Teacher/Video	SSUP_ET_TN GR4_SG1_L1_Willett_C1
Content Area	Energy Transfer
STeLLA Strategy	Strategy 4: Engage students in communicating in scientific ways
Context	This clip is from Lesson 1 of 5 in the Energy, Every Day, Everywhere unit. In this lesson students are introduced to the anchoring phenomenon, a toy car launcher system. Students first share what they know and wonder about energy, explore the car launcher system, and develop a Driving Question Board. In this clip, the students are sharing their initial ideas about the lesson Focus Question, "How do we know if something has energy?"

00:04	T	All right, so I want to share out. And it's not that many of us, so we can- we can have this time to share out, okay? Everybody if we want, all right?
00:16	T	So Antavius- Antavius brought up one that I thought you all were probably going to bring up a long time ago but you didn't. I said, "Ah, Antavius, that's one of 'em." Maybe, I don't know.
00:29	T	But it's interesting, because I'm thinking the same thing, maybe, Antavius, okay? So what did you say, Antavius?
00:37	SN	We got- we have energy.
00:40	T	What do you mean, we? Who- who?
00:42	S	People got energy.
00:43	T	Antavius said people have energy.
00:45	SN	A human being.
00:47	T	Hu- what? How do you know that?
00:51	SN	'Cause if- when we run, we get- we get tired and-
00:57	T	Ooh. Okay. So- so- okay, Antavius, so you're saying that I can use my energy up?
01:05	S	It'll even come back up.
01:08	T	Well, how do I get it back?
01:09	S	You've got to stop running.

01:11	SN	Water.
01:12	SN	(Inaudible).
01:13	T	Water maybe can help.
01:15	SN/T	Or breathing./Breathing. Oh- oh my goodness, so you mean to tell me I have energy.
01:22	SS	Yes.
01:24	T	And I can use it and I can get it back?
01:28	SS	Yes.
01:29	T	Oh, my. Okay. Y’all telling me something I- I didn’t know. Y’all- anybody agree? Disagree? Want to add?
01:40	SN	I agree.
01:41	T	You- why do you agree?
01:43	S	I agree because when you eat healthy and you go out and run, it gives you more energy.
01:51	T	So maybe when I eat healthy, I can have more energy. Hm. Agree, disagree, want to add, piggyback? Antoine, you want to add? What do you want to add?
02:10	SN	He’s only-
02:12	SN	Or- or you can go to sleep and- or just sit-
02:15	T	What?!
02:16	S	or just sit down.
02:17	T	So you’re telling me I can sleep? Or I can rest and I get some more energy?
02:26	SS	Yes.
02:28	T	Wow. I don’t know. We’re going to test a whole bunch of stuff out and figure this out, ’cause I want to know what’s going on. I want to know what’s going on. I’m interested. Are y’all interested?
02:42	SS	Yes.
02:43	T	Okay? Anybody else want to share what they think? How- how do we know if something has energy? DeShauna.

02:52	SN	When- when you have energy, it's like-
02:56	T	Read what you have, read your thoughts that you put.
02:58	SN	The air-
02:59	SN	When you put gas in your car and it's used up and it's on E, then you will know when it's going to end up and it's almost done. It'd be full if it said F.
03:09	T	Okay, so DeShauna and anyone else, think about what De- DeShauna just said. She said when I- I know that we can put gas in the car and it goes to F, which means full, right?
03:23	SN	Yeah.
03:24	T	Which means we put enough gas in the car for it to be full, right?
03:29	SN	For energy.
03:30	T	And DeShauna says full means now we have energy. But what is going on that we know it has energy? What does that mean? What does it look like?
03:42	SN	I disagree.
03:43	T	Oh, we have a disagreement. What- why?
00:03:45	S	I disagree because when you're on a half a tank, you still have energy.
00:03:50	T	Ooh! He says nah uh uh uh, it doesn't have to be full. It can still have energy if it has a what?
00:03:58	S	Half a tank.
00:03:59	T	Half tank. But what does energy look like? What does it mean? What do you mean, it- it still has energy? What do you mean?
00:04:08	S	'Cause it still have enough gas to run.
00:04:10	T	To do what?
00:04:11	S/T	Run./Ooh. So he said energy looks like it's running. Right? Okay, okay, okay, I like that. Yes?
00:04:22	SN	Energy also powers lots of things.
00:04:25	T	Hmm. Here he's back at power.

00:04:29	SN	What he means is if you’re on half a tank, you still have power in the car.
00:04:35	T	Okay, so we’re still on this thing, power. What does power mean? What does power look like? I just- I want you to think about it. I want you to think about it. I- I’m going to take-
00:04:49	SN	I already know.
00:04:50	T	One more. I want you to read yours.
00:04:57	SN/T	Me?/Yes.
00:04:59	S	I know something has energy because it’s moving or starting or it can show you that it’s moving like people.
00:05:09	T	Hm, did y’all hear what she said? She said she knows that something has energy because it can move or it can start. Hm. Look at what we said. Things that we know. But we’re going to test it out. I don’t know. I don’t know.

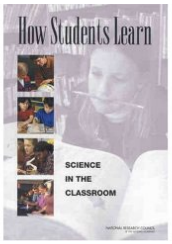
TIMSS Science Public Release Lesson USA 3 clip 1 (clip id: TSCP001-5-001-C3)

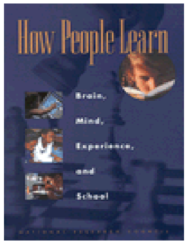
Timecode	Speaker	Dialogue/Logging
00:00:03.00	T	Okay. Everyone should have the "Pulley Potpourri" sheet out in front of you;
00:00:06.00	T	the lab sheet.
00:00:08.00	SN	Who thought of that name?
00:00:10.00	T	I did. It's my lab.
00:00:38.00	T	Shh. We're gonna get started on the lab today.
00:00:45.00	T	Shh. Folks, I need your attention up here, please.
00:00:50.00	T	I'm glad you guys are having so much fun coloring inside the letters,
00:00:53.00	T	but (if) I could get your attention up here, I would really appreciate it.
00:01:01.00	T	We went over this yesterday. I'm just gonna recap it today because it's been 24 hours,
00:01:04.00	T	and I know you forgot.
00:01:10.00	T	You're just gathering three pieces of data from each pulley setup.
00:01:15.00	T	You're gathering the effort distance, the effort force and the resistance force.
00:01:22.00	T	As I went over yesterday, you measure the resistance force just by picking the weight up with the scale,
00:01:32.00	T	and you measure the effort distance by using the ruler in centimeters to measure
00:01:35.00	T	how far you pull when you lift the weight by 10 centimeters.
00:01:45.00	T	The resistance distance in every case is 10 centimeters.
00:01:50.00	T	If I can have your attention back here-
00:01:55.00	T	just quickly go over this for the first setup again.

00:01:58.00	T	There are two rulers back at the station.
00:02:06.00	T	You'll be using both of them at the same time.
00:02:09.00	T	One person is gonna be measuring resistance distance; one person is gonna be measuring
00:02:13.00	T	effort distance.
00:02:15.00	T	So you'll have one person using the centimeter side of the ruler.
00:02:18.00	T	There's an inches side.
00:02:22.00	T	Don't use the inches; use the centimeters.
00:02:24.00	T	They're gonna be measuring how high the bottom of the weight goes up.
00:02:29.00	T	When it's at 10 centimeters, that's as far as you're going.
00:02:33.00	T	While they're doing that, the person applying the effort to the simple machine,
00:02:35.00	T	the person pulling on the string,
00:02:42.00	T	is gonna be measuring how far they have moved the string to raise the weight ten
00:02:45.00	T	centimeters.

TIMSS Science Public Release Lesson Japan 1 Clip 1 (clip id: TSCP001-3-001-C1)

Timecode	Speaker	Dialogue/Logging
00:00:02.23	T	Uh, when you exposed water to electricity... Daijiro-kun.
00:00:09.25	SN	Oxygen and hydrogen.
00:00:11.04	T	Yes, it separates into to two separate substances of oxygen and hydrogen. Okay, that's the conclusion, right?
00:00:25.24	B	Water --> Hydrogen + Oxygen
00:00:45.17	T	Since you expose it to electricity, you call this type of separation... uh, Chihiro-san. What kind of separation is this called?
00:00:57.19	SN	Electrolysis.
00:00:58.11	T	Yes, electrolysis.
00:01:04.21	B	Electrolysis
00:01:15.15	T	Okay, electrolysis.
00:01:17.23	T	And this is what we did yesterday. So today, what we'll be thinking is water. Being exposed to electricity, it can be separated into hydrogen and oxygen. So what happens in the opposite?
00:01:40.06	T	What I mean is if we have hydrogen and oxygen, is it possible to make water?
00:01:48.22	T	If it was this way. How would it be if the arrow was pointing this way?
00:01:54.09	T	This is what I would like to consider today.
00:02:00.14	T	Okay then, now discuss with your neighbors to see if you think you can make water from hydrogen and oxygen. If you suppose that you can then talk about how you could do it.
00:02:16.06	T	So discuss in depth and think about it please.
00:02:19.14	T	If you suppose that you can't do it, then talk about why you can't do it.





Synthesis of Research from
How People Learn: Brain, Mind, Experience, and the Classroom
How Students Learn: Science in the Classroom

Adapted by BSCS from:

National Research Council. (2000). *How People Learn: Brain, Mind, Experience, and School*, Washington, DC: National Academies Press. Available for free download at www.nap.edu

National Research Council. (2005). *How Students Learn: Science in the Classroom*, Washington, DC: National Academies Press. Available for free download at www.nap.edu

KEY FINDINGS ABOUT HOW STUDENTS LEARN SCIENCE

1. Students' prior knowledge must be engaged.

A fundamental insight about learning is that *new understandings are constructed on a foundation of existing understandings and experiences*. Students come to the classroom with preconceptions about how the world works. The understandings they carry with them into the classroom will shape significantly how they make sense of what they are taught (see "A Fish Story" and imagine your students as the fish and the frog as you, the teacher). If students' initial knowledge is not engaged, the students might fail to grasp the new concepts and information that are taught; they might distort the new information to make it fit with their prior experience (as the fish did), or they might memorize facts for purposes of a test but revert to their preconceptions outside the classroom. NOTE: It is not just inattentive students who misinterpret science instruction; students who are trying hard to make sense of the science ideas will want to make the new science ideas fit with their own experience which can lead to misinterpretations of the science ideas.

With respect to science, everyday experiences often reinforce the very conceptions that scientists have shown to be limited or false, and everyday modes of reasoning are often contrary to scientific reasoning. Research shows that many high school and college students still hold the same misconceptions as young students, despite having studied the scientific explanations in high school and college. Students also have misconceptions about how scientists think and work, often failing to appreciate the centrality of conceptual knowledge in the scientific inquiry process.

Implications for Teaching

Draw out and work with the preexisting understandings that students bring with them.

- Abandon the model of the student as an empty vessel to be filled with knowledge and instead think of students' heads as filled with a myriad of wonderful ideas and experiences relevant to the science you are teaching. Actively inquire into students' thinking, creating classroom tasks that will reveal student thinking. Then plan ways to help students find the scientific conceptions useful and meaningful so they can change their initial conceptions to accommodate the new ideas. Students need opportunities to explore their own ideas, to appreciate the limitations of their ideas, to understand how scientific explanations are different from their own, to make sense of scientific explanations, and to use this learning process to change their everyday conceptions to ones that are more scientifically accurate and that make sense to the learner.
- The use of frequent formative assessment helps make student thinking visible to themselves, their peers, and their teacher. Given the goal of learning with understanding, assessments of all types must tap students' understanding and develop their ability to use and apply knowledge rather than merely repeating facts or performing isolated skills.

KEY FINDINGS ABOUT HOW STUDENTS LEARN SCIENCE

2. Organizing science knowledge into conceptual frameworks is essential in developing scientific understanding.

To develop understandings that truly change the way students think about the world around them, students need a deep foundation of usable knowledge that is organized in their minds as a connected, conceptual framework that they know how to use to make predictions, solve problems, explain new situations, and so forth. This kind of deep understanding contrasts with the kind of learning so commonly tested in science classrooms – memorization of lists of science terms and facts. This idea of learning with understanding has two parts: (1) To be meaningful beyond passing a test, factual knowledge MUST be placed in a conceptual framework (a set of connected "big ideas"), and (2) Concepts are given meaning through experiences with multiple representations that are rich in science ideas and details and through experiences with multiple phenomena that the ideas help explain. The scientific concepts take on meaning as students see their usefulness in explaining a variety of real-world situations and phenomena.

Students can be supported in building conceptual understandings by actively engaging in processes of scientific inquiry. Opportunities to learn science as a process of inquiry involve drawing from first-hand data and observations and using knowledge of the data and science ideas to reason about the phenomena under study. This process can be used to challenge and build on students' initial ideas and everyday experiences of the world. It can also provide evidence to help students see a need for different explanations and why scientific explanations make sense.

Implications for Teaching

Teach science in depth, providing many examples in which the same concept is at work and providing a firm foundation of knowledge of science ideas.

- Superficial coverage of all topics in science should be replaced with in-depth study of fewer topics that allows key science concepts to be understood.
- Teachers need in-depth knowledge of the science content they will teach, the nature of scientific inquiry and the terms of scientific discourse, and the relationship between science concepts and real-world phenomena.
- Assessments for purposes of accountability (e.g., statewide assessments) must test deep understanding rather than surface knowledge. A teacher is put in a bind if she or he is asked to teach for deep conceptual understanding, but in doing so produces students who perform poorly on standardized tests. Much work needs to be done to minimize the trade-off between assessing depth and assessing objectively (e.g., multiple choice tests).

KEY FINDINGS ABOUT HOW STUDENTS LEARN SCIENCE

3. Learning to monitor one's own thinking is essential in learning to think like a scientist.

A "metacognitive" approach ("thinking about thinking") to instruction can help students learn to take control of their own learning by engaging them in understanding learning goals and monitoring their progress in achieving them. A metacognitive, or self-monitoring, approach can help students develop the ability to reflect on their own thinking and learning processes.

In science, we can help students think like scientists by using metacognitive approaches that make scientific thinking processes visible and engage students in reflecting on how their own thinking is similar to and different from scientific ways of thinking. For example, students can examine the tendency of us all to attempt to confirm rather than rigorously test (and possibly refute) our current ideas. The approach is deepened when you help students learn why and how to create models of phenomena that can be put to an empirical test. Through metacognition, students reflect on their role in inquiry and on the monitoring and critiquing of their own claims, as well as those of others. Applying a metacognitive habit of mind helps students compare their personal ways of knowing with those developed through centuries of scientific inquiry. Being metacognitive about science is different from simply asking whether we comprehend what we read or hear; it requires taking up the particular critical lens through which scientists view the world.

Implications for Teaching

The teaching of metacognitive thinking should be integrated into the science curriculum.

- Help students understand the discourse that scientists use as they make sense of their data and observations – both their internal dialogue and external communication with a community of scientists. It is not enough to give students tasks that require them to think and reason. In addition, students need to learn how scientists think and reason and how that might contrast with their own ways of thinking and making sense. For example, students should learn to ask questions such as: *How do we know that? What's your evidence?*
- To help students monitor their developing understandings, engage them in reflecting on their learning, their changing ideas, and their remaining questions and wonderings. A lesson summarizing activity, for example, might prompt students to reflect on how their ideas have changed and why. Alternatively, the class might pause after a science discussion to reflect on ways they did and did not think and communicate in scientific ways during the discussion.

Ideas About Energy			
My INITIAL ideas	🔴	This idea is incorrect.	How my ideas have changed.
	🟠	I'm not sure about this idea--some parts may be correct and other parts incorrect.	
	🟢	This idea is accurate.	
	1. Energy is an observable and measurable property of a system.		
	2. Energy is something contained inside of objects.		
	3. An object has to be moving to have energy.		
	4. You can make energy by rubbing your hands together really fast until they feel warm.		
	5. Energy is lost as it spreads out within systems and readily transfers between systems.		
	6. Objects must be touching for energy transfer to take place.		
	7. There are many different kinds of energy.		
	8. The energy of hot water is similar to the energy of moving bumper cars.		
	9. An ice cube has no energy.		
	10. Any time there is an increase in energy in one part of a system, there must be a decrease in energy in another part of the system.		
	11. A marble wants to move from the top of the ramp to the bottom of the ramp.		
	12. My hand feels cold when I hold a piece of ice because the coldness of the ice moves to my hand.		
	13. Energy transformations are processes that convert energy from one form to another, whereas energy transfers are processes that carry energy across system boundaries.		
	14. Not all stored energy (potential energy) is converted to energy of motion (kinetic energy).		

	15. Energy and force are the same.	
	16. The energy of a moving object depends only on how fast the object is moving.	
	17. You must observe some change in an object to know that the object has energy.	

Ideas About Energy Mash Up

My INITIAL ideas			How my ideas have changed
		This idea is incorrect.	
		I'm not sure about this idea--some parts may be correct and other parts incorrect.	
	1.	Energy is an observable and measurable property of a system.	
	2.	Energy is something contained inside of objects.	
	3.	An object must be moving to have energy.	
	4.	You can make energy by rubbing your hands together really fast until they feel warm.	
	5.	Energy is lost as it spreads out within systems and readily transfers between systems.	
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	15. Energy and force are the same.	
	16. The energy of a moving object depends on how fast the object is moving.	
	17. You must observe some change in an object to know that the object has energy.	

Daily Reflections – Day 1 Name: ______________________

1. What are your first reactions to the claim that it is important to plan and analyze science teaching through the Student Thinking and Science Content Storyline Lenses?

2. This week we will be focusing on energy. What struggles have you encountered teaching energy? What seems to get in the way of students developing a firm grasp of the concepts around energy transfer and transformation?

3. Provide feedback about today's session and the program so far (likes, dislikes, questions, concerns, suggestions).