Next Gen PET

Teaching and Learning Extension M

# Engaging in Argument from Evidence: Preparation for Activity 8

## Purpose

This extension activity has the following sections.

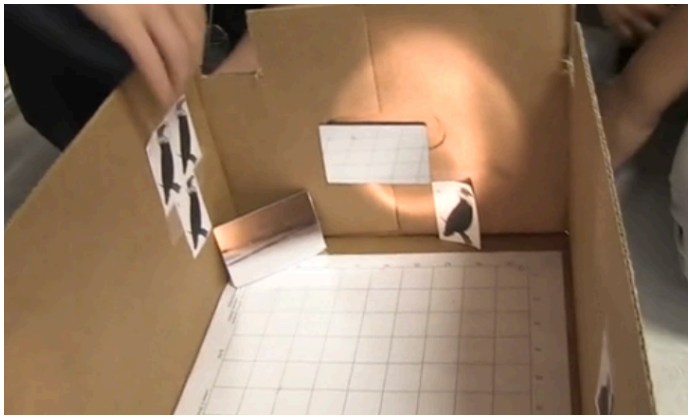
1. Video Analysis Guide. This includes instructions for how to access the video and questions to guide your observations.
2. Transcript of video
3. Reading about NGSS Practice 7: engaging in argument from evidence.

## Video Analysis Guide

Watch the video *Designing a Lighting System, Grade 5*. The video for this activity is presented in two parts.

Designing a Lighting System (Grade 5) Part 1
Designing a Lighting System (Grade 5) Part 2

These two videos describe the fourth lesson of the Engineering is Elementary curricular unit *Lighten Up*. The design challenge is for children to design a lighting system to light an Egyptian tomb (represented with a cardboard box). They will determine how well their system works by how well they can see hieroglyphics of vultures when looking through an eye hole.



Prior to this, they have investigated how materials interact with light and learned to use a tool to measure intensity of light. This tool is a plastic sheet with four different shades of grey. The students look through the sheet and identify the darkest shade of grey that they can look through and still see the eye of the vulture.

One of the things that the teacher does is create a system for scoring designs along a set of constraints and goals. They are awarded so many points if the cost is kept down and other points for being able to see more hieroglyphs, and seeing them more clearly.


How does creating a set of criteria to score design solutions help students compare solutions?


Identify a time in the Part 1 video where the scoring criteria facilitated these specific actions: (1) comparison across multiple groups' solutions, (2) guide design of solution, and (3) prompted students to recognize directions for improving their solution.

| Time | Actions facilitated by scoring system | Brief description |
|---|---|---|
| | | |

In Part 2 of the video, the students examine each other's solutions

Watch the Part 2 video and note what specific questions and comments students make about *other students'* designs (note these in the column labeled Students' Actions in the table below)? Refer to specific line numbers in the transcript. Do the same for the teacher actions in the column labeled Teacher Actions in the table below.

| Time | Students Actions | Teacher Actions |
|---|---|---|
| | | |

Look at the chart for student expectations for this practice. Which expectations of the practices did you notice students engaged in? Fill in the table below with the expectations you identify and the time from the transcript.

| Expectation | Time |
|---|---|
| | |
| | |
| | |

**EiE Light Lesson 4: Designing a Lighting System—Part 1**
**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

Designing a Lighting System (Grade 5) Part 1

00:00:00.00] TEACHER: So our guiding question for today is up on the screen. This is what we are trying to do today. So we're thinking about How can we use our creativity and what we've learned about how light travels, what we know about reflection, and what we know about intensity to design a lighting system for the inside of a tomb. That is a really big challenge. It's a combination of a lot of things. What do we already know that's going to help us today. Zachery, give me one.
[00:51.15] STUDENT: Reflection
[00:55.08] TEACHER: So we're going to use what we know about reflection. We're going to use
[00:57.23] STUDENT: What we know about intensity.
[01:00.29] TEACHER: What you know about intensity. You're going to use.
[01:03.28] STUDENT: Our creativity
[01:03.28] TEACHER: Your creativity. And the fourth thing?
[01:06.28] STUDENT: How light travels.
[01:10.01] TEACHER: What you've learned about how light travels. So you're going to combine all of those ideas. And what are you designing today?
[01:15.21] STUDENT: A lighting system
[01:17.08] TEACHER: A lighting system for the inside of a tomb. Very good. Would you say that a system is a type of technology?
[01:25.28] STUDENT: Yes
[01:27.24] TEACHER: Who can give a reason why they're saying yes? Why is a system a type of technology? Ianna?
[01:32.29] STUDENT: Cause you use it for things.

[01:35.13] TEACHER: Right and so the main idea behind a technology is that a technology is anything that

[01:42.28] STUDENT: helps you

[01:42.28] TEACHER: Helps you solve a

[01:44.12] STUDENT: problem

[01:44.12] TEACHER: a problem. A solution to a problem. So if our lighting system is solving a problem, then that makes it a technology. Good. Alright so um we remember our tombs. We know that our goal, our criteria is to be able to provide enough light, most intense light to each of the hieroglyphs so we can see each one most clearly. And the way that you know can see the hieroglyphs clearly is that you're able to see the details of the vulture hieroglyphs. Turn and tell person next to you, what are the three ways that light interacts with a material?

[02:23.22] STUDENT: reflect, absorb, or go through.

[02:30.02] TEACHER: When light bounces off a material, we call that Madison?

[02:32.23] STUDENT: Reflection

[02:32.23] TEACHER: Reflection, good. When light can't go through, is stopped by a material, we call that, Carolee?

[02:38.08] STUDENT: Absorb

[02:39.21] TEACHER: Absorb, good. Or absorption. And if light goes through a material?

[02:44.20] STUDENT: Transmission. Nice job Adianna. So looking up on the screen we've got this organizer. What do we call that cycle, Sean?

00:02:56.28]STUDENT: the engineering design process

[02:57.16] TEACHER: The engineering design process, right. And so we've already asked, or we've already seen how Omar asked his question and how he imagined and planned out his solution and how he created a lighting system to help with his performance. Did Omar in the story get a chance to improve it?

[03:17.04] No because the first time they tried it was when the performance was actually starting. So you're going to get an extra opportunity beyond what Omar, what we saw Omar do because you are going to get for improvement today.

SMALL GROUPS

[03:32.16] STUDENT: Reflect light. and make sure the hieroglyphs are all at like zero are showing as bright as we can possibly make them.

[03:51.14] STUDENT: Light reflects on reflective object.

[04:09.27]STUDENT: Some things we know about our lighting system. Light travels in straight lines, yep. Glass or metal objects. Hmm. How will you evaluate the lighting system. By a total.

[04:25.01]TEACHER: Okay let's get into these materials. If you would carefully take the materials that are in the bag out. These are all the materials that are available to you to use. Your design might only use two materials, but several of those two materials. Your design might use five materials but maybe only one of each. It depends on what your group is imagining what would work best. So we need to be thinking about how might you use these materials, how might you assemble them, combine some of them together how might you use them separately? How might you get them to best be able to complete your lighting system.

SMALL GROUPS

[05:08.15] STUDENT: I don't think we should the big mirror

[05:11.13] STUDENT: We should get like one or two of those and then like the small

[05:14.00] STUDENT: No, cause the small mirrors are a dollar each. If we get four small mirrors, that's four dollars. And if we get two

[05:15.07] STUDENT: two. That's only eight

[05:26.20] STUDENT: That's eight dollars. We're not going to spend that much money. That's a lot of money. That's a lot. And that's over $7 and that's only a score of 1. We're trying to keep it lower, not high.

[05:40.28] STUDENT: We can buy. We can buy one big mirror and then one small mirror and maybe something than fifty cents or fifty cents.

[05:50.07] STUDENT: We can get a mirror, some tape and maybe a popsicle stick.

[05:57.17] Teacher: You can put something on the floor of your tomb, so down into the box and it can stand up or lean or however it's going to work. You can attach things to the walls of your tomb, and you can hang part of your system from the ceiling. You're going to need to use the grid that's on the floor and on the ceiling to help you figure out placement if you're hangning something from the ceiling. So now that you've been thinking about what you might use, and how much of it you might need, you need to draw right on this grid. Here' s how we think we might set it up.

[06:32.07] STUDENT: if we put one right here, it's almost like on that one, so that means we can just put one right here

[06:37.08] STUDENT: No, cause we don't need one from right here, cause the light, the light source is already shining on A.

[06:43.04] STUDENT: Okay, so

[06:45.15] STUDENT: So A's fine, we just need to figure out out and like I was talking about how

[06:49.19] STUDENT: So we can do we can just put a mirror right here so

[06:52.00] STUDENT: No I was talking about how, putting a mirror like here

[06:54.04] STUDENT: So actually we need two.

[06:57.16] STUDENT: Right here and so the light, and we can angle the light like this, so then the light will reflect off this mirror and go to C and we can put another mirror over here so it can go over here.

[07:10.07] STUDENT: That's why it's going to come out to $3.40. So that's cheaper, that's less than $3.50 which we wanted to be at so.

[07:19.11] STUDENT: and if we needed to add anything, we can do it.

[07:21.00] STUDENT: and if we put one on the bottom, the reflect

[07:28.03] STUDENT: Maybe if we put one on the bottom and have these big ones

[07:33.23] STUDENT: You could put a slanted on one the bottom cause remember the first time we put it on the bottom

[07:39.16] STUDENT: Try to put a binder clip under it

[07:42.01] STUDENT: yep

[07:42.01] STUDENT: Put it slanted, they made it stay.

[07:47.12] STUDENT: Reflect off of it, and then maybe

[07:52.18] STUDENT: Yeah, cause you see some things and then having the other one around it, that would work too.

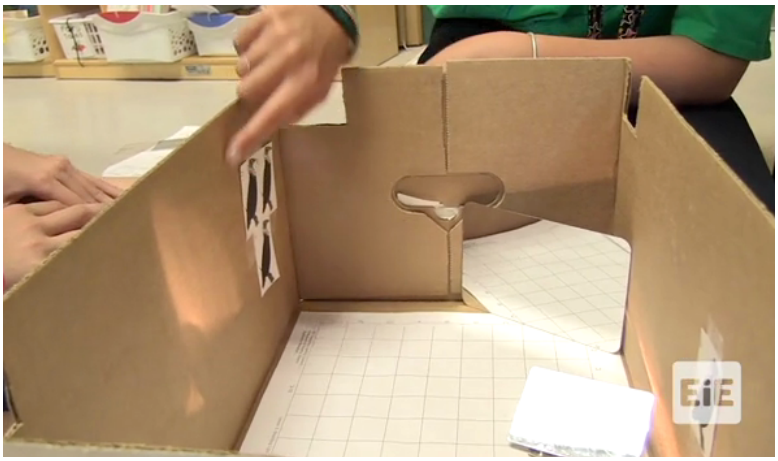
TEACHER INTERVIEW

[07:59.05] TEACHER: I like in lesson 4 that the students get some validation for their own ideas and that I always try to reiterate that there's no one right answer cause a lot of students get really hung up on well what's the right way to do this? And I realize that if I divulge too much, I'm taking that experience away from them. So in lesson 3, lesson 4 rather, the groups of 3 us really a great way to work cause even if you have one student who doesn't feel as strong, you've got two there who are going to support them and let them, again, letting them choose their own grouping, they're are going to pick some kids that they feel familiar with and that the risk taking becomes less risky and more open. More familiar. If one child is off, the other will make up for it and say, "no no no - we forgot to plan it out" or "we forgot to - you know you can't go to plan and pick materials yet, because we have to imagine what's going to work." So, you know with a group of three, it's a good dynamic, because they can kind of keep themselves in check.

**EiE Light Lesson 4: Designing a Lighting System—Part 2**
**Transcript**

Designing a Lighting System (Grade 5) Part 2

[00:18.06] TEACHER: Alright, Danielle, needs? three small mirrors, a craft stick, here's your tape, here's your ruler for measuring the tape, your string or your yarn is in here.
[00:35.24] (Students putting solutions together)
[00:44.13] STUDENT: And we can get on to here
[00:44.13] STUDENT: It's going to be more darker when it's like, when the lights going
[00:51.29] STUDENT: But then you're covering up that one.
[00:54.20] STUDENT: oh yeah. So we're going to have to put the mirror right here and get this mirror out of the way.
[01:01.18] STUDENT: and then we can put a mirror in here, angle it.
[01:06.28] STUDENT: yeah I was going to say we can put one right there
[01:08.09] STUDENT: we can put it here
[01:08.09] STUDENT: you can tape something to it, and it would like keep it. We could use
[01:17.24] STUDENT: Okay so
[01:21.00] STUDENT: it can go over
[01:21.00] STUDENT: So we can break this in half and put tape and then
[01:22.27] STUDENT: Do you have scissors?
[01:26.09] STUDENT: Yep, that's good. Abby, look it, there's a reflection over here Abby.

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[01:38.02] STUDENT: We just got to move it. We missed one because the mirror is blocking it.
[01:42.08] STUDENT: Maybe if we stand it - I don't know if that would work or not.
[01:50.24] STUDENT: Look it!
[01:53.12] STUDENT: See, it's not on B. You can't see B barely
[01:56.10] STUDENT: No, it's not on B. It's on everything except B, D, E and F.
[02:01.16] STUDENT: I think that it's a 3. Zeek?
[02:05.13] STUDENT: yeah it's a 3
[02:10.04] TEACHER: Okay so let me just ask you why? What are you noticing that you're saying "okay we need another mirror?"
[02:17.29] STUDENT: Because we can light up this one, this one, and this one. But, that one doesn't - this falls and this doesn't get either
[02:27.29] TEACHER: okay so what you're actually doing, because you're so advanced in your engineering brain, you've got such a wrinkly engineering brain, that you're actually skipping over that whole last, you're actually testing and improving at the same time. So what I really need for you to do for the on paper part is I need you to score it the way that it is now, and then for your second design, that's when you can see, what difference would a second mirror - a small mirror make? Okay. So do all your scores - intensity and cost - do it all for the way you set it up this time, and then we'll look and see how it might be improved.

WHOLE CLASS DISCUSSION

[03:06.04] TEACHER: You can return any materials you won't use in your second design to me and if you need something in addition or something different, I can give you that.

SMALL GROUP
[03:14.00] STUDENT: Well, your improved lighting system design, then create, test your design to see if your improvements worked.
[03:26.06] STUDENT: So we just moved it a little bit closer to the larger mirror.
[03:35.27] STUDENT: it's a 3.
[03:43.14] STUDENT: North is 3.
[03:49.20] STUDENT: That's where we need it, but it's not sticking.
[03:50.08] STUDENT: let it go.
[03:54.20] STUDENT: Can't see any of these though, you can see that one.
[04:03.03] STUDENT: That one's already reflecting on that, so we don't have to worry about it.
[04:06.15] STUDENT: it could use a little bit more, but it's not

[04:10.16] STUDENT: It works
[04:14.17] STUDENT: Is it still on?
[04:19.11] STUDENT: Yeah.
[04:19.11] STUDENT: Alright. try it with the light. Go in this hole and try it.
[04:29.22] STUDENT: Oh it is a little
[04:32.12] STUDENT: And then our total score for intensity would be a three.

WHOLE CLASS DISCUSSION

[04:36.19] TEACHER: Alright 5s, you know after each time after we do any kind of small group work like this, it always helps us to make sense out of what was done by sharing out what happened. What we're going to do is I'm going to have everyone share their design number 1 scores for cost and for intensity. So if you did a second design, but you didn't have a chance to score it yet, it's okay. So what was your cost score?
[05:13.06] STUDENT: Six.
[05:14.06] TEACHER: A six. And what was your intensity score?
[05:18.20] STUDENT: Two
[05:19.22] TEACHER: Group 2, what was your cost score?
[05:21.17] STUDENT: six
[05:22.18] TEACHER: six. And your intensity score?
[05:24.15] STUDENT: 18
[05:25.21] TEACHER: 18. Alright, so let's look at this. So what do we know about most of the groups' costs scores? Zachery?
[05:37.13] STUDENT: They're all- they all use less money.
[05:42.25] TEACHER: Right, most groups as a generalization, most groups had a 6 because their cost was less than $3.50. Do you think that having spent less money always guarantees success?
[05:59.12] STUDENT: No
[05:59.12] TEACHER: No right, exactly. So there's no guarantee that as long as you spend less than $3.50, that you're necessarily going to have the best design. Looking at intensity scores, there were some groups that had high intensity scores, 17, 18, 21 being the highest. Did the groups that had the highest intensity scores always have the lowest - the highest cost score?
[06:25.03] STUDENT: No
[06:30.06] TEACHER: No, not always. Two of them, the group who had a score of 17 and had also spent less than - in the least category for money. So they had a six. Group 2, who also had a high intensity score, they had not spent so much money. Alright so looking at this and thinking about this. If the highest score that you could get for cost was a 6, all of these groups already maxed out their cost score. They could not possibly improve their

cost score because they're already at the highest level. The highest intensity score that you could get was a 4 for each and there were 6 hieroglyphs. So what's the highest intensity score that you could have gotten? A 24. So, was every group open to improving their intensity score?

[07:28.22] STUDENT: yeah

[07:28.22] TEACHER: absolutely. So everyone could have improved their intensity score. We're going to go around to the other tombs carefully maneuvering around the room. I want you to go and see well how did somebody else do it? What did they do the same as us? What did they do different?

[07:44.17] STUDENT: it was me, Danielle, and Doug. We just put a mirror in here, so the light that was going to A, it reflects off here, but the cardboard helps cause it's like slightly reflective, so some of the light over here, went to B and and like some of the light from the cardboard and also some of light reflected from the mirror to.

[08:15.08] STUDENT: Now I see how you got all the light there on the corners

[08:18.13] STUDENT: I see how you were doing it, cause yes, that's a good idea, but how did you get C to reflect into B's. You should have - maybe if you guys improve it, what you guys should do is have maybe a

[08:39.09] STUDENT: And have you flipped it onto B so it you would have so you would have more intensity

[08:47.05] STUDENT: We did have a mirror right here so it would go right here and we had another mirror right here so it would go right down that.

[08:52.21] STUDENT: Cause you put one here and a small mirror facing that way.

[09:01.17] STUDENT: How did you get the flashlight to reflect off this mirror?

[09:06.16] STUDENT: we knew that if we covered the mirror with the whole thing, it wouldn't cover that so we tried to put it at an angle where it would hit C and like go past so it could hit A.

[09:17.07] TEACHER: So what do you think they spent more money on Naftaly? Why do you think their cost was so much? They used more what size mirror?

[09:24.21] STUDENT: Large

[09:25.11] TEACHER: More of the large mirrors. And that made it more expensive, right? But do you feel like the cost was worth it?

[09:30.07] STUDENT: Yeah, basically it ended up almost all of them. It's just that they kept falling, they moved.

[09:37.18] STUDENT: plus, the way the mirrors are, it's casting a shadow.

TEACHER REFLECTIVE INTERVIEW

[09:42.16] TEACHER: When we do data sharing in my class, the premise is always, let's just see where everyone else was, because they're so social and so - so they're always so interested in what everybody else is doing. In fact, we had a whole thing to share about declaring their own personal independence, just be your own learner, and it's very hard. Some kids would rather just be left alone, and then there's other who have to know what everyone else is doing. And that's just part of their persona. So, it affords the students who wants to be left alone to not have to stand up and speak in front of everyone. But still we're getting the benefit of what they found out from some member of their group. After the sharing at the carpet the speaking member of that group, she came up to me and said, "I really think I did something wrong with these scores" so I went over with her and we looked at her tomb cause I asked them to keep them set up, and I said, "look if that's where th most intense light was, then you'd still be able to see it through the darkest section of that intensity meter." She says "yeah." I said, "so really you've flipped that scale. Every time you should had a four, you gave yourself a zero. And every time you should have a three, you gave yourself a one." And so she said, "Oh that makes a ton more sense."

# Practice 7 Expectations

## Engaging in argument from evidence

*"The study of science and engineering should produce a sense of the process of argument necessary for advancing and defending a new idea or an explanation of a phenomenon and the norms for conducting such arguments. In that spirit, students should argue for the explanations they construct, defend their interpretations of the associated data, and advocate for the designs they propose." (NRC Framework, 2012, p. 73).*

| Grades K-2 Expectations | Grades 3-5 Expectations |
|---|---|
| Engaging in argument from evidence in K–2 builds on prior experiences and progresses to comparing ideas and representations about the natural and designed world(s).<br><br>• Identify arguments that are supported by evidence.<br><br>• Distinguish between explanations that account for all gathered evidence and those that do not.<br><br>• Analyze why some evidence is relevant to a scientific question and some is not.<br><br>• Distinguish between opinions and evidence in one's own explanations.<br><br>• Listen actively to arguments to indicate agreement or disagreement based on evidence, and/or to retell the main points of the argument.<br><br>• Construct an argument with evidence to support a claim.<br><br>• Make a claim about the effectiveness of an object, tool, or | Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s).<br><br>• Compare and refine arguments based on an evaluation of the evidence presented.<br><br>• Distinguish among facts, reasoned judgment based on research findings, and speculation in an explanation.<br><br>• Respectfully provide and receive critiques from peers about a proposed procedure, explanation, or model by citing relevant evidence and posing specific questions.<br><br>• Construct and/or support an argument with evidence, data, and/or a model.<br><br>• Use data to evaluate claims about cause and effect.<br><br>• Make a claim about the merit of a solution to a problem by citing relevant evidence about how it meets |

| | |
|---|---|
| solution that is supported by relevant evidence. | the criteria and constraints of the problem. |