UNDERSTANDING A COMPASS

PLANNING YOUR EXPEDITION

Check that your compasses have been stored properly. Magnets close to the compasses will affect their accuracy. Also, be aware of metal objects near, in, or under the desks or work tables that could affect students' results.

Most students are aware that compasses are used to determine direction in some way. They may have experience through scouts or camping. However, where do compasses come from and how are they used? Do they really point north? How do magnets affect a compass? These are some of the questions that students will ask and answer by completing this activity. This Expedition is used in conjunction with others, and compasses will be used in a practical application in Expedition # 19 "Making a Map Using a Compass."

The invention of the compass in its present form transformed travel and exploration. Many times students believe that an invention has to be "big" to be important. It is possible that they miss the tremendous effect that "smaller" inventions have on the development of culture and society. Certainly the compass is one of these that is easily overlooked by middle school students. The intention is to introduce compasses as measurement instruments, to begin to articulate how magnetic fields affect a compass, and to discuss compasses in relation to the development of culture.

This activity can be used in a number of places according to your preference. You may wish to use this before Expedition #7, which focuses on the difference between magnetic north and geographic north.

1. Have students write in their Alpha Logs what they know about compasses. Pass out compasses to each student and allow them to observe and investigate their behavior, characteristics, and properties. By encouraging individual, unstructured observation, students begin to articulate their own ideas about compasses and take a look at preconceived ideas about what they think a compass is and what they think it does.
2. Allow students to begin their work investigating how the bar magnet affects the compass. They may, at this point, go beyond noticing that geographic north and magnetic north are different, to noticing the tilt of the compass needle. (You may wish to refer to the CD-ROM and the work of Robert Norman who first noticed this tilt.)
3. As students work they will write observations, draw conclusions, and state explanations about what they are experiencing in their Alpha Logs.
4. Groups share with one another or with the class as a whole, their findings. At this point, students could share their homework ideas. This activity may change their ideas about early explorers and adventurers. It is important that they articulate ideas before

BACKGROUND

For a detailed history of lodestones and the development of compasses, see Hidden Attraction: The Mystery and History of Magnetism by Gerrit L. Verschuur (Oxford University Press, 1993).

Early scientists and travelers noticed a particular quality of a rock found in Magnesia in northern Greece. This rock became known as a lodestone and was observed to attract iron and repel like stones. The observation of magnetic properties led to the further discovery hat the lodestone always pointed toward the mine in which it was found. However, on closer examination, it appeared all lodestones actually pointed in the same direction, not just to the area in which they were found. Using the North Star (Polaris) as a point of reference, it became clear that there was a definite north-south orientation to the lodestone.

Finding a way to measure and study this phenomenon resulted in early attempts at manufacturing compasses. Once sailors started using compasses, they realized that there was a distinction between magnetic north and geographic north. Manufacturing compass needles became important as did the directions that went with them enabling sailors to remagnetize the needles with a lodestone when necessary. So, sailors still carried with them the original compass, the lodestone, as well as the new technology.

EXCURSIONS

Either read to students or have them read "How We Were Tracked By A Tripod" by John Christopher, in Science Fiction Stories edited by Edward Blishen (see Appendix C). Students can create an explanation of how the Tripods are tracking the main characters. Are they using compasses? If not, could they have used compasses? How does the metal enable the Tripod to track the boys? By answering these questions (and any others either you or the students formulate), students are encouraged to find a relationship between the activity they did and a fictional adaptation of that information.

SC.C.2.3.1-3

LA.A.1.3.1-4, 2.3.1-8, LA.E.2.3.8

Lodestones were the basis not only for scientific advancement and the evolution of science but for myths and legends that sought to explain the magnetic phenomena. Early investigators had little science knowledge with which to explain their observations, so they resorted to using what they did know--the natural world. Early on, observers thought that lodestones all pointed toward Polaris because of a celestial connection. Have students create their own explanations with reference to natural phenomena to explain lodestones. This will prepare students for predicting outcomes and explaining results.

SC.C.2.3.1-3, SC.H.1.3.1-7, 3.3.5-7

SS.A.1.3.1-3, 3.3.1-3

Gulliver's Travels by Jonathan Swift contains a section about a magnetic island that can be rotated. The island is made of lodestone and the magnetic qualities of lodestone are used as the basis for explaining how the island was moved and why. Reading this aloud and basing class discussions upon Swift's explanations for natural phenomena serves as a vehicle for students to clarify their own ideas about magnetism (see Annotated Bibliography, Appendix C).

SC.C.2.3.1-3

LA.A.1.3.1-4, 2.3.1-8, LA.C.1.3.1-4, LA.E.2.3.8

Design a bulletin board that indicates the north-south orientation of the bulletin board and presents information on compasses, their history and characteristics, influences on modern technology (for instance, navigational devices). Translating what students have learned into language that makes it clear to others is a way for students to gain a deeper understanding of the subject matter.

SC.C.2.3.1-3

Serendipity is a word that is used in reference to scientific discovery and innovation. One cannot help but notice that some events appear to happen in a random fashion. Students might ask "what if?" type questions. "What if Christopher Columbus had not said three days but had said two?" "What if the crew asked a week before they did?" [See "Homework."] "What if Clyde Tombaugh was on vacation the week he was able to detect Pluto?" This type of questioning can get students started thinking about the way scientists ask and answer questions. Questioning is a way to model behavior that is done in real-world situations. A good source of serendipitous scientific discoveries is Odyssey magazine, Cobblestone Publishing, 7 School Street, Peterborough, NH 03458.

SC.H.1.3.1-7, 3.3.5-7

SS.A.1.3.1-3, 3.3.1-3

Notes:

FOR YOUR PLANBOOK: Understanding A Compass

Suggested time: 1 hour

Gear: bar magnet, compass, drawing paper

National Science Content Standards: A, B, E, F, G

Sunshine State Standards Benchmarks: SC.C.1.3.1, SC.C.2.3.1, SC.C.2.3.2, SC.C.2.3.3, SC.H.1.3.1, SC.H.1.3.2, SC.H.1.3.4, SC.H.1.3.5, SC.H.1.3.7, SC.H.3.3.5, SC.H.3.3.6

Sunshine State Standards Benchmarks -- Language Arts: LA.B.1.3.1-3, 2.3.1-4

Sunshine State Standards Benchmarks -- Social Studies: SS.A.1.3.1-3, 2.3.1-5, 3.3.3, SS.B.1.3.1

Homework: Allow students one week to complete this assignment. According to information found in Hidden Attraction (see Appendix C), Christopher Columbus carried on his voyage to the new world a lodestone with which to magnetize compass needles. The tale goes that as his crewmen grew more and more impatient he made a deal with them: They would sail west (according to his compass) for a specified time after which, if they did not see land, they would turn around and sail home. Have students speculate in writing where Christopher Columbus might have landed if he had the ability to determine geographic north rather than magnetic north. To accomplish this task, students will be required to research Christopher Columbus' voyages, where he first landed and subsequent landings. They will determine, by measuring the angle of declination (see "The Earth's Magnetosphere"), where Columbus might have landed or *if* he would have reached land at all.

Homework Assessment: Look for a synthesis of ideas from the students as to how far-reaching one incident in history can be. The papers that are turned in should ask questions such as, What if the sailors had made their demands a day (or week) earlier? What if the lodestone was not closely guarded? Research papers should include indication of the difference between magnetic and geographic north in a way that connects with historical events. The most important lesson to be learned from this assignment is the relationship between scientific discovery or invention and how we view things now.

Assessment: Check Alpha Logs for preconceived ideas about compasses. The Logs should demonstrate that students have moved beyond the basic idea of a compass pointing north to the fact that it is a measuring device. Beyond that, the Logs should indicate a realization that there are misconceptions about compasses (they always point north) that the students can now explain.

Students organize a panel to debate old versus new technological developments. The discussion should indicate a knowledge of the layering of scientific innovations; students recognize that each new technology that is advanced is done so after a period of refinement based on earlier discoveries. The compass is an excellent example of this. The debate format will assist some of the students who are still having trouble envisioning a compass as technology.

Have students write a fiction story that includes a homemade compass as the device that either helps someone in the story or is the focus of the story. For instance, soldiers in World War II had compasses in their buttons in case they were taken prisoner; or a magnetized needle could be included in a package to a prisoner who would then use it to make a compass to find his way home. In order to do this effectively, students will be asking critical questions and analyzing them. Look for clear answers to well-articulated questions.

Have students create compass art to be displayed around the room or around the school. Classes could compare the work developed and discuss in large or small groups the relationship of artwork to science and math (if students made the leap from the compass to geometric shapes). This assignment demonstrates the link between art and technology, science and art, and creativity in science.

UNDERSTANDING A COMPASS

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Finding a way to measure and study this phenomenon resulted in early attempts at manufacturing compasses. Once sailors started using compasses, they realized that there was a distinction that needed to be made between magnetic north and geographic north.

Manufacturing compass needles became important, as did the directions that went with them enabling sailors to remagnetize the needles with a lodestone when necessary. So, sailors still carried with them the original compass and the lodestone, as well as the new technology.

1. Write in your Alpha Log everything that you know about compasses. Do not worry about whether you are "right" or "wrong."
2. The Materials Manager should collect your equipment: a compass for each group member, bar magnet, and drawing paper.
3. Now, make another list in your Log of characteristics and properties of a compass. If there is anything that makes you believe that you were incorrect in your first list, cross out those items.

4. Place the bar magnet on your desk with the north pole pointing away from you. Place the compass on the magnet so that the north-seeking end of the needle points to the north pole of the magnet. Observe what happens to the compass needle and draw a picture in your Alpha Log. Discuss the following questions with your group and answer them in your Log:

   1) Is the needle of the compass still pointing to the north pole?

   2) Is this what you expected to happen?

   3) Why do you think this happened?

   4) What do you think will happen if you move the compass around the magnet?

   5) Explain your answer.

5. Before you test the theory that you have just expressed, make a group decision as to how you want to record your further investigation. Do you want to write your findings in sentence form? Do you want to draw a diagram each time you move the magnet? Do you want to make a model? Can you think of any other way to display your information? You will be sharing your findings with other groups, so be creative!

6. Test the theory that you set forth in answer to the questions above. Move the compass around the magnet. Since each time you move the compass you introduce another variable, you might want to measure the distance you move the compass so that you are consistent. Record the results of each trial in the manner you and the group decided in Step 5.

7. Share your results with another group. In your Log write several paragraphs about what you shared, what you learned from the other group, and this activity in general.