Lab 3
Photography

At UW-Madison we have, for many years, used a wet photography lab, which thrilled the students. If at all possible try to reproduce this at your institution, as it is by far the most fun and rewarding experience for the students and the instructors. Have the students take a black and white photograph, possibly on a single-exposure film. Then have them develop and print their photograph. We divided the students into small groups, and had some of them acquire a photo, while others were developing and others printing. With a little effort on coordination this yields the best results and limits the equipment to purchase for this lab.

Alternatively, a digital photography lab could be organized.
It is best to have digital cameras that interface with computers, so the students can acquire images and see them as files right away. We used a Canon PowerShot G7, which can easily be interfaced with a PC and comes with decent software for remote capture. It may become obsolete very soon, though, so we recommend that you optimize the choice of camera yourself.

Fun experiments with digital photography include comparisons of images taken with different pixel resolutions, or different ISO "film speed", which corresponds to binning of pixels on the CCD. The higher the ISO the higher the sensitivity (requires less light), but the lower the resolution.

Other experiments may require the students to change the exposure time and keep the aperture setting, or vice versa. These changes are surprisingly accurate and quantitative: doubling the exposure time (1 step) really corresponds to twice the amount of light on the CCD, as does changing the aperture by 1 step down.

Many cameras have different options for illumination sources, e.g. incandescent light or sun light. It is fun to acquire images of the same object changing this setting, and observing the great difference it makes in the photographs when the setting does not match the illuminating light source.

The most interesting, though a bit challenging, experiments are those on the depth of field. Changing the aperture changes the depth of field, as already seen in Lab 2. The f-number is usually called "aperture" in most cameras, but pay attention: this does not mean aperture diameter! It really means f-number = focal length/aperture diameter. Photographs of small objects in the laboratory, such as marbles, or tinker toys, lego bricks, soda cans, or books, spread horizontally on a desk will all serve the purpose. Small f-numbers (small "apertures") will show the objects in the foreground well in focus, and those in the background out of focus or vice versa. There is no way to have them all in focus simultaneously because the depth of field is too small. Larger f-numbers will instead allow nearby and far away objects to be in focus simultaneously.