Heat

Topic: Heat
Target Age: 5 to 9
Planning Framework: Mythic'
Unit Length: 2 to 3 weeks
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Fire behavior analyst, JOHN MCCOLGAN took this photo while on the Sula Complex fire just north of Sula, Montana, on August 6, 2000. John is a Bureau of Land Management employee for the Alaska Fire Service in Ft. Wainwright, Alaska.

Description

One of the topics commonly studied in the early science curriculum is heat. Commonly these days a significant part of the topic is to deal with the misconceptions that students typically have formed about heat. For example, because they have been encouraged from earliest days to put on their ?warm sweater?, they commonly believe that sweaters are themselves the source of the warmth they feel when they put them on. While such misconceptions will also have to be dealt with in a unit such as the one sketched here, the central focus for our aim to engage students? imaginations in the topic will be a little different, and our starting point, with Greek gods, will also be somewhat unusual.

Unit Outline

1. Locating Meaning:

What is emotionally engaging about the subject? How can it evoke wonder? Why should it matter to us?

In order to help students connect emotionally to the material, teachers need to first identify their own emotional attachment to it. A sense of wonder about something is usually connected to this attachment. Everything that we teach can evoke some kind of wonder and produce some emotional response in us. A sense of wonder and an emotional response to material are important in engaging students' imaginations. So this first question asks the teacher to feel for what is wonderful about the topic. This can be difficult if the topic is Heat, and it has usually been taught for its informational content as a simplified science unit. The trick, though, is to try to re-see the topic of Heat through the eyes of the students, to catch at what can stimulate the sense of wonder about it. Especially when teachers have been taught to become expert at organizing classroom activities and structuring topics into instructional units, this can be hard. It is asking the teacher to do something that is, for most of us, quite unfamiliar—to begin by feeling about the topic.

Sources of meaning:
I often find it helps to pull such everyday science topics out of the routine manner in which we tend to deal with them—informing students in a compact way what we have learned about the topic. What we often do with such an approach is inform students but fail to embed the topic in a dimension that exposes its history and wonder. I find it is often useful, with science topics, to begin with the ancient Greek myths, because they usually present something central to the topic with great vividness, which we can then build the content around. (Those are, after all, the historical bases from which subsequent scientific understanding grew.)

Sources of emotional engagement:
The vivid way in which the ancient myths make clear the power that control over heat gave human cultures and the terrible dangers inherent in that power.

2. Thinking about the content in story form:

How can we shape the content so that it will have some emotional meaning? How can we best bring out that emotional meaning in a way that will engage the imagination?

2.1 Finding binary opposites:

What binary concepts best capture the wonder and emotion of the topic? If this were a story, what would the opposing forces be?

Now to the work of locating the best binary oppositions on which we can construct the "story" we are going to tell. It should be possible to select the one that seems best, though you might want to note some alternatives, in case you find the first set chosen doesn't quite carry you through the lesson or unit as well as you might have expected.

Main opposition: Heat as helper/ Heat as destroyer

Possible alternatives: Hot / Cold

2.2. Finding images and drama:

What parts of the topic most dramatically embody the binary concepts? What image best captures the dramatic contrast?

Here the goal is to identify the drama inherent in learning about Heat. Remember, every topic has some kind of dramatic conflict in it. Which conflict best illustrates the binary opposites we've identified? Again, as the teacher, trying to feel the drama is as important as thinking about it. We are so accustomed to thinking about content, and about concepts, that we often forget that every topic also has a wide range of images attached to it. And the image, remember, can carry the emotional meaning of the topic and can also make the topic much more memorable—if we find a good image, of course. Looking for a core conflict, contradiction or drama that seems to best convey the wonder and emotion of the topic of Heat is easy if we begin with a couple of the Greek myths.

Image or metaphor that captures the binary oppositions:
Prometheus stealing fire from the gods and being punished by Zeus; Phaeton trying and failing to drive Apollo's fiery chariot across the sky; Haephestos, whom the Romans called Vulcan, limping around his workshop.

Content that reflects binary oppositions:
The way uses of heat in human cultures can benefit us or go out of control and destroy us.

2.3. Structuring the body of the lesson or unit:

How do we teach the content in story form?

Having done the hard work that has put in place the basic structuring elements--we've identified the binary opposites and the basic drama--it should be relatively easy to create a narrative plotline of the content. The opposites provide the cognitive and emotional framework of the story. Remember, all good fictional stories are built on a conflict or puzzle; the only difference here is that the "story" content is the curriculum content.

Sketch of overall story structure of the lesson:

So our initial teaching might begin with the myth stories that explain, in an emotionally engaging way, the vital importance of heat to human life, and its dangers. The daring of Prometheus, giving fire to humans, and the terrible punishment of Zeus, show the importance control of heat has played in human civilization. It is a power that has made us like the gods. Phaeton's escapades show what destruction can follow when this terrible servant gets out of control. (Phaeton is allowed to drive Apollo's fiery chariot, which is to us the sun, across the heavens. But he loses control of the chariot's terrible fire-breathing horses and causes devastation on the earth. The god of light, Apollo, quickly regretted giving his child a wish and pleaded, "No,

my child, choose something else. You ask for too dangerous of a gift. Even Zeus, the mighty god of thunder, will not drive the chariot of the Sun. The horses breathe out flames and the chariot itself is fiery hot. So powerful are the steeds that I, a full-grown god, can barely restrain them. What chance would a mortal boy have? The journey is steep and at times I have grown dizzy looking down from the great heights at the Earth below. The path through the stars leads near great, dangerous creatures. You would have top pass Taurus, the giant bull and by the fierce lion. If you succeed in getting past them you would face the Scorpion with its huge deadly stinger and the pinching claws of the great Crab. I beg you to pick some other gift. Think of all the riches in the world or pearls from the boundless sea. Ask for any of these and I shall gladly give it to you." Anyone unfamiliar with these stories can find them in any of a dozen tellings in books of Greek myths. It is very hard to make them dull.)

The middle of our unit needs to elaborate the theme of Heat as destroyer/Heat as helper. The middle of the unit needs to be seen as like the middle of a story. It is not to be developed by simply putting various relevant content in some logical sequence. Rather the teacher must think more as a story-teller developing a theme. So the content selected will be influenced by the theme. We will choose as experiments, for example, not so much those that get at key facts, but those that expose key facts in light of our theme. It is what they expose about the constructive/destructive forces of Heat that matters now. Experiments with heating water and generating steam can tie in with the stories of Hero of Alexander's steam engine, used for religious ceremonies!, and then that of James Watt. These stories need to catch the human purposes, hopes, fears, struggles, of the individuals, and embed their discoveries and inventions in them as they relate to our theme. Experiments using silver or matt black reflectors over glasses of water and measuring the temperatures of the water after they have stood in the sun for some time can be engaged with the theme through wondering how space ships and astronauts can best be protected from the sun's burning rays in space. And so on. The difference in this approach is more a matter of context, and its emotional quality, than in the typical content of such a unit. From here we could move to discuss convection and conservation.

Or one might begin from the story of Haephestos and lead into a study of volcanoes—which were assumed to be flames from Haephestos's workshop. This could lead into ways to measure heat.

There are now a thousand lesson plans available on the Internet, any one of which will suggest experiments teachers can perform to enhance students' understanding of heat. They can easily be incorporated into this unit, as long as each of them is presented as building on our theme of Helper / Destroyer. Usually they will work best if associated with one of the powerful stories with which we began. In the process of moving from our initiating stories, students will learn that heat is a form of energy that moves from hot objects to cold ones, and all the other usual information that typically is dealt with in such a unit, including the common misconceptions about heat (sweater are warm, etc.).

3. Conclusion

How does the story end? How do we resolve the conflict set up between the binary opposites? How much do we explain to the students about the binary oppositions?

Every story has an ending in which the conflict is in some way resolved or at least explained. For younger students a simple resolution may be appropriate; for older students an exploration of the opposites and the dramatic space between them can be explored. The conclusion can therefore take on many forms; from students' presentations, to displays, to a story that shows another form of the opposition being worked out, to dramatic presentations of the story with visuals, and so on. Remember, the conclusion is another opportunity for students to feel the drama of the story and internalize the material while expressing their understanding of it in imaginative ways.

Concluding activity:

Students might be asked to list the ways in which Heat helps their lives, and the ways it is a danger to them or causes them some discomfort or pain. They might then be encouraged to weight the items they have on each side, and write whether they think our needs for Heat in our homes, schools, malls, and so on comes without some great cost. They might like to consider how far we might be behaving a little like Phaeton or whether we are always using Prometheus's gift wisely.

Another conclusion to this unit might come in considering the constructive and destructive potentials of Heat in nuclear power. This urgent present issue is still grasped in the terms given vivid form in the ancient Greek myth of Prometheus and Zeus. Nuclear energy promises a Promethean gift to human beings, but Zeus may wreak vengeance for our attempts to harness his godly power. The myth catches, that is, a way in which we still emotionally orient ourselves to the constructive and destructive potentials of Heat.

4. Evaluation

How can one know whether the topic has been understood, its importance grasped, and the content learned?

Any of the traditional forms of evaluation can be used, but in addition, teachers might want to get some measure of how far students' imaginations have been engaged by the topic. Remember, various kinds of information evaluations, including discussion, debate, art-work, journal writing, experiment analysis etc. can be done as the unit is being taught.

Forms of evaluation to be used:

Evaluation of such a unit might be gained from traditional kinds of evaluation instruments -- from informal questions which require that children have learned the basic facts and understood their relationship to the main theme to more formal assessments at the conclusion of the unit. What this kind of framework also calls for, however, might be something written, dramatized, drawn, that gives evidence of the emotional impact of the unit while using supporting knowledge, skills, and understanding. So students might be invited to express their strongest feeling about heat, indicating the areas of their lives where it is most valued, and those in which it is most feared.