Using a Principled Design System to Identify Community College Outcomes

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Goals
We are designing, developing, and validating a prototype post-secondary learning assessment instrument. We want to define and assess “domain-specific reasoning” outcomes, a form of knowledge and skill informed by cognitive science research. Such knowledge and skill reflects the deep forms of knowledge that form the foundation for domain expertise.

Procedure for Identifying Deep Domain Knowledge and Skills for Assessment

- Identify “big ideas” in fields through domain analysis
- Convene biology and economics expert panels to conduct domain analyses
- Define “big ideas” as both the strategic and schematic knowledge structures that characterize expert reasoning

Evidence-Centered Design (ECD) Framework for Domain Analysis

Core Domain Knowledge and Reasoning Identified by Expert Panels

The experts generated the following “big ideas” to characterize the kind of fundamental reasoning unique to each domain.

**Economics Big Ideas**
- Three levels of “big ideas”
  - Fundamental concepts: Incentives, Tradeoffs, Efficiency, Scarcity
  - Behavioral concepts: Decision making occurs at different levels: individual, firms, markets, and government. This schematic way of organizing the key concepts of a domain characterizes a fundamental form of knowledge that domain experts use strategically to frame problems for analysis.

In economics, the fundamental concepts of incentives, trade-offs, efficiency, and scarcity inform different models of decision making. Decision making can occur at different levels: individual, firms, markets, and government. This represents the way of organizing the key concepts of a domain characterizes a fundamental form of knowledge that domain experts use strategically to frame problems for analysis.

**Biology Big Ideas**
- Two levels of “big ideas”
  - Fundamental concepts: Evolution, Bioenergetics
  - Behavioral concepts: Different levels of analysis: Cell, organisms, populations, ecosystems

Representations of Two Examples of Domain-Specific Big Ideas

In biology, the fundamental concept of bioenergetics informs explanatory models of biological systems. Biological systems occur at different levels, extending from the lowest level of the cell up to the highest level of the biosphere. This representation depicts bioenergetic processes at the ecosystem and population levels. This schematic way of organizing the key concepts of a domain characterizes a fundamental form of knowledge that domain experts use strategically to frame problems for analysis.

Next Steps
- Calibrate and operationalize domain-specific reasoning skills to be measured at end of sophomore year to focus on “big ideas” that reflect non-intuitive reasoning important to everyday situations.
- Early feedback from experts:
  - Biology: Always realize that whenever you observe, experiment on, model, or think about, any biological system in isolation, you have broken important connections between that system and its context. You don’t fully understand the system until you have reconstructed those connections.
  - Biology: It is a series of our current understandings about the patterns in nature and how they work based on evidence from observations and experimentation.
- Understanding the concept of evolution provides a necessary framework to understanding biology.
- Economics: An efficient allocation of resources is one that yields the greatest good. It is the most achievable desired outcome for the smallest expenditure of resources.

- Design and develop assessment tasks
- Pre-pilot and refine assessment tasks
- Pilot test assessment tasks
- Analyze validity results from pilot tests
- Prepare reports and assessment documentation

Expert Panelists

**Biology**
- Eric Jakobsson, University of Illinois, computational biology education
- John Jungck, Beloit College, computational biology education
- Paul Kassner, Amgen, drug development
- Patricia Morse, University of Washington, field biology
- Rick Vosburgh, Nekton, biomechanics

**Economics**
- William Becker, Indiana University, principles education
- Thomas Borcherding, Claremont Graduate University, government impact on firms
- Chris Makler, Apila, principles education
- Allen Prohofsky, California Legislative Analyst’s Office, taxation

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