"Twinkle, twinkle, variable star."

REAL SCIENCE FOR REAL KIDS

Chuck Bueter
Adler Planetarium
1300 S. Lakeshore Drive
Chicago, IL 60605

Abstract: Science comes alive for high school students in a hands-on, minds-on program at Adler Planetarium. Students use observatory equipment to conduct research on variable stars.

In recent years, several national studies[1] have assessed the achievements of American high school students. The studies clearly suggest that students must get hands-on experience using the tools of the scientific trade if they are to meet the challenges of the future. Adler Planetarium has developed a pilot program that allows students to conduct research on variable stars using the tools of astronomy. Initial results suggest the pilot program is meeting its objectives and can be replicated for use in additional classrooms.

The Doane Observatory, adjacent to the planetarium, is an obvious site for having student activity. As Douglas Hall of Vanderbilt University puts it, "A telescope unused is a telescope wasted."[2] However, a project using an Adler-based telescope has to overcome or accommodate hurdles common to planetariums in Midwest cities. Light pollution is the greatest adversary, for the Doane Observatory is near the heart of Chicago. Additionally, clouds frequently interrupt viewing schedules in Chicago, so the experiment has to tolerate intermittent data gathering as well.

Perhaps the greatest challenge in initiating any new research is finding an experiment appropriate to the facilities. The program has to be neither too hard nor too soft—too hard in that it is beyond the capabilities of the existing equipment; too soft in that it has already been done before and would merely be a redundant exercise.

The study of variable stars represents one of the great areas in science in which amateur astronomers can make genuine contributions to professional research. For intrinsic and extrinsic reasons, certain stars vary in brightness. The process by which amateurs measure the stellar fluctuations is straightforward. The magnitudes of variable stars are visually and photometrically compared to the magnitudes of known-value stars.

A network of amateur astronomers funnel their observations to the American Association of Variable Star Observers (AAVSO), which acts as the main conduit between amateur observers and the professional researchers. The AAVSO notes astronomers seek its services "to receive real-time, up-to-date information on unusual stellar behavior; to assist...programs using earth-based large telescopes and instruments aboard satellites; to correlate optical data with [instrumental data]; and to carry out collaborative long-term data analyses on the behavior of (particularly) large amplitude variable stars."[3]

The pilot program underway at Adler is entitled the Variable Star Program, or VSPr (Vesper means "evening star"). The intention is to have high school students gather data from the Doane Observatory by utilizing its 20-inch Cassegrain reflector telescope, its Photometrics CCD imaging system, and an Optek SSP-3 photometer borrowed from the Yerkes Observatory. As the program matures, students who gather data on-site will distribute images on computer disks or by modem to off-site participants. All other VSPr activities can then be performed off-site.

VSPr goals and objectives were pooled from several existing sources, including the national studies previously cited and Adler's Strategic Long Range Plan. Further direction came from National Science Foundation (NSF) grant guidelines[4].

In order to assess the program, the participants were asked prior to their first class to complete a 50-question, baseline survey. Some of the questions parallel those in the *1990 Science Report Card;* some are based on objectives from NSF grant guidelines; and some address my personal curiosities about the students' interest in astronomy and research. At the conclusion of the experiment, the students will be asked again to complete the survey.

As with any experiment, the researchers need background information on the subject and techniques for studying it. Therefore, a user's handbook was compiled to enlighten all VSPr participants—the students, their teachers, and myself—on this astronomy specialty. The handbook opens with a suggested curriculum outline, for many teachers who delve into VSPr's brand of hands-on science may be uncomfortable developing a new curriculum. After introducing students to basic, naked-eye observing procedures, the manual addresses the particulars of manipulating the telescopes and computers. The role of amateur observers and the AAVSO techniques for observing variable stars comprise much of the remainder of the

handbook.

Twenty four high school students participate in the pilot program, with VSPr being an adjunct to their astronomy class. All participants will maintain a journal of their activities, determine magnitudes of two naked-eye variable stars, visit the observatory at least once, and submit a statement on their VSPr role and results.

Each student has signed up for his/her own role in this group project, for not all students can come downtown to gather data at night. For example, student photographers will videotape observatory procedures, variable star observation techniques, and recording methods for use in teacher workshops. Writers will draft funding requests; maintain correspondence with researchers, donors, and news sources; and submit their findings to journals[5] dedicated to high school researchers. Artists will make VSPr Handbook improvements and collaborate with Adler's exhibits department in designing a VSPr display. Computer operators will store, extract, enhance, and evaluate recorded images from the observing runs.

Initial on-site observing runs have been very successful. Students have become familiar with specific stars and constellations, and they have demonstrated competency in using the observatory equipment. I want to stress that the positive results are apparent in both the cognitive and affective domains. It is difficult to deny the students are interested in using the observatory when, on their own accord, they choose to observe nearly every clear night from twilight to well after midnight. Notably, the most active participants in on-site observing are females, who are usually greatly under-represented in the sciences.

After becoming familiar with the sky through naked-eye stargazing, the students get hands-on practice with telescopes, ranging from a 3-inch refractor to a 20-inch reflector. By trial and error they are isolating *their* stars (in an inverted, backward field) and measuring their brightnesses. Soon the students will begin gathering data on variable stars in the Pleiades star cluster. A few Pleiades stars have some unusually high spin rates, which the students will investigate.

———————————

How can you involve your visitors, students, or members in real science without building a major observatory?

First, I recommend you get a feel for variable star astronomy by reading some good reference materials, such as David Levy's *Observing Variable Stars*[6].

Second, contact the AAVSO[7]. Right now they are seeking amateurs to contribute observational data to researchers who are using the Extreme Ultraviolet Explorer (EUVE) and HIPPARCOS satellites. The AAVSO is exceedingly courteous in helping new members establish observing programs.

Third, start off by observing variable stars that are within the limits of the naked eye or binoculars. Bright stars such as Beta Lyrae, Delta Cephei, Algol, and Betelgeuse are among the ranks of variable stars in need of amateurs to study them.

The study of variable stars is *real* science for everybody — the students, the teachers, the scientists with whom they collaborate, and organizers such as myself. If you are not in an observer-friendly site, yet you want your patrons to get hands-on experience in original research, variable stars offer many opportunities.

Works Cited

1 *A Nation at Risk: The Imperative for Educational Reform* (Washington, D.C.: Office of Technology Assessment, 1988).

Educating Americans for the 21st Century: A Report to the American People and the National Science Board, (Washington, D.C.: The National Science Board Commission on Precollege Education in Mathematics, Science and Technology, 1983).

The 1990 Science *Report Card,* Lee R. Jones et al., (Washington, D.C.: The National Center for Education Statistics, 1990).

Science for All Americans: A Project 2061 Report on Literacy Goals in Science, Mathematics, and Technology (Washington, D.C.: American Association for the Advancement of Science, 1989).

2 *The Study of Variable Stars Using Small Telescopes,* John Percy, ed. (Cambridge: Cambridge University Press, 1986), p. 69.

3 The American Association of Variable Star Observers (AAVSO) statement sheet, (Cambridge, *1992).*

4 *Materials Development, Research, and Informal Science Education: Program Announcement,* (Washington D.C.: National Science Foundation, 1991).

5 *The Journal of Student Research*

Journal of High School Science Research, (Tigerville, S.C.: Applied Educational Technology).

6 *Observing Variable Stars: A Guide for the Beginner*, David H . Levy, (Cambridge: Cambridge University Press, 1989).

7 Dr. Janet Mattei, Director, AAVSO
25 Birch Street, Cambridge, MA 02138
(617) 354-0484