Learning environments are complex systems that the discipline-based education research (DBER) community seeks to understand and reform in order to achieve more effective and equitable outcomes. This goal requires the development and integration of theory that informs the measurement of latent student traits and illuminates their potential impacts on key outcomes. However, much of the work in biology education is atheoretical, which limits the precision of our measurement models and hinders robust, empirically-driven causal explanations for the patterns we observe. Unified theoretical frameworks, and the conceptual grounding they offer are essential for making progress in our understanding of learning. The cognitive coherence of learners’ mental models is an important, yet often overlooked theoretical framework that informs the measurement of student traits. Research shows that biological reasoning lacks cognitive coherence in novice learners, but this fact is rarely incorporated into the tools we use to measure latent traits. For example, evolution knowledge has been found to be dependent upon the scale of evolutionary change (e.g., macroevolution vs. microevolution) and the lineages that are changing (e.g., plants vs. humans). In this talk, I present results on the cognitive coherence of two latent traits in introductory biology learners: Evolution acceptance across scales (i.e., microevolution, macroevolution, and human evolution) and movement of matter across taxa (i.e., plants, animals, and fungi). My work shows that not only did this population of students have an overall lack of cognitive coherence for evolution acceptance (students more readily accept microevolution than human evolution) and movement of matter (students have more accurate knowledge about matter in plants than in animals), students also differed in exactly how they were incoherent. These results advance conceptual understanding of biological reasoning and offer critical insights into the development and improvement of measurement models for these traits. The linking of theory and measurement is a central goal of my work. However, understanding complex systems ultimately requires linking theory-driven measures with causal explanation, and furthermore, with an analytical framework that is capable of testing causal, system-level hypotheses. To this end, I will introduce how I use latent variable path analysis to test causal models in order to design more effective and equitable educational spaces. Overall, this work has important implications for how biology should be taught both in terms of the framing of the content and the structure of the learning environment.