner atmospheres.

[03:20:00] Teacher: How did mom, I should say in the book, test out her technologies? When she was testing things out, she said she can't actually go up in space to these planets. She's an engineer on Earth. So she's working with people, but she couldn't go there so what did she do? Kira?
[03:42:00] Kira: She was using like the water for the thicker atmosphere maybe.
[03:48:00] Teacher: Why do you think it's important to make a model?
[03:50:00] Student: Because if you don't test it, it might not work when you need it.
[03:58:00] Teacher: Would you want to be the person that goes up to the moon for the first time and they haven't ever practiced it or tested it in model situations like this. And they're like, okay, this is the first time we've done it. Go and practice.
[04:10:00] Class: No.
[04:11:00] Teacher: No, so it's really important 'cause they need to see if it'll work. From what we've just talked about and with the golf balls and

with Sydney's example, parachutes will fall more slowly in what kind of atmosphere? Logan?

[04:21:00] Logan: A thicker atmosphere?

[04:24:00] Teacher: Does everybody agree with Logan that it's going to be a thicker?

[04:28:00] Class: Yeah.

[04:29:00] Teacher: Yeah. Parachutes are going to fall more quickly in what type of atmosphere?

[04:30:00] Class: Thinner.

[04:33:00] Teacher: Okay. What step in our engineering design process are we using when we are doing all of this?

[04:39:00] Student: Ask.

[04:40:00] Teacher: Yeah. Are we asking a lot of questions?

[04:41:00] Student: Yeah.

[04:42:00] Teacher: We're asking a lot of questions and then we're answering a lot of those questions with practicing different things, okay? The challenge that I'm going to give you today is that you are going to be aerospace engineers just like Mie in the story and you are going to be developing a parachute that they need to include on a space craft. We can't make a real one, like an actual one, because we don't have enough room in here. We're going to have to make a what?

[05:08:00] Student: A model.

[05:09:00] Teacher: We're going to have to make a model and we're going to have to go through our steps of the engineering design process, which the first one is?

[05:16:00] Student: Ask.

[05:17:00] Teacher: Asking questions and then once you do that you're going to

[05:20:00] Class: Plan. Imagine.

[05:21:00] Teacher: Imagine. And then after that part, you're going to

[05:25:00] Class: Plan.

[05:26:00] Teacher: Plan. And then after that part, you're going to

[05:28:00] Class: Create.

[05:29:00] Teacher: Create. And then the last thing, you're going to

[05:32:00] Class: Improve.

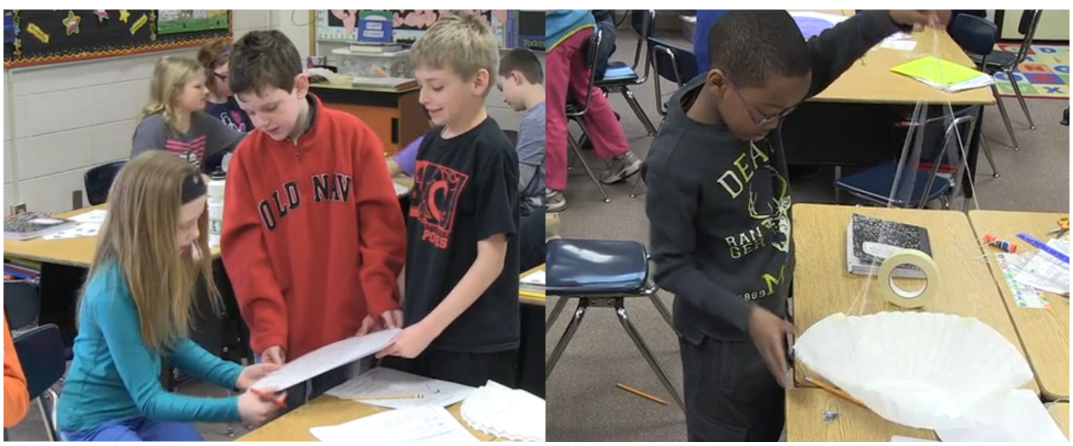
[05:33:00] Teacher: 'Cause you're going to create and try it out and then we're going to improve on it. So, what is your mission? Matt?

[05:41:00] Matt: To build a parachute that will help us land in any planet that we need, thicker or thinner

[05:49:00] Teacher: Well, especially a what? What did I say? Especially what kind of atmosphere?

[05:52:00] Student: Thin?
[05:53:00] Teacher: Especially a thinner atmosphere, but you're going to be building a parachute. There's three key things that we're going to be thinking about then today. Canapé materials, what is it made out of? That's one of our variables that we are going to test. So, we have our three main parts: our canapé, our suspension line, and our load. You're going to be doing about three trials so if you didn't get to see canapé size 'cause you did canapé material, you're going to have seen it in process in the back. We're going to go through it and then we'll be able to differentiate and talk about how these things affect it, how did it matter? Did it make things go faster, did it make it go slower?

Constructing Parachutes – multiple groups



Students make parachutes and each group changes one variable (e.g. canopy size, canopy material, and suspension length).

[06:30:00] Student: That's good enough, that's good enough
[06:32:00] Student: Yep.

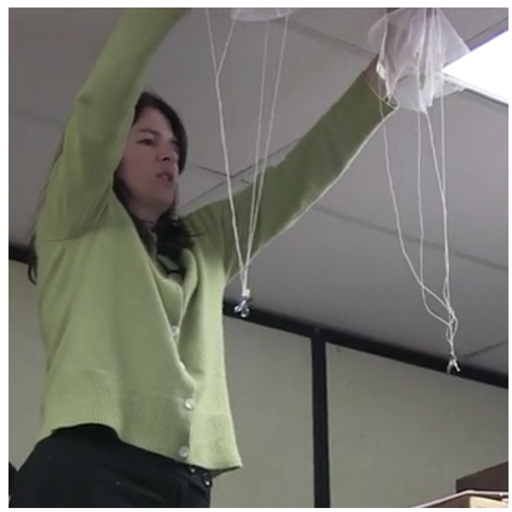
[06:36:00] Teacher: So, I would you know if you want to measure them out and see.

[06:39:00] Student: If you hold it like that, look it, that one's shorter.
[06:43:00] Teacher: Well, are you holding it at a different, is it at a different angle so it's going up? So, how can you test it to check and see for sure? What could you use?
[06:52:00] Student: A measure.
[06:53:00] Teacher: Yep, use a ruler.

[06:55:00] Logan: I'm going to cut.
[06:56:00] Student: Logan wait. No. Let me make a crease.

[06:59:00] Student: Put the string right there. Then, tape it down.
[07:06:00] Student: I got it, tape it.
[07:09:00] Student: There.

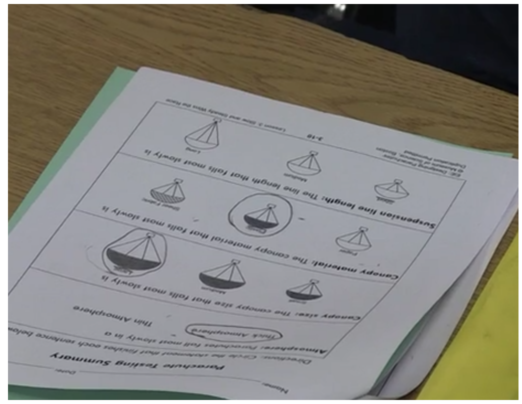
Class Data Collection and Sharing Results

Groups each present their findings and teacher helps the whole class collect data to identify the relationship between the variable each group changed for their parachutes and the drop rate.

[07:10:00] Teacher: As we're dropping these, we want to be at about the same height and do you think as I'm dropping I'm going to have the canopy lined up right with this part here – it's about seven feet – or am I going to have the load lined up with that part? If I have the canopy lined up here, what about the people with suspension line differences? The load's going to be what?
[07:34:00] Class: Different.

[07:36:00]	Teacher:	The loads are going to be different and we want the loads all to be at the same height. So, what do you think I'm going to line up at the top of this?
[07:42:00]	Student:	The load.
[07:43:00]	Teacher:	The load. Alright, so we'll do three trials. Look at what they've got. So, what material does Ava have?
[07:54:00]	Class:	Coffee filter.
[07:55:00]	Teacher:	Coffee filter. What material does Justin have?
[07:57:00]	Class:	Plastic.
[07:58:00]	Teacher:	Plastic. K, and what material does Ty have?
[08:00:00]	Class:	Fabric.
[08:01:00]	Teacher:	Fabric, so this is like a sheer fabric. Okay, so. Count down. Oh, that one's twisted.
[08:05:00]	Class:	Three, two, one.
[08:12:00]	Teacher:	Alright, let's do two trials of the canopy size. Which one do you think will drop first?
[08:20:00]	Student:	The smaller.
[08:22:00]	Teacher:	The smaller? Why?
[08:24:00]	Student:	Because it's got less weight.
[08:26:00]	Teacher:	Okay.
[08:27:00]	Class:	Three, two, one, launch off.
[08:33:00]	Student:	Woohoo.
[08:34:00]	Teacher:	So which one fell first?
[08:35:00]	Class:	Medium.
[08:36:00]	Teacher:	Okay, move back.
[08:37:00]	Class:	Three, two, one, launch off.
[08:39:00]	Teacher:	Which one fell fastest?
[08:41:00]	Class:	Mini.
[08:43:00]	Teacher:	Which one fell the slowest?
[08:45:00]	Class:	Biggie.
[08:46:00]	Teacher:	The biggest, okay.
[08:47:00]	Class:	Three, two, one, blast off.



Student explains why the larger parachute takes longer to drop and the teacher leads a class discussion about the meaning of their findings that students explained using the Parachute Testing Summary worksheet.

[08:50:00] Teacher: We're going to go through this; we're going to talk about what we observed; we're going to reflect quickly on it. The thick atmosphere is where it falls more slowly because there is more particles.

So, do you think ideally the canopy size, the bigger one fell more slowly or the shorter one?

[09:06:00] Student: Large.

[09:07:00] Teacher: You think the large. What do you think Logan?

[09:08:00] Logan: Umm, the large.

[09:11:00] Teacher: And why do you think that is? It went back to, I think Owen or Caleb said it.

[09:15:00] Student: The large, the canopy can hold more and so that will make it fall more slowly. If the small one doesn't have enough air like the large, it will just quickly go down and not get enough.

[09:32:00] Teacher: Okay, so that surface area of the canopy had a big impact on it. There was more resistance or more drag because it had more surface for the air to be captured under right? So we, so far to summarize, have thicker atmospheres, larger canopies, plastic or less holes in the material make it fall slower. So, look at that information you have there now and keep that in mind because tomorrow – now we've played around with materials and all this – now tomorrow, you're going to be given just some materials and you'll have to pick and choose as a group and you're actually going to design a parachute too. You're going to draw out your designs individually and you're going to collaborate with a team and decide which designs and pieces do you want to go with, and you're going to create them. And you'll have other options besides just the three types of material that we picked today.

[10:27:00] Teacher: [Reflecting on the lesson…] In lesson three when they collected data to use for the next lesson when they are actually creating their parachutes, I think getting the kids hands-on and having them develop them, and then sharing the data they collected – cause each group did a different variable or a different factor, so one group just did canopy size, one group just tested canopy material, and one group tested suspension length. So, I think them sharing their ideas was really useful because they had to give an explanation or they had to be able to help the other groups out with it. I think the way that I helped with it was making a lot of connections the next day back and forth between what they had learned. I think that's one of the most important things is to just keep referencing back to what they did and make those connections.

Practice 3 Expectations

Carrying out investigations

"Students should have opportunities to plan and carry out several different kinds of investigations during their K-12 years. At all levels, they should engage in investigations that range from those structured by the teacher – in order to expose an issue or question that they would be unlikely to explore on their own (e.g., measuring specific properties of materials) – to those that emerge from students' own questions." (NRC Framework, 2012, p. 61)

Scientific questions often lead to investigations. In this activity, you will be conducting a short activity with a group of students based on a lesson plan provided.

Grades K-2 Expectations	**Grades 3-5 Expectations**
Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions. • With guidance, plan and conduct an investigation in collaboration with peers (for K). • Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence to answer a question. • Evaluate different ways of observing and/or measuring a phenomenon to determine which way can answer a question. • Make observations (firsthand or from media) and/or measurements to collect data that can be used to make comparisons. • Make observations (firsthand or from	Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K– 2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. • Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered. • Evaluate appropriate methods and/or tools for collecting data. • Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. • Make predictions about what would happen if a variable changes. • Test two different models of the same proposed object, tool, or process to

media) and/or measurements of a proposed object or tool or solution to determine if it solves a problem or meets a goal. • Make predictions based on prior experiences.	determine which better meets criteria for success.