Overview: Using milk and coffee as a physical model for naturally layered systems (e.g., summer lake stratification and winter inversions), students investigate the common components of these natural phenomena. Students observe and construct the mathematical concepts of (1) multivariable functions, (2) traces and level curves, and (3) partial derivatives. The lab offers an opportunity to discuss relationships between mathematical objects in higher dimensions and their single variable counterparts.

Lesson Outline: The Coffee Thermocline Lab is highly adaptable and suitable for a variety of mathematical settings. Adjustments to the schedule and expectations are encouraged in order to fit student needs and course objectives. The outlined expectations and agenda are geared for students with multivariable calculus. See Pedagogical Resources for additional teaching and scaffolding suggestions.

Lab Setup: The layered system is created in a clear glass using coffee, milk, and a long funnel.

Data and Examples: Data along with some student approaches are presented to illustrate the range of student creativity and to help prepare teachers to scaffold student thinking.

Background and Extensions: To build biological context and facilitate in lab presentation, a brief discussion of compartment models is presented here.

Assessment Items: Primary assessment of student learning is taken from students' written reports. Additional assessment items targeting lab objectives are included here.