Using the Anchoring Phenomenon Routine to introduce a science unit

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One way to start a unit is to use an anchoring phenomenon, which serves as the unit focus and requires several science ideas to explain it (Penuel and Bell 2016). The Anchoring Phenomenon Routine (APR) by Reiser, Novak, and McGill (2017) introduces students to the unit of study via an anchoring phenomenon and provides an opportunity for students to describe their observations, ask questions, and develop tentative explanations. Instead of the teacher maintaining sole responsibility of developing the lesson sequence, student questions derived from the APR are used to establish the order of lessons. By using student questions, classroom investigations become meaningful to students because their input affects the learning path (Reiser, Novak, and McGill 2017).

After choosing an anchoring phenomenon for a unit of study, I write an explanation of the phenomenon for myself (Figure 1) to thoroughly think through the science concepts involved in the event. Writing the explanation first is an essential step because it establishes a clear understanding of what students need to know to explain the phenomenon.

**Anchoring Phenomenon Routine**

To introduce students to the anchoring phenomenon, I use the four elements of the APR, which requires students to:

1. explore the anchoring phenomenon through observation and interaction with the phenomenon,
2. attempt to make sense of the phenomenon by constructing an initial explanation based on their observations,
3. develop an initial explanation based on their observations,
4. refine their understanding as they engage in further explorations and discussions.

**NGSS Connections**

**Disciplinary Core Idea**

PS3.B: Conservation of Energy and Energy Transfer

- When the motion energy of an object changes, there is inevitably some other change in energy at the same time.

**Crosscutting Concepts**

Energy and Matter

- Energy may take different forms (e.g., energy in fields, thermal energy, and energy of motion).
- The transfer of energy can be tracked as energy flows through a designed or natural system.
3. identify related phenomena by connecting the activity to other examples or outside-of-school experiences, and
4. develop questions and next steps related to the target science concepts.

For each element, students document their thinking in their notebooks, and later transfer their notes to a class record during the class discussion (Figure 3). Teachers can create a class record on large bulletin boards, chart paper, virtual notepads, or virtual collaboration documents. A class record lists initial student observations, questions, investigations, and explanations posted by the teacher so students can track the development of the concepts being taught. Students reflect on their learning by connecting observations made in the investigation to the bigger picture, and then they plan their next investigative steps (Reiser, Novak, and McGill 2017).

In the first element of the APR, students observe and interact with the phenomenon to develop a tentative explanation, which allows students to ask questions for clarification (Reiser, Novak, and McGill 2017). For example, when introducing the concept of energy, I had students strike together two steel spheres that are separated by a piece of paper (Figure 4). The initial collision between the two spheres creates a hole in the paper, and after a few strikes, the smell of burning paper becomes apparent. I first demonstrate how to strike the spheres together before allowing students to try it. Place students in groups based on the number of spheres available. Even if supplies are limited, all students can have the opportunity to strike the spheres together because the activity is brief. Colliding steel spheres can be purchased from Arbor Scientific and Educational Innovations for under $30. (Note: Safety glasses are required for this activity. Be sure to pick the ball off the floor if it falls to prevent a slip, trip, or fall hazard, and caution students to avoid pinching or smashing fingers.)

After students observe the hole created by the spheres, they often wonder how changing the material between the spheres or increasing the thickness of the paper with extra folds will affect the results. After attempting several trials while following the original directions, students note their observations and

**FIGURE 1: Example explanation**

The central science concepts for colliding spheres are the law of conservation of energy and energy transformations. Mass and velocity affect the kinetic energy of the sphere. The mass of the sphere and its composition are essential to the success of the event. More mass means more kinetic energy. Each colliding sphere has a mass of approximately 454 grams (1 lb.). The spheres are steel, a dense, strong material. Steel does not break or deform on collision, thus transferring more kinetic energy in the form of heat and sound. If, for example, the composition was lead, it would deform on contact, creating a larger contact area. Because the energy transfer is spread over a larger area, the temperature change is less. If the spheres moved slowly to where they only tapped each other with the paper in between, an indentation in the paper is possible, but no hole would be made. Slow-moving spheres have less kinetic energy. More speed means more kinetic energy.

When moving objects collide, they can stop and bring the kinetic energy to zero. According to the law of conservation of energy, the energy must go somewhere. Here, energy transfers in the form of sound energy [hear the collision] and thermal energy [heat]. The smell of burning papers provides evidence of the transferring thermal energy. The thermal energy ignites the paper and burns a small hole. It is possible the spheres retain some energy, causing them to vibrate during the collision, but any energy in the spheres eventually ends up as heat and is dissipated. When we changed the paper to aluminum foil, concentric circles are left in the aluminum foil after the collision. The circles are further evidence of the transfer of energy to heat. The temperature of the aluminum foil rises enough to melt, and then it cools quickly, capturing the circular waves in the melted aluminum.
wonderings in their notebooks. The teacher conducts a class discussion where students share their observations, and then records students’ observations on the class record.

In element two of the APR, students construct an initial explanation for their observations in their notebooks. In this case, students include a drawing of the colliding spheres with their initial explanation with arrows to show movement. Students annotate the picture with phrases describing the forward motion, collision point of contact, and source of heat, and then write a narrative to explain their thinking.

Having students work individually to record their initial thoughts will allow you to track their conceptual development and learning. Most of my students focused on forces creating heat in their initial explanations and failed to recognize the energy transfer. After students record their initial thoughts, they form small self-selected groups to share their thinking. This helps students build a consensus explanation and model that becomes part of the class record. Students then evaluate the different group consensus models to find areas of similarities and differences between the groups.

During element three of the APR, students connect the activity to other examples or experiences they have had outside of
In element four of the APR, students develop questions and further investigations related to target science concepts (Reiser, Novak, and McGill 2017). Students generate questions such as:

- What if the objects were smaller?
- What if we moved the spheres more slowly?
- Why does the paper get hot?
- Do the spheres have to be round?
- What if we changed the object between the colliding spheres?
- Do the spheres need to be steel?

Notice how the questions students generated during step four fit well with the information needed for students to write an explanation of the anchoring phenomenon. For example, by wondering if a hole forms in the paper when the striking objects have less mass, future student investigations connect the concepts of potential energy and kinetic energy to explaining the anchoring phenomenon.

**Conclusion**

Once students complete each step of the APR, teachers use the information on the class record to plan a sequence of lessons designed to address the concepts outlined in their initial written explanation. Student engagement is at its peak because they asked questions in which an answer was not immediately provided, and to make meaning, more investigations are necessary. Sometimes the initial list of students’ questions might miss a concept crucial to writing a complete explanation, which is why teachers must write a complete explanation before carrying out the APR.

**REFERENCES**


**RESOURCE**