Making Physical Measurements from Student's Own Images

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"Where do you look through?"

Have you been asked "where do you look through?" during a public event at an observatory?

We dutifully explain that there is no eyepiece, that astronomy is a quantitative science using high-tech instruments placed at the focal plane, and that data such as images or spectra are recorded for later analysis, etc. etc. This exchange illustrates a gap between the astronomer's work and the public's perception of astronomers.

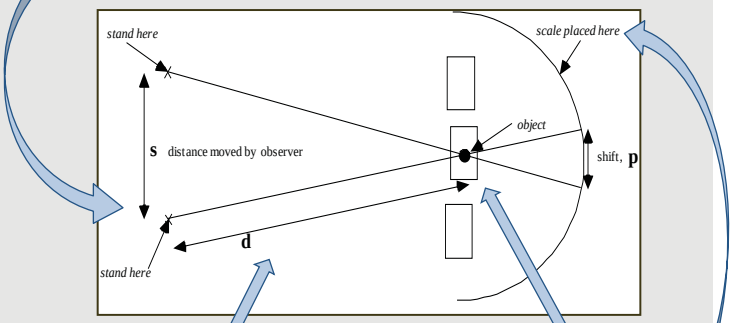
The survey course for non-science majors at Kwantlen Polytechnic University attempts to bridge this gap, in part, by providing opportunities for students to experience their own scientific process of taking data and analysing them for quantitative results. Two lab activities involving imaging are described here.

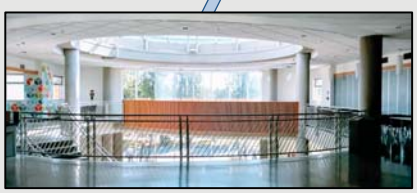
Both activities take students out of the laboratory for active engagement and demonstrate the idea that systematic analysis of image data can yield scientific measurements.

Parallax

First lab of the course, it gets students active and collaborating.

- A ball ("star") is placed across a large room
- Photographs are taken from two different locations
  - Locations represent points on Earth's orbit around Sun
- Parallax shift against background "stars" is measured from images
- Calculation yields distance





open gap between "star" & Sun

Student image: "star" & angular scale

Advantages:

- Students see what instructor sees. A previous version of this activity was done without cameras and photographs. Students didn't always know what to look for and measure. Now, a large image on the screen (you can put your finger on it) makes the concept & communication clearer.
- Students are already familiar with instrumentation
- At KPU Richmond Campus, there is a large gap in the floor between the "star" and the solar system, so parallax is really the primary method for distance measurement.

Imaging the Moon

Later in the course, students observe the Moon using 8-inch telescopes.

2 week lab (Part 1 – Observations & Part 2 – Analysis)

- Real sky observations
- Students make own telescopic observations
- Images are captured with CCD from a webcam
  - just remove lens & place on focal plane
  - webcam software is student-friendly
- Students analyse their own images
  - image frames are compiled to form a lunar mosaic
  - crater & maria sizes are measured in km
  - sizes are compared to Earth features (e.g. lakes, islands…)
- Students also work through the logistical steps of telescope time assignment, scheduling and weather.

Advantages:

- No campus observatory needed
- Uses everyday equipment (webcam & computer)
- Students learn the value of pre-planning and good note-taking

Overall:

The observation part of the lab is a fast-paced evening and fulfilling for students and instructor alike. Although seemingly a logistical nightmare, it runs smoothly once the details are worked out. Students have consistently reported enjoying making the observations and learning that measurements can be made from their own images.

See more in:
Sato, T. (2014) Imaging the Moon II: Webcam CCD Observations & Analysis (a two-week lab for non-majors),
Ensuring STEM Literacy: a National Conference on STEM Education and Public Outreach, ASP Conference Series, Vol. 483, J.G. Manning, J.B.Jensen, M.K. Hemenway, and M.G. Gibbs, eds.

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