Combining Real World Experiences with WorldWide Telescope Visualization to Build a Better Parallax Lab

Bucknell UNIVERSITY

E.F. Ladd, E.C. Gingrich, K.E.K. Nottis (Bucknell), P. Udomprasert, & A.A. Goodman (Harvard)

Introduction

Students learn best in active exploratory environments that draw upon their intuitive understanding of the world around them. Transferring this learning into the astronomical context is often difficult because the size, scale and structure of the universe and its primary contents are so different from students' everyday experience.

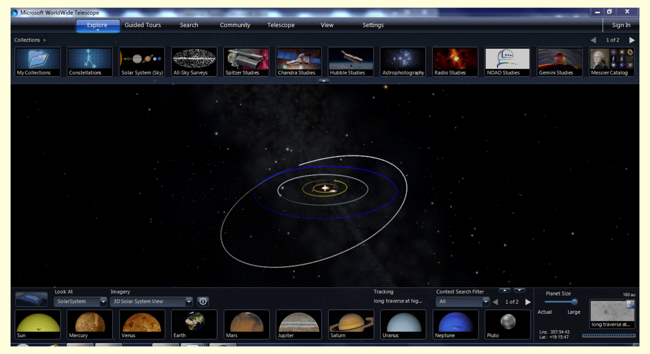
Because of the large distances to even nearby stars (compared to the size of the Earth's orbit) astronomical parallax measurements typically involve small angles – far too small for visual observation. However, the concept of distance determination via parallax is not limited to these small angles, and students can be introduced to the technique in the terrestrial environment. In this lab activity, students use small terrestrial telescopes to measure the distances to nearby campus landmarks.

Visualization tools, such as Microsoft's WorldWide Telescope (WWT), can help students to better understand the astronomical realm by providing multiple perspectives on the universe

The laboratory activity presented here is the first in a series of labs designed to integrate hands-on exploration with WWT visualization to improve student understanding of the size, scale, and structure of the universe.

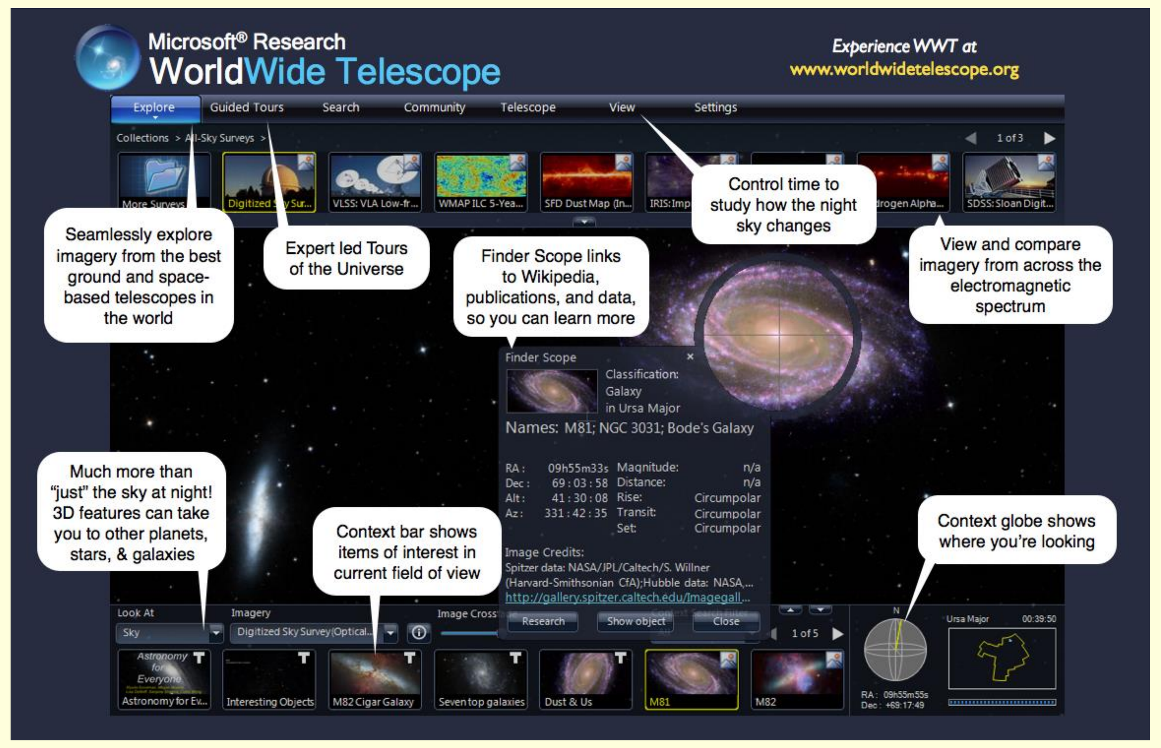
What is WWT?

WorldWide Telescope is a rich visualization environment that functions as a virtual telescope (or even spaceship!) allowing anyone to make use a real astronomical data to explore and understand the universe.



WorldWide Telescope provides the tools and framework to revolutionize STEM education by offering students, learners, and educators:

- unprecedented access to astronomical data, allowing them to experience the thrill of discovery that comes from exploring and understanding our universe;
- tours that guide and encourage learners to engage actively with the material;
- the ability to explore the universe in three dimensions, helping them visualize ideas that are otherwise challenging to understand through traditional media.



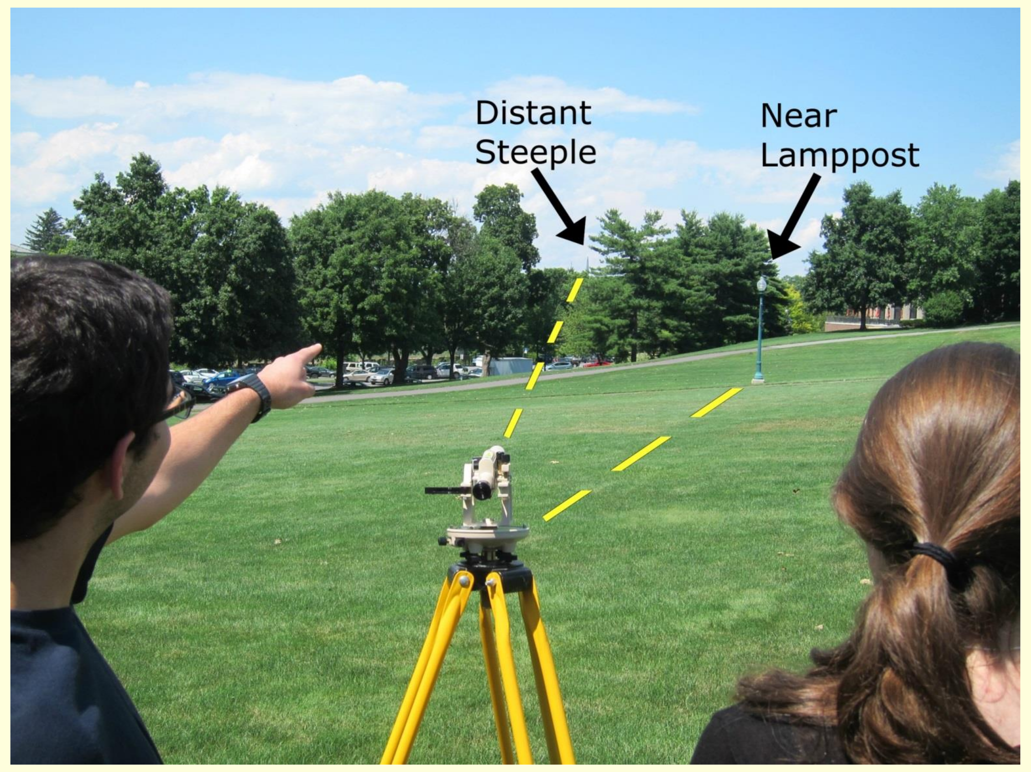
Main Points:

- **We use hands-on, real-world activities designed to promote a more intuitive understanding of parallax.**
- **Virtual environments like WWT help students transfer concepts to the astronomical realm.**
- **Combining hands-on activities with virtual environment exploration may produce deeper learning.**

Measuring Parallax on Campus

The hands-on component of the lab activity involves measurement of the parallax shifts for prominent objects in the campus landscape.

Students use a surveyor's transit to identify lines of sight to distant and nearby objects.



The line of sight to a distant landmark (here, the steeple of church in town) is used as a reference direction for angle measurements.

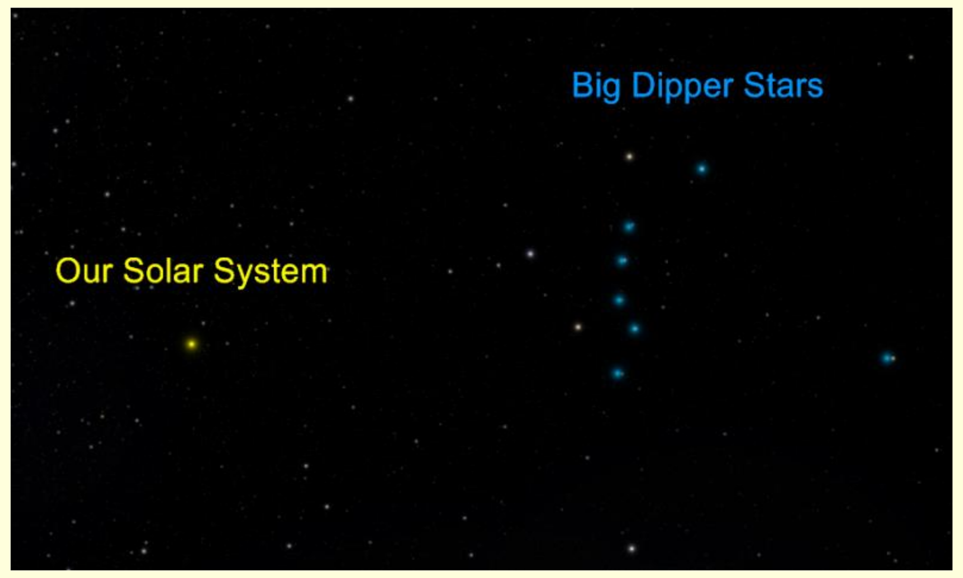
Students measure the angle between the reference direction, and the direction to a more nearby object, such as an on-campus lamp post.

Measurements of the angular separation between the reference direction and the direction to the nearby object are made at several positions in an "orbit" around a central "Sun." The Sun is a pizza tin marked with twelve sections denoting the months of the year.

Students typically make measurements at six to nine positions in the orbit.

Visualizing Astronomical Parallax

Students use WWT to transfer their parallax intuition from the terrestrial to celestial environments. Using the pseudo-3D multi-perspective capability of WWT, students view the well-known asterism the Big Dipper from Earth, and from another location six parsecs from Earth. Over this large baseline, the parallax shift is quite obvious, and students can discriminate between nearby and faraway stars. They make detailed measurements of the parallax shift, and determine the distances to several Big Dipper stars.



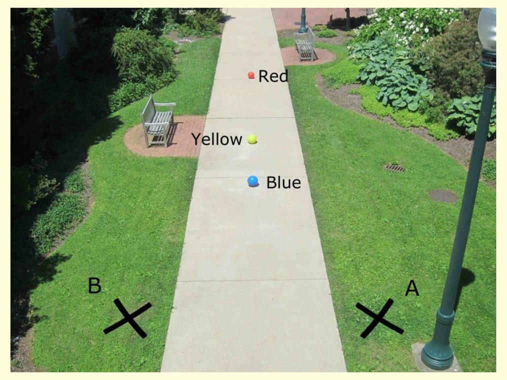
Students can then observe the Big Dipper from an "overhead" perspective, which shows the actual distances of these stars from Earth. Here, the blue dots mark the seven prominent stars in the asterism. All are located at a distance of about 80 pc from Earth, except for one which is substantially more distant.

Assessment

This lab activity was piloted in an introductory astronomy class in fall 2013 at a small liberal arts college. Forty five students participated in the lab activity during three separate lab sessions, each guided by an instructor and undergraduate teaching assistant. Students completed a four question quiz at the conclusion of the lab. From both the quiz results and anecdotal student feedback, it appears that student understanding of parallax has improved.

A more formal assessment tool which probes student understanding of concepts of size, scale, and structure in astronomy is currently being developed. The "Size, Scale, and Structure Concept Inventory" (S3CI) is the subject of a companion poster of the same name by Gingrich et al. in this poster session. This concept inventory will be administered in pre/post format to classes that use this lab activity, so that we can measure changes in student understanding resulting from this and other WWT-enhanced lab activities.

At right is the figure from an example question in the S3CI. For details, please see the Gingrich et al. poster.



Acknowledgements

This research project is supported by the National Science Foundation's TUES program (DUE-1140440). Additional support is provided by Microsoft Corporation.