Bones Vignette Activity

A vignette about an elementary science lesson is presented on pages 2-6. Participants should read the vignette and look for examples of the elements of effective instruction described in the How People Learn presentation. They can keep notes on the record sheets found on pages 7-11.

Facilitators may want to reference the key ideas listed on pages 12-16 (this document is not intended for participants).

Implementation Idea

Break participants into 5 small groups and assign each group an element of effective instruction. Each group should prepare to explain to the others how the instruction in the bones lesson related to their assigned element, using evidence (line numbers) from the vignette. Group members should be prepared to answer questions from other participants during their presentation. Encourage groups to find a way to involve all members in the presentation.

Bones

Grade 4
Targeted Idea: Students will understand that the shape and relative size of a bone provides a clue to its function.

1 The students in this fourth grade class have been studying the human body. They are just beginning to learn about the skeletal system. The teacher starts the class by showing students the sternum (chest) and a leg bone from a human skeleton, but does not give them any information about the bones. The teacher asks students to look at the two bones and write in their notebooks two ways the bones are similar and two ways the bones are different and why they think the bones might be different. Once students have had the opportunity to record their thoughts, the teacher asks the class to share their ideas and writes students' responses on the board. Students say things like both bones are hard and white, but one is round, while the other is flat. The teacher follows up on students' comments and engages students in the following discussion:

2 T – You all said that the shapes of these two bones are really different. Why do you think the shapes are so different? Tim?
Tim – I think they must have come from different animals.
Kara – But, maybe, they could be from the same animal. Because I saw a cat's skeleton once and it had lots of different types of bones.
T – Interesting, Tim and Kara have different ideas about where these bones came from. Tim thinks they came from different animals, can you tell us why?
Tim - Because they look so different, they must be from different animals. But, maybe, they could be from the same animal.
T – It's okay if you are not sure. Kara said that he thinks the bones came from the same animal because he has seen a skeleton of a cat before and it had lots of different bones. So, if the bones came from the same animal, why might an animal have such different bones in its body? Any thoughts?

3 Shelly – Because they came from different parts of the body.
T – What about the different body parts make the bones different?
Shelly – The body parts are different shapes. Like your arm and hands look different and both have bones in 'em.
T – Okay, does anyone have anything to add?
Jenica – I think maybe the bones are just made to look different, that is just the way they are.
T – Mmm, Jenica said she thinks that is just the way the bones are made. Let's think about what bones are for, what do they do? Do all bones have the same purpose?
Matt – They all make our bodies stiff, so we are not blobs.

4 T – Okay, so bones give us a shape. Any other thoughts?
Kara – Well, I think they all do the same thing, because they are just there to hold us up.
T – Okay, they hold us up. Anything else we think bones might do? [pauses] By raising your hand, show me how many think all bones have the same purpose? [majority of students raise their hands] How many think they have different purposes? [a few students raise their hands] And, how many are just not sure? [the remaining few students raise their hands] Okay, well over the next

few days we are going to be taking a closer look at bones and we will come back to this question at the end of this unit.

5 The teacher moves into the lesson for the day. Students are given a set of model mouse bones and a key with an illustration of a complete mouse skeleton. Each bone on the key is labeled. Students are asked to "reconstruct" their mouse's skeleton using their key as a guide. The students work in teams of two and are encouraged to talk with other groups to help identify each bone and build their skeleton. As the students work the teacher circulates between groups and questions students about their bones. For example:

6 T – Alright, you guys are coming right along, looking good. As you are putting your skeleton together, what are you noticing about your mouse's bones?
Misha – They are really small and hard to put together.
T – Oh, yeah, that's true. What about the shapes of the bones, are they all the same shape?
Matt – No! There are lots of different kinds.
T – What are some of the differences you have noticed?
Misha – Um, some are really long and round on the ends. Some are really tiny and skinny.
7 Matt – Yeah, like the finger bones are itty bitty, but the ribs are pretty long.
T – Are there any bones that are kind of unique, that seem different from the rest?
Matt – The skull is kind of different.
T – Right, that one is a little different from the others. Are there some that seem similar to each other?
Misha – The leg bones all look similar.
T – Good, those are some really great observations.

8 The teacher goes to each of the nine pairs of students to ensure that they are observing the size and shapes of all the different bones as they build their skeleton. Once every pair has successfully constructed their skeleton the teacher has them clean up and lets the class know that the next day they will be continuing their investigation into their mouse bones.

9 The next day the teacher starts the lesson by reminding the class what they talked about and did the day before. Next, students are given a stack of cards. Each card has a labeled illustration of a mouse bone (e.g., femur) on it. Students are asked to examine the shape of the bone on each card and then to sort cards into one of three groups based on the shape of the bone. The three groups are: long rounded bones; short rounded bones; and flat bones. The teacher asks students to make a column for each group in their notebook and to list the names of the bones they put into each
10 group. As students work, the teacher walks around asking and answering questions to help clarify the task for students. Once students have sorted their cards, the teacher has them share what bones they put into each group and why. There are several questions about which group certain bones belong in. The teacher helps students reach a class consensus on which group to place each bone into and develops the class chart listed below:

Class Bone Groups

Long Rounded Bones	***Short Rounded Bones***	***Flat Bones***
Femur	Vertebrae	Skull
Ulna	Tarsals	Scapula
Humerus	Phalanges	Patella
Radius	Carpals	Sternum
Tibia & fibula		Pelvis
Clavicle		
Ribs		

11 The teacher then leads a class discussion about the bones in each group and their possible function. She asks students to think about where the bones in each group are found in the animal's body. Following is an excerpt from that class discussion:

12 T – This is very interesting. We see that there are some very different shapes and sizes of bones, but that sometimes bones look similar or have similar characteristics and are easy to group based on the way they look. So, let's take a look at the bones in our long bones category. Where are those bones found in the mouse's body? Andre, go ahead.
Andre – Lots of them are leg and arm bones, like the femur and humerus.

13 T – Alright, legs and arms. Any other bones in that group that are from a different part of the animal's body?
Andrew – Yeah, the clavicle and ribs are kind of in the chest.
T – Good. I want everyone to pull out their cards for this group and let's take a closer look at these bones. We know that most of them are in the legs and arms of the animal, but some are in the chest. Do you notice any differences between the bones from the different parts of the body?

14 Shelly – The leg and arm bones are all thicker than the other bones.
Jarvis – The ribs are pointy on the ends, but the leg and arm bones are all bumpy on the ends.
T – Hmm, okay, so do you think we could the bones in the long bones group into two different categories? How about thick bones with bumpy ends and thin bones that don't have bumpy ends? [students agree]

15 T – Now, look at only the leg and arm bones. You have already said that they are thick and bumpy on the ends, so these bones look similar. What do the leg and arms do for the mouse, what is their function?
Lara – They help the mouse move, and they can move fast too!
T – Right, do they do anything else?
Matt – They keep the mouse up, like standing up.

16 T – Great. Do you think the shape of those bones has anything to do with the fact that they all have a similar function?
Ben – They are kind of like tree trunks, they hold the mouse up like a trunk does for a tree.

T – Very nice comparison. Right, those legs and arms allow the mouse to move and they support it. Well, now I am a little confused because we have these other bones, the clavicle and ribs, that are shaped a little bit like the leg and arm bones, but they are different. You told me they are in the mouse's chest, what do those bones do for the mouse?
Andrew – Help it stay round.
17 T – Can you tell me more?
Andrew – Well, if it didn't have those bones, it would be all soft and squishy and sunken in.
T – Aha, I see what you mean. What is inside a mouse's chest; is there anything important in there?
Aisha – Yeah, it's lungs and organs.
T – Yes, and if those bones were not there, like Aisha said, the mouse would be soft and what
18 would happen to the mouse's organs?
Tim – They would get hurt!
T – That makes sense. Are there any other bones that seem like they might be protecting something soft in the mouse's body, maybe some other organs? [Pauses] What is inside that skull?
Ben – Oh, the brain!
19 T – Right, so the skull is protecting the mouse's brain. Are there any similarities between the ribs and the skull?
Tim – The ribs are kind of flat, well they are flatter than the leg and arm bones.
T – Yeah, they are kind of flat and when you put them all together, they form a cage around the mouse's organs. If you look at the bones in our flat bones group, the sternum and scapulas go with the ribs, they are kind of like armor, right?
Andre – Oh, yeah, like I have a pretend set of armor and it protects me from my brother when
20 he hits me.
T – [laughs] Right, so those ribs and the flat bones are for protection, like your armor. That is a different function than the one we determined the leg and arm bones have, right?
Students – Yeah!
T – Okay, let me summarize what we have discovered so far, we know that some bones look
21 very similar. Why do you think they look similar?
Ben – They do the same things.
T – How do know? Can give me an example from the bones we've sorted?
Ben: All of the bones that are thick and long provide support and help them move like the femur and ulna
22 T-Does everyone agree? [Most students nod.] Can someone give me another example from what you've observed?
Kara-All the flat bones protect our insides.
T – Excellent!

23 The teacher continues this discussion to guide students to understand that three major functions of bones are: 1) protection; 2) locomotion and movement; and 3) support and structure. Students summarize common characteristics for the bones that perform each function and realize that a bone might perform more than one function. Students also realize that there are some similarities across all bones, specifically that they are all hard and rigid. The teacher explains that all bones provide structure, referring back to students' comments at the beginning of the lesson about bones

giving an animal's body shape. The teacher has students write in their science journal the three functions of bones they have discussed and some characteristics of the bones that perform each function.

24 Next, students are given a worksheet with illustrations of "mystery" bones from various mammals on it. Students are asked to predict what function each bone serves and where it might be found in the animal's body based only on the bone's shape. The teacher reviews students' responses, having different students share what they wrote for each mystery bone and what evidence they have for their prediction about the bone's function and location based on their observations from the mouse skeleton. The teacher reveals what each bone is and what function it serves after the class agrees on a prediction for each one. The teacher then asks the class: "Based on what we have experienced, what do we think about that question I asked earlier; Do all bones have the
25 same function?" The class consensus is that bones have different functions, but that all bones provide structure and support. The teacher then asks what about a bone helps us know what function it serves and students indicate that the size and shape of a bone can help determine what the bone does and where it might be found in the animal's body.

To conclude the lesson the teacher leads the following brief discussion:

26 T – Okay, we have been talking about the different human body systems. What was our definition for a system?
Students – A collection of parts that work together to perform a function.
T – Right, so based on our definition of a system, are bones part of a system?
Matt – Yeah, because they work together.
T – Okay. The other part of our definition of system is that the system performs a function. So, do bones fit the whole definition of a system, do they work together and perform a function?
Students – Yes.
27 Jenica – I think bones are part of a system, but I don't know what the system is called. Like we said the stomach is part of the digestive system.
T – Good point, does anyone have any ideas about what the name of the system bones are a part of is called?
Kara – The skeleton system.
T – Right, very close, it is called the *skeletal* system. And there is another system that is related to the skeletal system that we will be learning about in a couple of days called the muscular system, together they are called the musculoskeletal system. Next, we are going to be looking at the way some bones come together and how their shape allows for different types of movement, so get ready to move in our next class!

Elements of Effective Science Instruction
Instructional Analysis Record Sheet

Bones

Directions: After reading the vignette, consider the following questions, one on each page for each element. Please list examples from the vignette that support your responses to each of the five focus questions.

Motivation: Motivation can be intrinsic or extrinsic. Ideally, effective instruction engages students by addressing something they have wondered about in nature or experiences in or out of school.	
Focus Question	**Examples from the Vignette of Instruction that Motivated Students to Engage with the Targeted Idea(s)**
1. What aspects of the instruction motivated students to engage with the targeted ideas?	

Eliciting Students' Prior Knowledge: Effective instruction helps students' bring to the surface their initial thinking about the targeted ideas and why they think a certain way about an idea so (1) teachers are aware of these ideas in making instructional decisions and (2) students are aware of how they personally think about the idea so subsequent experiences can build on or challenge these preconceptions. The prompt that is meant to surface students' prior knowledge should be directly aligned with the targeted idea, not just be related to the topic.	
Focus Question	**Examples from the Vignette of Instruction that Brought to the Surface Students' Initial Thinking about the Targeted idea(s)**
2. What aspects of the instruction brought to the surface students' initial thinking about the targeted ideas?	

Engagement with Relevant Phenomena: Effective instruction includes experiences that engage students intellectually with phenomena that provide evidence for the targeted idea. The phenomena explored need to be accessible to the learners, and the design of instruction and the teacher's facilitations should help focus students on the relevant aspects of the phenomena.	
Focus Question	**Examples from the Vignette of Instruction that Engaged Students with Relevant Phenomena**
3. What aspects of the instruction engaged students with, and helped them focus on the relevant aspects of, evidentiary phenomena? For example, what did students experience that prompted them to grapple with the intended content? (i.e., how an activity was structured, questions the teacher asked).	

Use of Evidence to Critique Claims: Effective instruction provides students with the opportunity to interpret data (either that they collect themselves or data that is provided to them) to make new claims or critique others' claims; the instruction gives students opportunities to examine whether conclusions drawn are supported by evidence.	
Focus Question	**Examples from the Vignette of Instruction of Students Using Evidence to Make, Support, and/or Critique Claims**
4. What aspects of the instruction provided students with opportunities to engage with evidence to make, support, and/or critique claims about the targeted idea?	

Sense Making: Effective instruction helps students (1) connect what they experienced in instruction to the ideas the lesson(s) were intended to develop and/or (2) relate the ideas they developed to their initial thinking about the targeted ideas, and/or (3) relate the ideas they developed to other scientific ideas/concepts.	
Focus Question	**Examples from the Vignette of Instruction where Students were Helped to Make Connections between the Activities of the Lesson and the Targeted Ideas, and/or Relate the Ideas in the Lesson to their Previous Understanding and/or Relate the Ideas to other Scientific Ideas/Concepts**
5. What aspects of the instruction helped students make connections between activities and targeted ideas, and/or relate the ideas in the lesson to other ideas (either their initial ideas or other scientific ideas)?	

Elements of Effective Science Instruction

Bones Vignette Key Points

Directions: After reading the vignette, consider the following questions, one on each page for each element. Please list examples from the vignette that support your responses to each of the five focus questions.

Motivation: Motivation can be intrinsic or extrinsic. Ideally, effective instruction engages students by addressing something they have wondered about in nature or experiences in or out of school.	
Focus Question	**Examples from the Vignette of Instruction that Motivated Students to Engage with the Targeted Idea(s)**
6. What aspects of the instruction motivated students to engage with the targeted ideas?	a. The teacher hooks the students into the lesson at the very beginning by having them examine real bones and posing a question that peaks students' curiosity. Having students examine the bones, asking questions about the bones, and hypothesizing about why the bones looked so different prompted students to wonder about why some bones are so dissimilar. Students were eager to provide their ideas (section 2-4). b. Posing the question, "do bones all have the same function" and having students publicly provide an answer prompted students to really think about whether or not all bones have the same function. The question motivated students to want to know the answer and engage in the subsequent instruction. c. The first activity that students were engaged with, reconstructing the model mouse skeleton, served as a motivating element. Students were given the challenge of putting the skeleton together, which motivated them to accomplish the task and gave them the opportunity to explore the bones of a mammalian skeleton more closely. Furthermore, the teacher's questions during the activity continued to motivate students to wonder why some bones look so dissimilar and, more importantly, why some look very much alike (section 6-7).

Eliciting Students' Prior Knowledge: Effective instruction helps students' bring to the surface their initial thinking about the targeted ideas and why they think a certain way about an idea so (1) teachers are aware of these ideas in making instructional decisions and (2) students are aware of how they personally think about the idea so subsequent experiences can build on or challenge these preconceptions. The prompt that is meant to surface students' prior knowledge should be directly aligned with the targeted idea, not just be related to the topic.	
Focus Question	**Examples from the Vignette of Instruction that Brought to the Surface Students' Initial Thinking about the Targeted idea(s)**
7. What aspects of the instruction brought to the surface students' initial thinking about the targeted ideas?	a. The elicitation of prior thinking about the targeted idea occurred when the teacher asked students to look at the two bones and write in their notebooks two ways the bones are similar and two ways the bones are different and why they think the bones might be different (section 1). In addition, the teacher asks students to share their thoughts about why the leg and sternum bones look so different and if they think that all bones have the same function (section 2-4). The teacher's questioning allowed her to probe into students' ideas without labeling any students' thoughts as right or wrong, thus allowing students to freely share their ideas and keep the door open for them to explore their own ideas about why bones are sometimes shaped very differently and how that relates to a bone's function.

Intellectual Engagement: Effective instruction includes meaningful experiences that engage students intellectually with important science content. The mode of learning may vary, as long as students have opportunities to investigate meaningful questions, engage with appropriate phenomena, and explicitly consider new experiences and knowledge in light of their prior conceptions. The important consideration is that instruction engages *students* in doing the intellectual work.	
Focus Question	**Examples from the Vignette of Instruction that Engaged Students in Thinking/Talking about the Targeted Idea(s)**
8. What aspects of the instruction engaged students in thinking/ talking about the targeted ideas? For example, what did students experience that prompted them to grapple with the intended content? (i.e., how an activity was structured, questions the teacher asked).	a. The purpose of the skeleton reconstruction was to allow students to interact with the similarities and differences between the bones and see where each bone is located in the animal's body which would give them a clue to its function. As students constructed their rodent skeletons the teacher ensured that they were engaged with the relevant aspects of the activity by going to each group and asking probing questions that focused students on the size and shapes of their rodent bones, as well as the similarities and differences between them (sections 6-7). b. The activities were structured so every student had the opportuntiy to observe the similiarities and differences between the bones and consider their functions. Students worked in pairs to reconstruct their mouse skeletons. Moreover, asking each student to record their observations and class data in their own notebook increased the opportuntiy for every student to engage with the target idea. c. Having students sort the bone cards into pre-defined groups provided students with sufficient structure to engage with the activity without short-circuiting their learning. Students were not just doing an activity, but were focused on making observations about the shapes of the bones and were engaged with trying to categorize the bones into each group. d. Teacher questioning about the sorted bones and where they are located in the skeleton helped students engage with examples of the idea that similarly shaped bones have similar functions. (section 12-20)

Use of Evidence to Critique Claims: Effective instruction provides students with the opportunity to interpret data (either that they collect themselves or data that is provided to them) to make new claims or critique others' claims; the instruction gives students opportunities to examine whether conclusions drawn are supported by evidence.	
Focus Question	**Examples from the Vignette of Instruction of Students Using Evidence to Make, Support, and/or Critique Claims**
9. What aspects of the instruction provided students with opportunities to engage with evidence to make, support, and/or critique claims about the targeted idea?	a. Students used their observational data as evidence to claim that bones with similar shapes have similar functions and bones with very different shapes have different functions. Students were encouraged to use examples from their mouse skeletons to support their statements. (section 21-22 and section 24). Students also concluded from their data, the bones they are examining have several different functions and, with some guidance from the teacher, clarified what those functions are.

Sense Making: Effective instruction helps students (1) connect what they experienced in instruction to the ideas the lesson(s) were intended to develop and/or (2) relate the ideas they developed to their initial thinking about the targeted ideas, and/or (3) relate the ideas they developed to other scientific ideas/concepts.	
Focus Question	**Examples from the Vignette of Instruction where Students were Helped to Make Connections between the Activities of the Lesson and the Targeted Ideas, and/or Relate the Ideas in the Lesson to their Previous Understanding and/or Relate the Ideas to other Scientific Ideas/Concepts**
10. What aspects of the instruction helped students make connections between activities and targeted ideas, and/or relate the ideas in the lesson to other ideas (either their initial ideas or other scientific ideas)?	a. The teacher's questioning and guidance helped students make sense of their observations about the size and shapes of bones. The teachers skillful probing prompted students to make important connections between their observations and the target idea. It was evident from student responses that most understood that the shape and size of a bone provides information about its function (sections 21-24). b. By asking students to reflect back on their initial thinking about whether bones all have the same function in light of their new understanding, the teacher confronted students' initial ideas and provided them with the opportunity to examine how their thinking changed. c. Students were given the opportunity to make sense of the target idea more broadly by applying their understanding to a new scenario. Once students understood that the size and shape of a bone is related to its function and what those functions are, they were challenged to predict what the purpose of mystery bones might be based only on their shape (sections 23-24). d. At the end of the lesson the teacher connected the idea of bones, their form and function, to the bigger idea of systems, specifically body systems. Students were able to connect their new understanding to a larger framework or body of knowledge. Specifically, the teacher connected the ideas students learned in the lesson to prior lessons about body systems and set them up for the next lesson about the muscular system (section 25-27).