Using Variable Star Research to Enhance Scientific Literacy in High School Students

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Abstract

I present examples of how the study of variable stars by high school students can be used to develop and enhance functional scientific literacy. Over the course of a high school semester, students conduct background research on several variable stars, decide on a suitable star to study, use a combination of school telescopes and robotic observatories to gather data, reduce the data and then present their results.

Gains in the development of scientific literacy are most obvious in the areas related to asking questions about the natural world, making empirical observations, applying scientific theories to problems, critically evaluating observations, clearly communicating findings, and using the epistemic and content knowledge to make informed decisions in their daily lives.

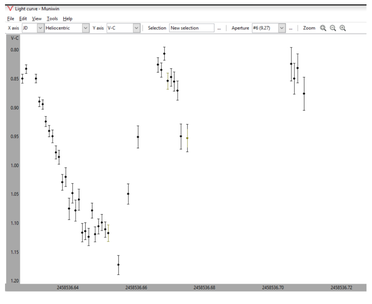
Introduction

Variable Star Research with High School Students

During a semester-long course spanning five months, students in high school astronomy classes between the ages of 14 and 17 were introduced to variable star research. Students completed background research on several variable stars before selecting one to study in detail. The selection of variable stars was guided by students' interests and was often motivated by stars they had read about in popular media or read about on the internet. Over the past four years, these have included KIC 8462852 (Tabby's Star), HDE 226868 (the companion star of Cygnus X-1), and BL Camelopardalis among others. During the research phase of these projects, students were tasked with learning about the star's astrometry and physical properties. The research was guided by teacher instruction, online simulations, and AAVSO resources such as the Variable Star Index.

Over the next four months, they used school telescopes or gathered data using Skynet's (https://skynet.unc.edu/) robotic telescope at Athabasca University. While data was being gathered, students used the AAVSO DSLR observing manual, Variable Star Plotter and Variable Star Index students to develop an understanding of how to reduce raw data and produce light curves. Data reduction was completed using either Muniwin or IRIS.

After completing their data reduction, students created a presentation or wrote an article summarizing their project. In one case, this culminated in a peer-reviewed article (Atiah et al., 2018) and in another, a presentation to the Royal Astronomical Society of Canada.



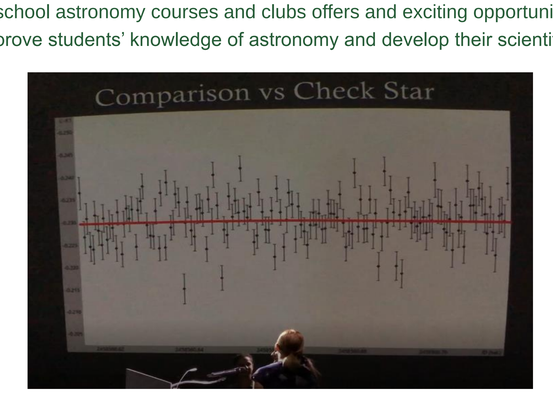
Left: Students taking photographs of their chosen target stars outside of the school. Right: Partial light curve of BL Cam produced by students using Muniwin.

Understanding Scientific Literacy

The development of Scientific Literacy has been one of the most significant themes of science education since the 1960s (Shamos, 1995). Despite the prominence Scientific Literacy has taken in education there is little evidence showing educational efforts of the past three decades have produced significant changes in scientific literacy. Although it is challenging to measure scientific literacy in the population, estimates indicate that fewer than 15% of the American population is considered scientifically literate (Miller, 1983).

The situation is complicated by the lack of clear definitions for what constitutes scientific literacy. Current thinking focuses on the need for reasoning skills in social contexts that focus on everyday problem-solving and thinking (Holbrooke and Rannikmae, 2009). This has comparatively little to do with discipline-specific knowledge or skills. There is also little conclusive evidence that learning more science content directly equates to improved scientific literacy.

Despite this, astronomy in general, and variable star research in particular offers a fruitful arena for developing an interest in science, reasoning, and problem-solving skills (Price & Lee, 2013) all of which are important parts of scientific literacy. Although most research on the intersection of astronomy and scientific literacy focuses on informal learning or citizen science projects, the development of high school astronomy courses and clubs offers and exciting opportunity to both improve students' knowledge of astronomy and develop their scientific literacy.



Students presenting to the Royal Astronomical Society of Canada on the results of a their study of BL Camelopardalis

Conclusion

Variable star citizen science research projects give students numerous opportunities to develop astronomical content knowledge while developing their scientific literacy. When appropriately designed, students define the problem to be studied and ask their own research questions. With a small degree of astrophotography experience, students are able to gather their own data and be directly connected to the analysis and evaluation of that data. Public interest in astronomy also provides several opportunities for students to present the results of their work and communicate their understanding of astronomy and science.

These are important aspects in the development of citizen science and provide an effective pathway for using variable star research in high school environments.

Astronomy & Scientific Literacy

Astronomy is a strong motivator for high school students to learn about science. Rather than use variable star research to teach science content, which has limited impacts on scientific literacy, the motivation for these research projects was to use variable star research as a context for students to develop the skills and attitudes needed to be scientifically literate.

Decades of research (Holbrook & Rannikmae, 2009, Shamos, 1995) have led to five important aspects of scientific literacy that need to be better developed in high schools.

1) Defining and asking questions about the natural world.
2) Making empirical observations and understanding the important role these observations play in scientific discovery.
3) Critically evaluating experiments, observations, and conclusions.
4) Clearly communicating about science.
5) Making informed decisions about issues that involve science.

Students' initial research and selection of a topic was guided by their interest in astronomy and focused on appropriate questions that could be answered by photometry.

A significant focus of each research project was on the production of observations of the variable star students chose. This served the dual purpose of teaching students about the required astronomy-specific skills while at the same time requiring students to appreciate the importance of empirical data in science. The task of analyzing data and critically evaluating the results is daunting for high school students. For each research project, students had to submit a report or make a formal presentation that went through a formal or informal peer review process. In addition to presenting their results, this demonstrated the importance of a community of peers and experts in science as well as highlighting important social contributions to the development of new knowledge.

The last part of the project asked students to explain how the knowledge and skills they developed during the research could be applied to problems in their daily lives. Rarely were these answers specific astronomical knowledge, but were often an appreciation for uncertainty in science, critical reflection on pre-conceptions, and a better understanding of the need for scientific reflection in everyday decision-making.

References

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