Light Pollution

ACTIVITY 1

Objective

In this activity, students will observe that the faintest stars which they can see in the sky are affected by many things: the adaptation of their eyes to the dark, the presence of clouds or haze, the time of year, and the presence of light pollution.

General Information

This activity is for students at the grade 6-12 level. It can be performed by individual students but, for safety and social reasons, it is best completed within a group. If possible, different students, or groups of students, should observe from different kinds of sites — a street corner, backyard, park, rural or wilderness site, etc. It takes about 30 minutes of evening work, plus time to discuss the results in class. The observations lead to discussion of how certain factors or variables affect an observational result. The activity may lead to an interesting investigation of how the eye adapts itself to the dark. Note, however, that this is not a test of vision. Different students will have different visual sensitivity. This is just one more variable to be controlled.

Background Information

Two thousand years ago, astronomers called the brightest stars "first magnitude" and the faintest stars "sixth magnitude." Brighter stars, therefore, have smaller magnitudes. Now the magnitude system is a quantitative way of specifying the apparent brightness of the stars. The faintest star that an observer can see at a location at a given time is called that site's "limiting magnitude," a measure that depends on many factors.

Ursa Minor (The Little Bear), including The Little Dipper asterism, is a constellation which can be seen throughout the year from the northern hemisphere. It has stars ranging from magnitude 2.02 (the brightest) to fainter than 6.00. In some urban and/or light-polluted locations, even the 2nd-magnitude stars may be invisible. A few bright stars (like Capella, magnitude 0.08, in nearby Auriga) will then have to be added.

What the Students Will Do

- locate Ursa Minor in the night sky
- record the conditions under which they observe the constellation
- determine the faintest star which they can see in the constellation and
- note its magnitude (their limiting magnitude)

Materials List

Students will need a seasonal star chart; this can be obtained from most astronomy magazines. They will also need a chart of Ursa Minor, showing the magnitudes of the stars (Figure A1-1). Optionally, you may want to provide your students with a standard form on which to record the information in item (5) below.

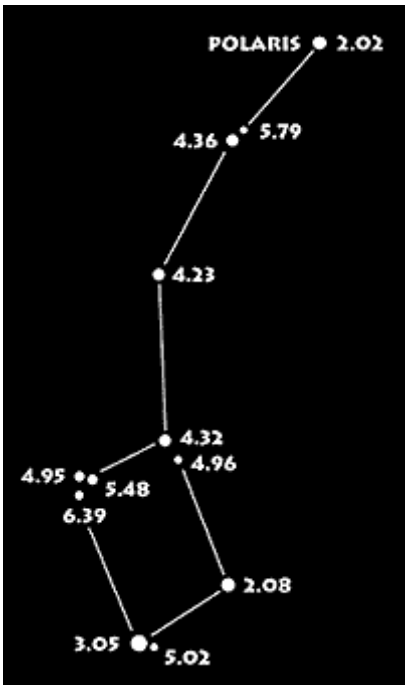

Figure A1-1

Doing the Activity

In this activity, look directly at the stars and constellations, rather than looking out of the side of your eye ("averted vision"). Averted vision may be more sensitive, but it introduces an additional variable into the activity which is difficult to control.

1. Use your seasonal star chart to locate the Big Dipper, Polaris (the Pole Star), and Cassiopeia. Ursa Minor curves back from Polaris towards the end of the handle of the Big Dipper.

2. Use the chart A1-1 to identify as many of the stars in Ursa Minor as possible.

3. Record the magnitudes of the faintest stars in Ursa Minor that you can see. Which star is the faintest (has the most positive magnitude)?

4. Remain outside, in the dark, away from bright lights, for at least 15 minutes more. Repeat the observation, and record the results. When you have finished your observations, you may want to return to a more normal light-polluted location to show the huge loss in limiting magnitude.

5. Record the following information about your observing conditions: (a) place of observation (be as specific as possible); (b) comments on the location, especially with regard to lighting; (c) comments on the sky conditions; (d) number of minutes that you have been in the dark; (e) comments, if any, about your eyesight; (f) comments about your experience as a sky observer — are you a beginner or an expert?

Evaluation

The evaluation will be based on the student's report on and discussion of the results. Have they provided clear, complete information about their observation? Do they have an appreciation of the factors (variables) which might affect their limiting magnitude?

Closure

Students will observe that their limiting magnitude depends on the extent to which their eyes have adapted to the dark and on the brightness of the sky. This depends on the presence of natural light (the Moon) and artificial light (light pollution).

ACTIVITY 2

Objective

In this activity, students develop a plan to reduce light pollution by identifying the sources of the problem, the scientific and technological issues involved, the possible solutions, and the technological, economic, and political processes for achieving those solutions.

General Information

This activity can be done at the grade 6-8 level, but it is most suitable for the grade 9-12 level because the societal issues may be complex. Students can work in teams of three to five, with each team member assigned to specific tasks. The activity is open-ended, so it may be done quickly in a brain-storming format, or it may become a term project. This activity can integrate science and technology with social sciences such as business, economics, and politics.

What the Students Will Do

- prepare a clear, concise report on the problem, including the scientific, economic, and societal issues
- list the options available to solving the problem, and the pro's and con's of each
- choose the most promising option, even though it might not be ideal
- identify the methods and channels for implementing this option
- act!

This activity, therefore, provides a "model solution" for dealing with other science-technology-society issues.

Doing the Activity

1. Choose any light pollution problem that you have identified in your neighborhood. It may be light trespass from a security light next door to your house. It may be glare from a high-intensity light in your schoolyard. It may be all-night illumination of a playing field or used-car lot. It may be inappropriate lighting of your local street or highway.

2. Prepare a brief report on the problem, which includes the scientific, technological, economic, and other societal issues. Is the lighting efficient? Effective? Safe? Attractive?

3. Through brain-storming, identify possible solutions to the problem, and list the pro's and con's of each. Discussions with others will be helpful and can lead to understanding.

4. Use discussion and consensus to choose the most promising solution.

5. Determine what is necessary to try to implement that solution. What information do you need? What diplomatic or political channels can you use? Prepare a plan of action.

6. Act!

Evaluation

The students will be evaluated on their project report and their ability to discuss the issues involved.

Closure

After completing this activity, students should have a better understanding of the practical processes for dealing with the light pollution problem and with other environmental and societal issues.