

# NGSS Science and Engineering Practices in Secondary Education through Real Astronomical Research



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## Abstract

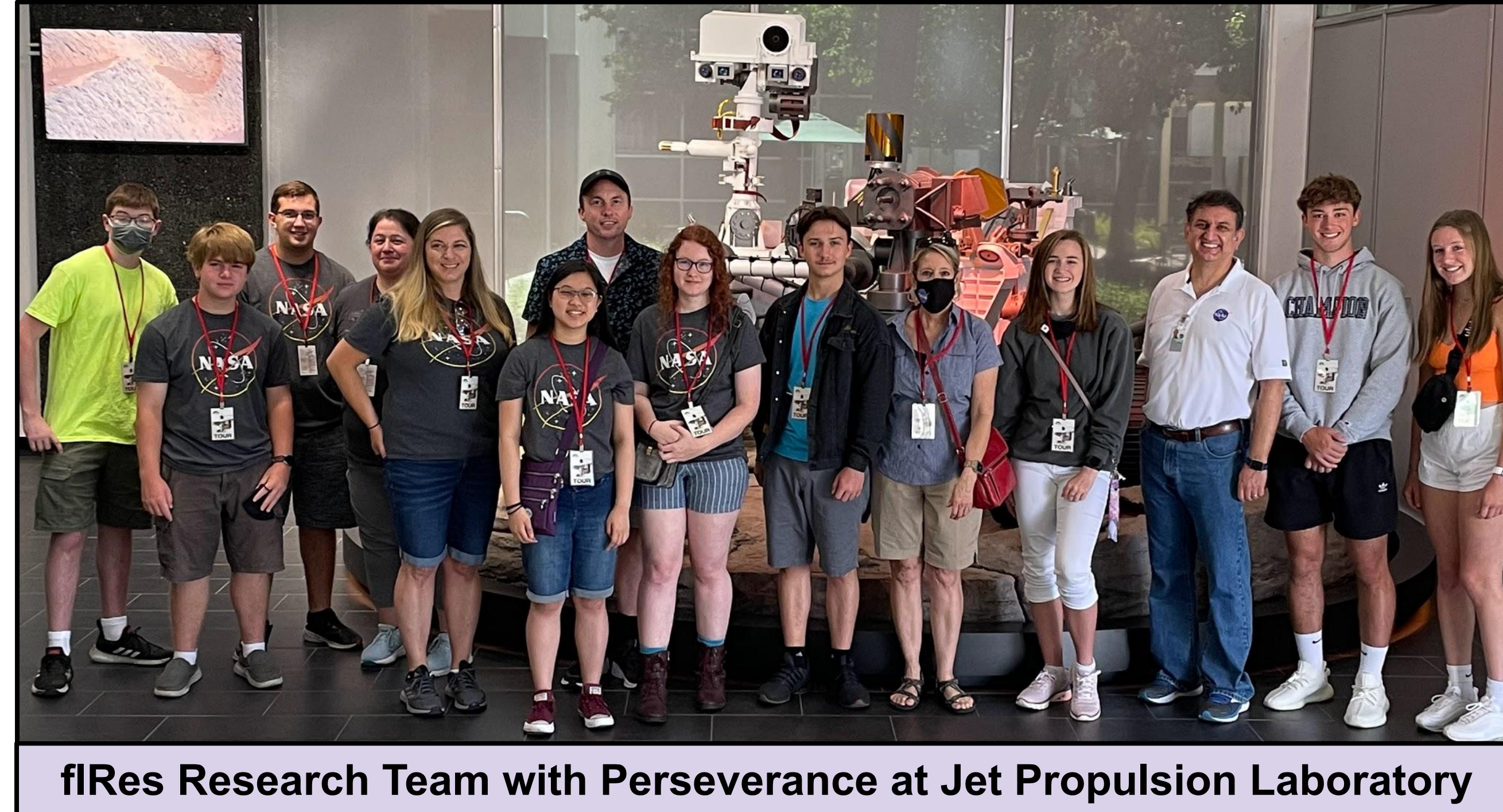
Teachers and their students of the fIRes team utilized the Science and Engineering Practices of the Next Generation Science Standards (NGSS), which strive to move the real world methods of “doing science” into classrooms. One educational focus for this project was to incorporate the eight practices of science and engineering that are identified in the NGSS into student instruction, especially those of questioning, active student research, collaboration with peers, and communication of results. This research was made possible through the NASA/IPAC Teacher Archive Research Program (NITARP) and was funded by NASA Astrophysics Data Program.

### Team Minnesota

#### Focus: Asking Questions and Defining Problems

With the shift to NGSS, the focus is now in phenomenon-based learning and asking questions. After starting NITARP, I began to encourage my students to ask questions which lead to more discussion, deeper thought, and surprising new knowledge.

- Will there be any effect in the far away future if there's no eclipses and the moon is slowly moving away from the Earth?
- What do geologists do when finding layers but its not there like a conformity or there are no fossils?
- If humans took a break from burning so many fossil fuels could the climate go back to how it should be?
- Did the Cambrian explosion greatly affect greenhouse gases?



fIRes Research Team with Perseverance at Jet Propulsion Laboratory

### Team Pennsylvania

#### Focus: Developing and Using Models

**Model Used:** NOAA's Science On a Sphere® Explorer

The **Science on a Sphere Explorer** is a visualization software with over 500 datasets that provides information collected from satellites, ground observations, and computer models. Models are used in science to aid in the development of questions and explanations, to make predictions, and to communicate ideas. After NITARP, I now challenge my students to ask questions and predict outcomes by a wide variety of datasets and models.



Question	SOS Explorer Data sets
What causes rock to be molten underground?	Tectonic Plate Boundaries, Ages of the Seafloor
Why does marine debris collect in certain areas of the ocean?	Marine Debris: Garbage Patch Experiment, Sea surface Currents, Ocean Circulation, Ocean Conveyor Belt



**Student Perspective:**  
**How has NITARP changed your understanding of science?**  
 “This experience has opened my eyes to the exploration of space. There is so much we know about space, and so much we don't know.”

**Student Perspective:**  
**How has NITARP changed your understanding of science?**  
 “Science is exciting because of the potential for new discoveries.”



### Team Illinois

#### Focus: Planning and Carrying out Investigations

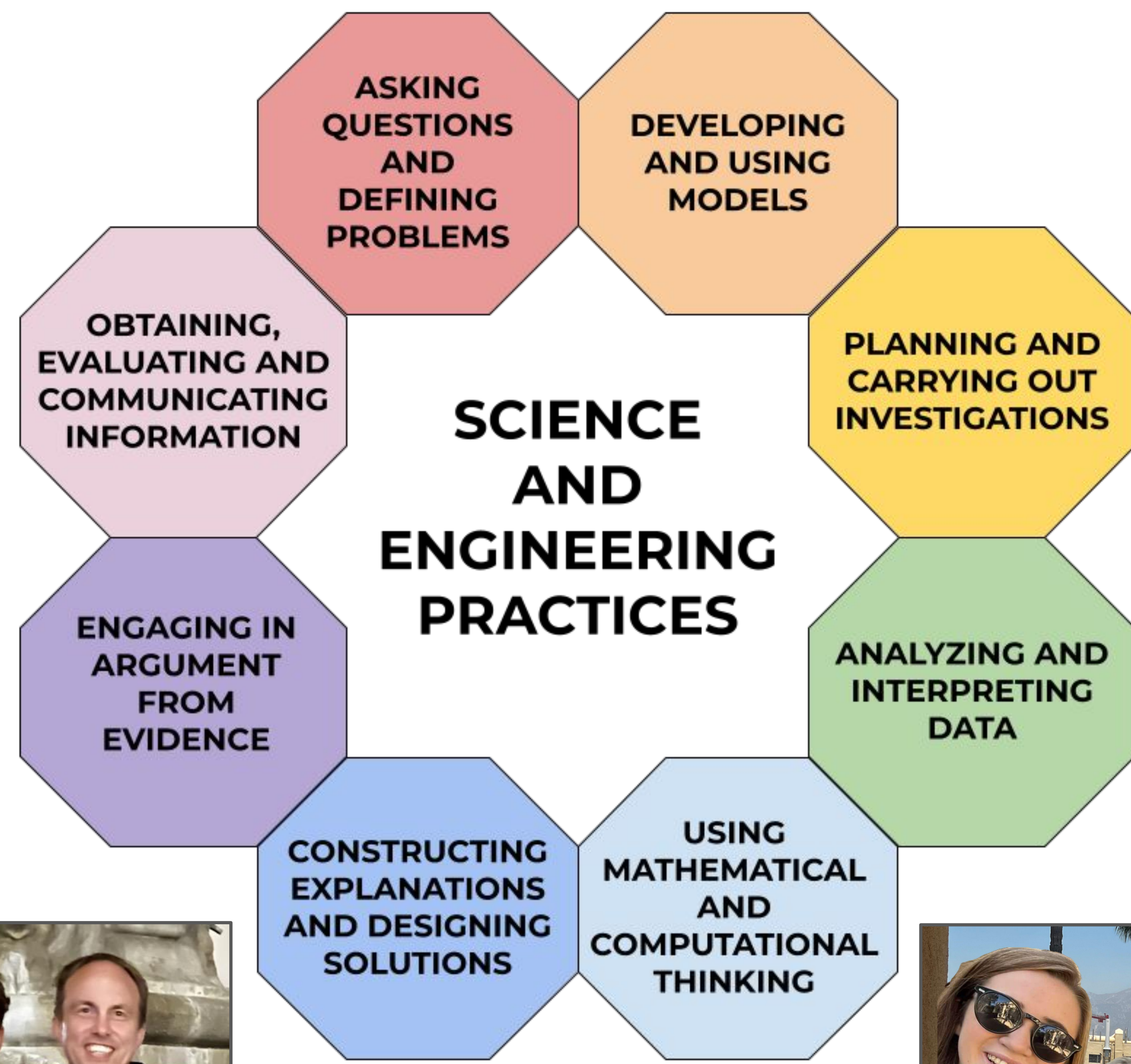
Participating in NITARP has inspired me to revisit the science practices described in the NGSS and see them in a new light. Despite teaching the scientific method for the last 22 years, this was the first time that I had the opportunity to actually use it in original, professional-level research.

**An Example of a Classroom Investigation Inspired by NITARP:**  
 What variables contribute to the apparent brightness of a star?

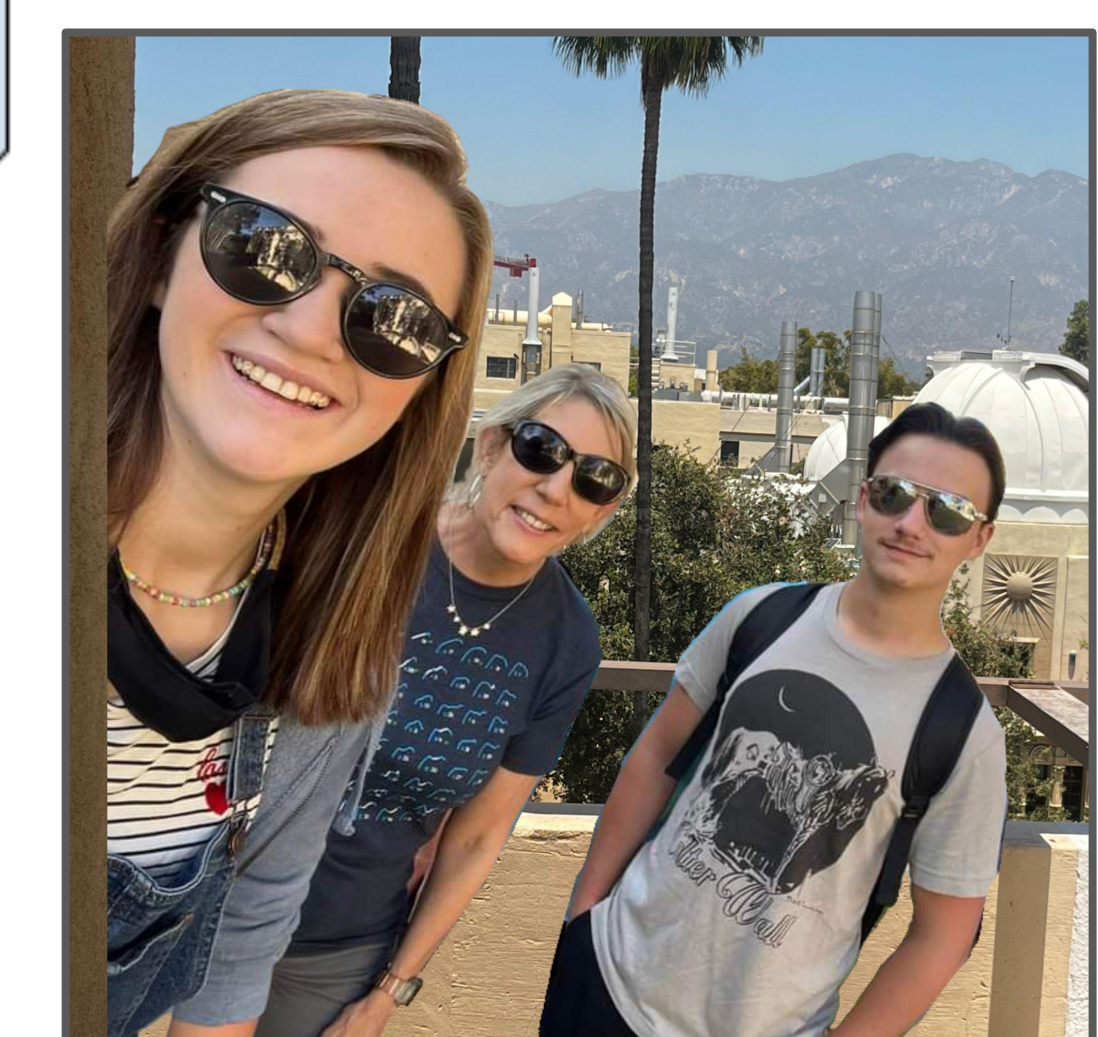
**Methods:**

- Students cut circles of varying size in a posterboard to represent different-sized stars
- Cutout stars were held over an open end of a box that contained a phone running a light meter in the data collection app **Phyphox** to read luminosity data

**Teacher Perspective:** **How has NITARP influenced your teaching?**  
 “For the first time, I did not know the answer, nor could I look it up, nor could I ask someone else what we were supposed to find. I found the experience simultaneously unsettling, freeing, and exhilarating.”



**“Science is not just a body of knowledge, it's a process.”**  
 -Dr. Varoujan Gorjian



### Team Tennessee

#### Focus: Analyzing and Interpreting Data

NITARP has fundamentally changed my teaching practice and solidified the idea that the way to learn science is by doing science, which prompted me to create a student scientific research group emulating the NITARP experience on a small scale. These research opportunities specifically address the NGSS Science and Engineering practices, which require students to investigate the natural world as scientists.

**Classroom Practices Inspired by NITARP:**

- Students self-select projects with the objective of answering scientific questions (non-Googleable)
- Students represent their research in science competitions
- Students consult with subject-matter experts, but do the hard work to discover answers to their questions.

**Student Perspective:**  
**How has NITARP influenced your future career choices?**  
 “Before NITARP, I originally planned on having a career in the forestry field. However, after being influenced by my experience in California, I have decided that I will include astronomy or science in my future career choice.”