

## Editorial

# Variable Stars and Science and Math Education

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Observation, analysis, and interpretation of variable stars can be a powerful tool for effective science and math education. That was the motivation behind the AAVSO's *Hands-On Astrophysics* project (Percy and Mattei 1998), which subsequently evolved and expanded into the on-line *Variable Star Astronomy* (<https://www.aavso.org/education/vsa>), thanks especially to the work of Donna Young. Students can develop and integrate their science, math, and computing skills, motivated by the excitement of doing real science with real data. Project components may include background reading and planning; research judgment, strategy, and problem-solving; careful observation and measurement; recognizing and dealing with random and systematic errors; computer programming, and data processing and management; construction, analysis, and interpretation of graphs; concepts of regularity and prediction; and curve-fitting, time-series analysis, and other statistical and numerical procedures. At the conclusion of their project, students can communicate their results through a paper, poster, presentation, or informal discussion with their classmates.

*JAASO* already welcomes papers based on student projects. They are reviewed in the normal way, to ensure that their content is accurate and significant. My students and I have published many papers in these pages, most based on AAVSO data. Good science is done. The students benefit. AAVSO members and observers learn how their observations contribute to science and education. It's a win-win-win situation.

I believe that the AAVSO and *JAASO* can go even further in contributing to science and math education. AAVSO Director Stella Kafka's hopes for *JAASO* include having more papers which connect variable star astronomy and STEM (science, technology, mathematics, engineering) education. Does that just mean more papers with students as co-authors? Yes and no. Such papers are already frequent, and always welcome. There is even more that the AAVSO could do.

(1) Undergraduate research experiences are highly valued in college and university education, but instructors are not always aware of how students can do projects which are original but manageable. We could therefore collect ideas—both general and specific—for student projects, and disseminate them to science and math educators, both through *JAASO* and through other widely-read and respected sources. These ideas should be accompanied by brief, user-friendly instructions on how to get started. This project could perhaps be supported by a small grant, or otherwise carried out on a voluntary basis, by a small team (I would be happy to participate).

*Variable Star Astronomy* is a good starting point for high school students, and it includes many activities. The next step would be a guide to original *projects*. What science is doable, and worth doing? What sources of un-analyzed data are available, in addition to the AAVSO International Database? How can they be accessed, and data downloaded? How can AAVSO analysis tools such as *VSTAR* be used to analyze the data? What are the challenges in analyzing variable star data? What constitutes a good final project report, written or oral? Much of this information already exists on-line, and could be linked to. The document could conclude with an annotated list of published student projects—preferably ones which were exemplary or innovative in some way.

The AAVSO has already carried out a useful “step one” by setting up a new Education and Outreach forum, promoting outreach to students and educators. It solicits help in finding suitable projects, invites success stories and advice on what worked and what didn't, and encourages sharing of resources and materials. Many AAVSO members and observers are formal or informal educators. They have experience in both variable stars and in education. Let's use the forum, and think about how we could proceed further. At one time, the AAVSO had an Education Committee. It seems to be dormant. Why not revive it?

(2) We should also encourage project supervisors/mentors to use best educational practices, and encourage and actively solicit education papers which reflect and convey these—perhaps even new and improved practices. This would be helpful to other students and educators. To me, any effective educational activity or project should have four components: (1) the educational *objectives* for the student (not just for the project); (2) educational *content* such as the development of STEM knowledge, skills, and attitudes; (3) an effective *process* for achieving the objectives and educational content, such as by inquiry-based learning; and (4) *assessment and improvement* at every step in the process, both as the project proceeds, and at the end. For instance: is the purpose of the project to provide the student with an engaging and beneficial educational experience? Or just to get the project done? Does the student have any say in what project, or part of a project to do, and how to do it? Is there scope for inquiry-based learning? Is the student encouraged to be curious and creative? Does the student meet regularly with their supervisor/mentor? Is there a constant emphasis on the student's intellectual growth?

(3) For those with some background in education research, there might even be opportunities for research on students'

understanding of stars and their evolution; see Percy (2015) for a brief guide to education research. Much research has been done on students' understanding of earth-moon-sun relations. Much *less* has been done on students' understanding of stars, galaxies, and the universe (Lelliott and Rollnick 2010). Warning: remember that education research in a school or other institutional setting may require the approval of an ethics committee.

I encourage you to discuss these ideas on the new "promoting outreach to students and educators" forum: <https://www.aavso.org/forums/variable-star-observing/variable-stars-education>

## References

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