Using a Principled Design System to Identify Community College Outcomes

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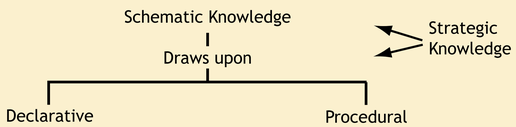
Goals

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

The structure of strategic knowledge



Shavelson, Ruiz-Primo, Li, & Ayala, 2003

- Through a combination of "priming activities" and "documentation activities," experts generated "big ideas" to characterize important strategic and schematic reasoning in the two fields.
- Define "big ideas" as both the strategic and schematic knowledge structures that characterize a hierarchical, networked cognitive structure of expert reasoning

Evidence-Centered Design (ECD) Framework for Domain Analysis

ECD Layer	Role	Key Entities	Selected Knowledge Representations
Domain Analysis	Gather information about the domain of interest that has direct implications for assessment: how knowledge is constructed, acquired, used, and communicated.	Domain concepts, terminology, tools, knowledge representations, analyses, situations of use, patterns of interaction.	Content standards, representational forms, symbol systems in domain

The Assessment Triangle

Pellegrino, Chudowsky & Glaser. 2001, p. 44

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
- **Models & Relationships**
  - Supply and demand
  - Inflation and unemployment
- **Modeling**
  - Information/Time
  - Identification and endogeneity

Different levels of analysis
- Individuals, firms, market, government

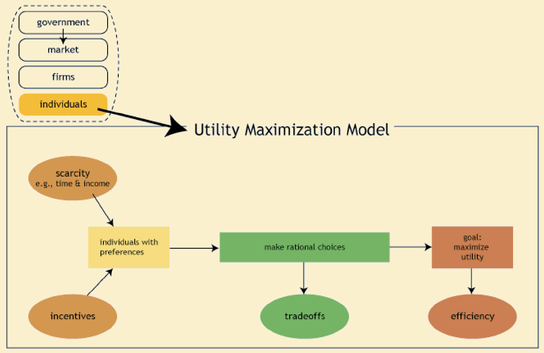
Biology Big Ideas

Two levels of "big ideas"
- **Fundamental concepts**
  - Evolution
  - Bioenergetics
  - Systems Biology/Form & Function
- **Biological reasoning process**
  - Hypothesis generation and testing

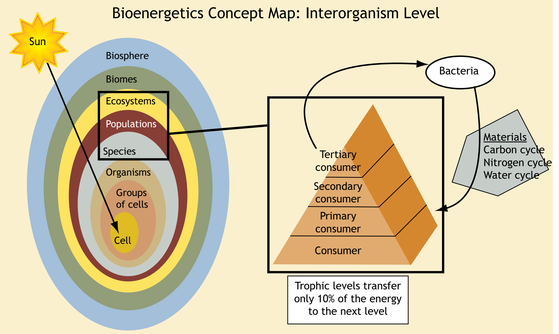
Different levels of analysis
- Cell, organisms, populations, ecosystems

Representations of Two Examples of Domain-Specific Big Ideas

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 representation depicts economic decision making at the individual level. 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 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. So you don't fully understand the system until you have reconstructed those connections.
  - **Biology** 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 provides the greatest good (as defined for an individual or society) at the least cost (as defined by what is forgone by the individual or society). Efficient allocation is not the least cost allocation. An efficient allocation is not the 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,** Aplia, principles education
- **Allen Prohofsky,** California Legislative Analyst's Office, taxation

Advisory Board Members

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- David Niemi, K12 Inc.
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- Cynthia Wilson, League for Innovation in the Community College

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