# Bringing Experiential Education into the Classroom

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## Abstract

The NASA/IPAC Teacher Archive Research Program (NITARP) partners small groups of secondary school educators, high school students, and research astronomers in a year-long research project. The majority of the research is completed remotely and authentically, meaning there is no expected outcome or single correct answer. Students and teachers alike engage in modern research practices to better understand a guiding research question. Using this experience, educators designed and implemented two multi-step modules to guide students through peer-reviewed, published journal articles and to create original light curves using the public NASA/IPAC Infrared Science Archive (IRSA). Students were able to practice the skills of accessing, visualizing, and analyzing data, in small groups and individually. Students that have participated in the summer research experience, coupled with the ongoing teleconferences, experienced a shift in their understanding of Science and scientists, as well as the process of doing science, especially as compared to a traditional classroom.

## Online Collaboration

The NITARP experience creates several learning opportunities for teachers and students alike by first establishing a baseline of knowledge and skills necessary to explore the research question. Learning outcomes are best when students are willing to fully invest in the learning activity and when the experiential learning is enjoyable (Dewey 1938). Through the opt-in, collaborative nature of the research experience, NITARP encouraged students to return to each telecon prepared to share and be celebrated for their individual work that fueled the collaborative goal. Furthermore, students created and reviewed light curves created by other students or teachers. Students' comprehension of graphs is closely tied to the process of constructing and explaining them (Berg and Smith 1994). Because students took an active role in the analysis of the archive data, they were better able to find and speak about patterns in the graphs.

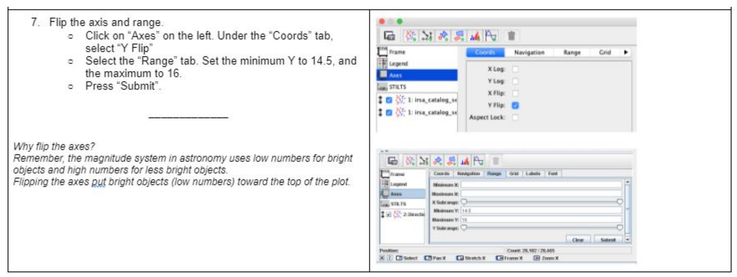


Figure 1: An excerpt from the education module on light curves, with instructions and screenshots of TOPCAT software

After building baseline knowledge and practice creating light curves, teachers and students determined it is essential for a scientist to be able to glean information from peer-reviewed articles and to actively work with data in order to advance in their field. First, the team created a graphic organizer to introduce students to one specific publication. Then, the team developed and tested a module to guide students through the process of downloading data and visualizing it through the software TOPCAT. Modules were created collaboratively over Webex, and shared using several online tools including Google Docs, Miro, and Google Classroom.

## Building the Modules

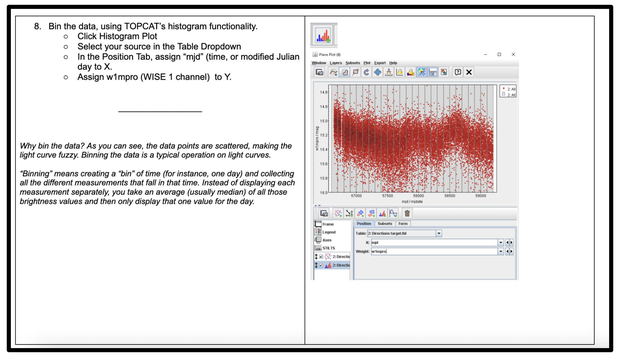


Figure 2: An example of contextual material and commentary giving a rationale for the procedure.

## Iterative Design

The teachers on the team began by listing out the steps to download data from the IRSA Catalog, then how to upload the data to TOPCAT and to plot it. Teachers created a two-column guide, including a written description and screenshots of the major steps. After, the module was shared with groups of students. Students offered feedback on the light curve module. Students generally suggested clearer instructions and supplementary visuals. One student specifically suggested providing diagrams to show the relationship between the lamp post, w1mpro, w2mpro, and the different components explored in the light curves, which may be included in future versions. Overall, students identified being able to engage with the data in an authentic way, different from their typical Science class experience. Students' comprehension of graphs is closely tied to the process of constructing and explaining them (Berg and Smith 1994). As students constructed the light curves, they were able to better grasp the material. In asking students to be critical of the material presented to them, they were better able to solidify their learning.

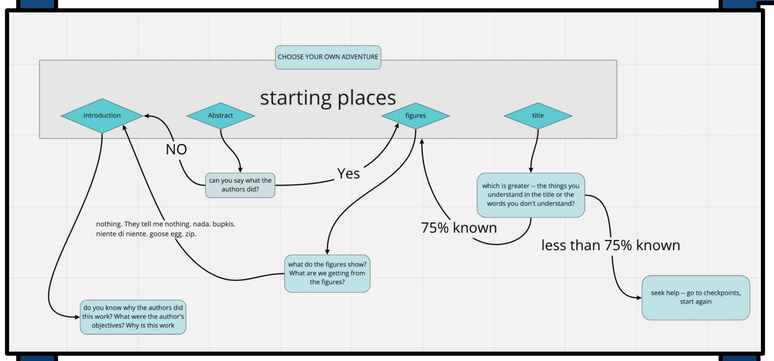


Figure 3: Graphic organizer guiding students through how to digest a scientific article.

## Future Work

Our NITARP team aims to continue to bridge the gap between scientist and Science classroom through ready-to-use tools made available to Science teachers nationally. In a future opportunity, we would include students earlier in the design and development process. Students often picture a man in a white lab coat when asked to describe a scientist and their daily work. Understanding the process and nature of science as consisting of only laboratory experimentation is a chronic limitation of Science courses nationally. This disconnect between the actual content and process of science limits students' understanding (Kastens 2008). NITARP allows students to experience the actual process of Science and to witness first hand how publishable content is discovered. Additionally, we would like to create several types of modules of different focuses, making each general enough to fit into any secondary-level Science class.

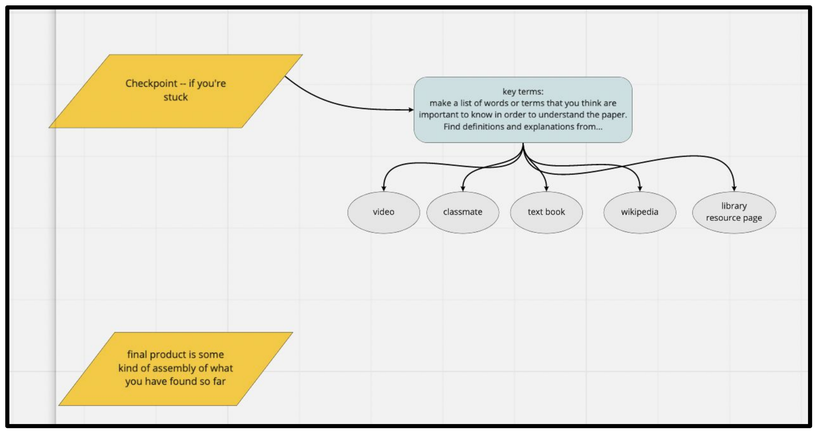


Figure 4: Students have options if they encounter challenges when reading.

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"I think it was really cool to be able to see a bunch of random dots on the screen and actually be able to draw a conclusion from it…"
–NITARP student

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