THE DARKNESS OF SPACE

A Teaching Strategy

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Abstract. This study examines the process by which a teacher may be able to answer a question asked in the classroom by using a scientific approach and a simple activity. This article examines a discussion of the question *Is space light or dark?* Priority in the discussion has been given to determining students' preconceptions about the interaction of light and matter. After this discussion, a classroom activity simulating the phenomenon of space helps students answer the questions they have posed.

Keywords: light and matter interaction, scientific approach, space

An observer looking at the sky on a moonless night will see that the dark regions of space are decorated with planets and stars. At sunrise, these decorations disappear as the sky is wrapped in light and blueness. With the appearance of the sun, the black background of the nighttime decorations turns into a blue setting. This is a common sight for a rural observer. Many people who are not observing with a scientific eye would regard this as a natural phenomenon. When the same phenomenon and series of events in which light and matter take a leading role are perceived with a scientific perspective, however, excitement increases. The question *How?* opens the door to scientific thinking. How is it that in the same sky, rays of sunlight reaching the Earth at different times of the day can cause such different effects?

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An elementary school teacher explaining to a science class why the Earth is dark during the night and light because of the sun during the day may have difficulty answering a pupil's follow-up questions. The child might ask, *Is space light or dark?* It is not easy for a teacher with no previous preparation to come up with a scientific answer to this question in the classroom environment.

Supporting Scientific Thinking by Reverse Questions

The best thing to do to answer a question like this is to increase the extent of the child's thinking process through activities that show an interaction of light and matter. Is space light, or is it dark? This question is beyond the experience of a teacher or child who has not taken an actual journey through space. How can we then carry the concept of space into our own environment? It may be helpful to start with the following question: If the sun is close to Earth and has the power to give us light, why is the sky dark?

In our discussions of this question, we established that middle school students, as well as science teacher candidates, have the following preconceptions about this subject:

1. Light can be seen.
2. Because the Earth is light during the daytime, space is also light.
3. Because the Earth is dark during the night, space is also dark.
4. Light can illuminate the environment without the presence of atmosphere or particles.
5. The sun, or other stars like the sun, can illuminate space.
6. Light rays follow a nonlinear route.

Most of the participants in the discussions thought that space is light. After helping them think by asking them the question, *Is space like we see it during the day or is it like we see it during the night?* we observed that several people changed

their minds and said that space is dark. In this discussion, we concentrated on two possibilities, rather than on the concepts of light and dark. Both possibilities are logical and commonly experienced situations. The students had different arguments for each situation. Would it be possible to find a common argument that explains both situations on Earth?

Setting Up an Experiment

When we turned off the lights in the laboratory downstairs, the environment became dark. It became light again when we turned the lights back on (see Figures 1, 2, and 3).

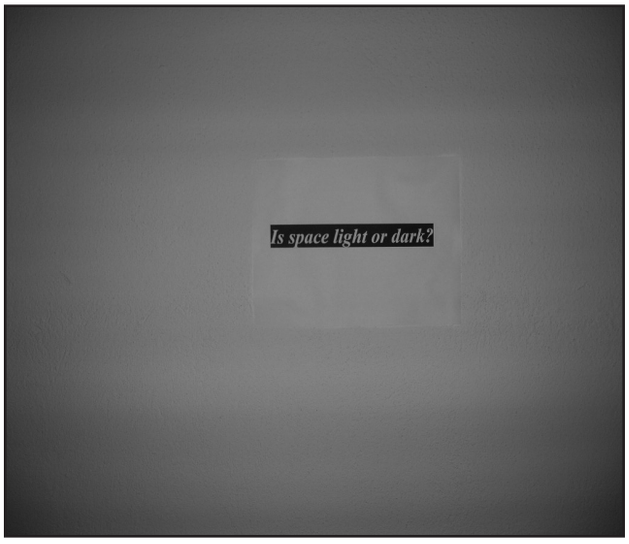

FIGURE 1. The screen can be read when the light is on in the laboratory environment.

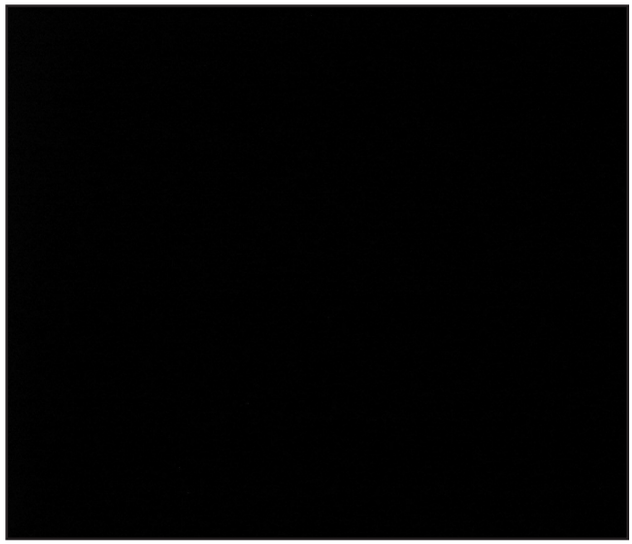

FIGURE 2. The laboratory environment gets dark when the light is off, so the screen cannot be read.

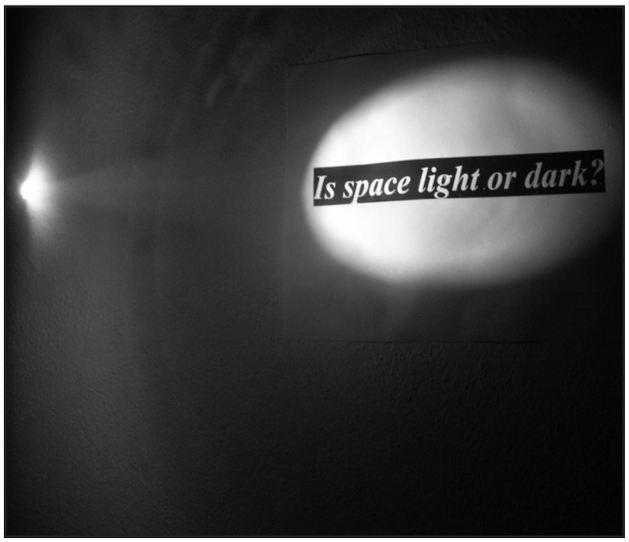

FIGURE 3. The screen can be read again when a flashlight is on.

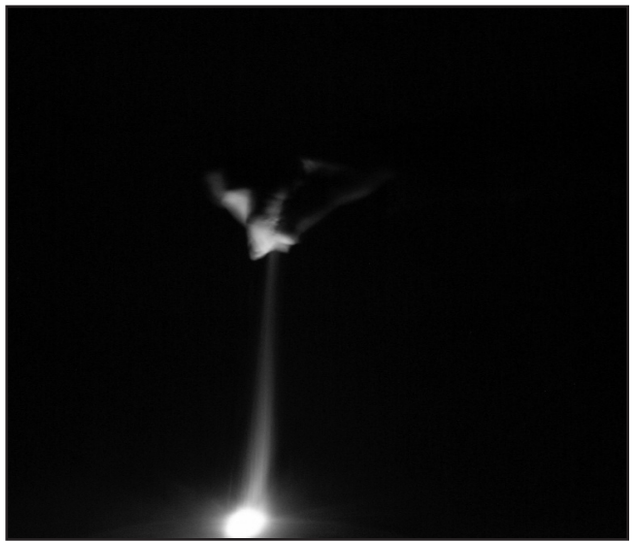

FIGURE 4. Light disperses on a linear route.

The first variable in this phenomenon was the presence of the overhead light, which played a basic role in the event.

Second, when we lit up a laser beam instead of a light bulb in the same room, we could see no effect between the source of light and the object that the light hit. Although there was a source of light, the linear beam did not light up its way when it did not interact directly with an object. When we scattered some particles of dust along the route of the light, the light's path became illuminated (see Figure 4). Light disperses on a linear route, but when it interacts with an object, the object lights up and becomes visible. When there is no interaction between light and matter, the light simply continues on its linear path.

We can conduct this experiment in the classroom by using a small box with holes cut out of the top, the bottom, and one side. When we hold a source of light to the bottom of the box, students can observe dust particles scattering from the top. They can also see what is happening inside by looking through the hole on the side of box. They become aware of the presence of the light as the dust particles scatter. If this brief experiment and the other activity in the dark laboratory are an example of the same concept, can the same be true in space?

Conclusion

If we consider space as a void, the stars as a source of light, and all the other masses without their own light sources (planets, satellites, meteors, etc.) as particles, we may think that only masses in space are lit up. Since light becomes visible only when it hits a mass, it would be light when the Earth and its atmosphere are turned toward the sun, but it would be dark under other circumstances. Furthermore, whether it is day or night, everything outside of the atmosphere (i.e., where particles do not exist) is dark. What is meant here is not an absolute darkness, but rather a nonabsolute darkness similar to what we experience in the sky each night.

At the end of the experiment with middle school students, science teacher candidates, and active science instructors, most participants changed their minds and agreed that space looks similar to the darkness that we see in the sky every night.

Implications for Classroom Teaching

This activity has been a classic in science teacher demonstrations. By using a small box with holes cut out of the top, bottom, and one side; a light source; and dust particles, many teachers have drawn parallels with what must be true in space (e.g., Croswell 2001; Science Spot 2009; Strobel 2009; Zoom School 2009). However, we tried to use this hands-on activity in an expanded manner to help correct preconceptions related to light and matter interaction. We believe that this science content–rich study can be used by science teachers who are looking for more than a quick how-to demonstration and who approach the physical world by simplifying its complex structure without destroying its essence.

This also is parallel to the National Science Education Standards (National Research Council 1998) statement that "students' understandings and abilities are grounded in the experience of inquiry, and inquiry is the foundation for the development of understandings and abilities of the other content standards. . . . Students need solid knowledge and understanding in physical, life, and earth and space science if they are to apply science" (104). In summary, students demonstrate an understanding of the natural world by learning about the composition of physical systems and the concepts and principles that describe and predict physical interactions.

The subject of interaction between light and matter is included in both middle and high school curriculum goals to teach students the linear propagation of the light and illuminate when across objects. Vision can only happen when light, eye, and objects come together. Consequently, this activity can be used as a start-up lesson for teaching light in physics classes intended for middle schools, high schools, and even science teacher candidates.

Answering questions we are asked spontaneously in the classroom environment is made easier through the use of scientific thinking and simple activities, and these methods are also the key to other kinds of questions we may encounter. In addition, treating and finding answers to everyday phenomena by means of scientific logic increases and broadens our sense of excitement, surprise, and curiosity. In this way, the attempts of teachers to understand the natural world have a positive effect on the wealth of their thinking process. Carrying this enthusiasm into the classroom makes an important contribution to increasing the learning motivation of the class as a whole.

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