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Open-ended projects in undergraduate optics and lasers courses

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This talk will describe the format and experience of undergraduate Lasers and Optics courses at Bethel University. The courses, which include a rigorous lecture portion, are built on open-ended research projects that have a novel aspect. They begin with four weeks of small student groups rotating between several standard laser and optics laboratory exercises. These may include, for example, alignment and characterization of a helium neon laser and measurements with a Michelson interferometer or a scanning Fabry-Pérot optical cavity. During the following seven weeks of the course, student groups (2-4 people) choose and pursue research questions in the lab. Their work culminates in a group manuscript typeset in \LaTeX and a twenty-minute presentation to the class. Projects in the spring, 2014 Optics course included experiments with ultracold lithium atoms in a magneto-optical trap, optical tweezers, digital holography and adaptive optics. Projects in the spring, 2015 Lasers course included ultrafast optics with a mode-locked erbium fiber laser, quantum optics, surface plasmon lasers (led by Nathan Lindquist) and a low-cost, near-infrared spectrometer. Several of these projects are related to larger scale, funded research in the physics department. The format and experience in Lasers and Optics is representative of other upper-level courses at Bethel, including Fluid Mechanics and Computer Methods. A physics education research group from the University of Colorado evaluated the spring, 2015 Lasers course. They focused on student experimental attitudes and measurements of student project ownership.