Chewing on Ideas
Engaging students in meaningful learning about digestion

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Learning is the active mental process of arranging ideas and information to interpret the world around us. Individuals will attempt to make sense of situations by connecting them to pre-existing ideas. Prior ideas affect not only the learning of new concepts, but perception itself. That is, phenomena disconnected or at odds with what is believed often go unnoticed or are dismissed as anomalies. This helps explain why students do not learn the concepts that lessons are designed to convey.

This view of learning has a number of implications for teaching. For instance, teachers must create an environment where students will be mentally attentive to the planned experiences—be it an activity, discussion, or reading. Because students’ prior ideas are critical in learning, determining these ideas and pressing students to consciously wrestle with them should be at the forefront of teaching strategies. Teachers should continually monitor students to determine how they are integrating new experiences with prior knowledge. Not surprisingly, lecture, traditional reading assignments, and cookbook activities rarely compel students to engage in the cognitive discomfort associated with deep learning.

For example, students have a lifetime of experiences eating, but because these experiences are largely unexamined, students have misconceptions about digestion. Students ignore the role of the mouth, small intestine, and particular organs, believing that digestion occurs primarily, if not entirely, in the stomach. Students also think of digestion solely in terms of energy extraction, not as providing matter for the physical makeup of an organism. The function of intestines is perceived to be simply passing food along before it is eliminated.

Even after prolonged time-honored instruction regarding digestion, students often retain the ideas held prior to formal instruction. This is not surprising given that lessons regarding digestion often fail to catch their attention in ways that force students to question their prior ideas. Consider, for instance, how typical introductory biology textbooks introduce and elaborate on the digestive system. The student is greeted with explanatory text, diagrams, and vocabulary. If an activity is suggested, it typically follows this stale introduction, is often of the verification variety, and offers little opportunity for students to make decisions and challenge their prior thinking.

Teachers can modify activities to make them more congruent with desired goals and how students learn (Clark, Clough, and Berg 2000; Clough 2002; Clough and Clark 1994a and 1994b). Here we provide an example suggesting that stale textbooks, like cookbook ac-
tivities, can be modified to encourage student ideas, raise questions in their minds, and make subsequent instruction more meaningful. The following activity was created by turning dull facts about digestion into experiences and questions to be investigated. We know from years of experience that the activity promotes student interest, forces them to be mentally engaged, creates a window into their thinking, and compels them to reconsider prior notions about digestion. This experience physically and mentally engages students in the study of digestion and they are reminded of the activity on a daily basis throughout their lives.

**Come hungry!**

We give students two days notice before the digestion activity; they must come to class hungry and not eat for at least six hours—preferably longer—prior to class. A reward exists for their effort because they will be eating during class. (As a safety precaution, teachers should never allow students to eat in the laboratory; students should instead eat in the classroom, away from chemicals and harmful products.) Students may bring almost any food they wish, but our students typically choose to pool money together and order pizza. The two-day advanced announcement gives students time to bring their money to class the day before the activity, decide the kind and number of pizzas they want, and place their typically large pizza order. To avoid any potential problems with drinks, we bring water and a variety of soda for the activity. We also clear this activity with the school administration and explain the rationale behind the activity, as well as how we motivate students to engage in serious learning.

**How hungry are you?**

On the day of the activity as students enthusiastically enter class, the overhead projector is on with only the first two numbered items in Figure 1 revealed. We instruct students to begin writing. (Questions referred to throughout this manuscript are found in Figure 1.) Students are instructed to begin eating only when given permission.

While students continue writing, we open the pizza boxes and strategically place the pizzas and other food students have brought around the room so students can see and smell the food. We then ask students, “How hungry are you?” Good-natured student protesting always occurs at this point. We then ask Questions 3 and 4. While some students notice that their saliva output has increased and stomach rumblings are rampant, other students do not report these responses. We follow these observations with, “What do you think may account for the different responses?” With appropriate wait-time and positive nonverbals, students offer suggestions such as “how hungry a person is” and “the kind of food available.”

Understanding that experience alone does not lead to a scientific understanding of phenomena, we point out that the reported physiological responses occurred even though the students weren’t yet eating, thus raising Question 5. Students quickly note the role of odor and sight, but some students admit their physiological reaction began before they could see or smell the food. Simply anticipating eating the pizza seemed to prompt a response, which indicates that prior experience with a particular food influences physiology.

Because students want to eat the pizza more than they want to study their reaction to it, pressure exists to move quickly through the pre-eating portion of the activity. However, serious thinking is promoted only if teachers use appropriate wait-time, positive nonverbals, accept students’ ideas, and use students’ ideas to further discussion. Done effectively, only five to ten minutes pass in the pre-eating activity, leaving plenty of time for students to eat and continue learning.

**FIGURE 1**

**Digestion activity.**

**Before you eat:**
1. List the foods you will eat.
2. How many hours have passed since you last ate?
3. List three areas where you feel your salivary glands.
4. Describe how your stomach is behaving.
5. What stimuli are making your salivary glands secrete saliva?

**Answer these questions while you eat:**
6. How many times do you chew before swallowing? How did you determine this answer?
7. Describe in what order you use each type of tooth (for example, where does the food move while you are chewing?)
8. Try chewing without using your tongue. Describe your experience.
9. What are some roles of the tongue, lips, cheek, and roof of the mouth?
10. Try swallowing while sticking your tongue out. Describe your experience.
11. What role(s) do the tongue, cheeks and roof of the mouth play during swallowing?
12. What occurs when you swallow? Order the steps.
13. Where do you think the food will go now? Without looking in your book, trace the pathway and provide what you believe are the functions of each step in the pathway.
14. With a partner develop five questions you could investigate regarding aspects of digestion simply by eating.

**Final observations:**
15. Keep track of all foods you eat until your next bowel movement and then:
   a) Describe the relative color and speculate why this occurred.
   b) Describe the relative texture and speculate why this occurred.
   c) Describe the relative odor and speculate why this occurred.
   d) Speculate on the content of the fecal matter and explain your reasoning.

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Let’s eat!

We ensure students are aware they have tasks to complete while eating and reveal Question 6 immediately before giving permission to eat. While students are eating, we walk around monitoring that students are collecting the required information. Rather than tell students to conduct X number of trials and average questions should be posed such as, “How many trials must you conduct to gain confidence in the number of chews per swallow?” and “How might you present your data so it is understandable and meaningful to others?” For students not keeping track of their work we ask, “How will you remember all your data and ideas?” Another fruitful question is, “What factors affect how many times you chew before swallowing?”

After an appropriate amount of time, we ask Question 7. While monitoring students’ work, they should be asked, “What is the utility of using your teeth in that order?” and “What kinds of food might call for a different order?” After a few minutes we ask students to cut or bite a very small piece of food (no larger than 2.5 cm²). Small ice chips can be used as well. Question 8 is then asked, which always provides entertaining results. While most students claim chewing isn’t possible without the tongue, some students begin tossing their food back and forth by jerking and tilting their heads. After Question 9 is revealed, students easily make connections to what they just experienced.

We then instruct students to stop eating and distribute cups with small ice chips. We ask students Question 10. After students try swallowing the ice chips while sticking their tongues out, we ask Questions 11 and 12. Students come to understand the role of the tongue, cheeks, and roof of the mouth in swallowing. We then reveal Questions 13 and 14, permit students to continue eating, and encourage students to report what they think so we can better plan forthcoming lessons regarding digestion.

The end product

Toward the end of class, we move on to the final portion of the activity. Students are aghast when they see Question 15. After a few moments of acting as if we are serious, we let them know that we are not requiring this task (how would we ever know they actually did what is asked in 15a–c?). We then ask the following, “Assume that a person wanted to check out the end product and associate it with what they may have eaten, how could you know if what was being observed was associated with a particular food eaten?” After appropriate wait-time and perhaps further questions, some brave students claim that corn often goes through the system undigested and that if it was eaten along with the food in question it might provide a tracer. Notably, students do not need to actually perform the observations in Question 15 to raise significant questions in their minds that will be addressed in the digestion unit. This is important for learning about digestion, but also for teaching students that much can be learned about the health of an organism by attending to bowel habits—a personal lifelong habit we promote.

Making multiple connections

This activity creates in students’ minds a “need to know” grounded in everyday experience. Relevant and concrete experiences prior to discussing science concepts illustrated in the activity help students better understand abstract descriptions and explanations appearing afterward in printed material. This in turn helps students make multiple connections grounded in personal experience—necessary components of robust long-term understanding (Clough 2002).

Personal experiences—simply eating, looking in mirrors, watching the movement of the sun, planets, and moon—do not compel students to seriously consider these events and develop ideas consistent with the scientific community’s interpretation. The activity and teacher role described here ensure the activity reflects what is known about how people learn, effective teaching, and powerful science activities (Bransford, Brown, and Cocking 2000). Sensitive addressing these issues also prepares students to consider personal habits to promote healthier lifestyles and personal examinations for signs of illness.

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References


