Domain-Specific Assessment: What foundational concepts and reasoning skills are community college students learning?

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Context for Domain-Specific Assessment

- A national debate about measuring student learning in higher education
  - Academically Adrift, Arum & Roska, 2011
  - Measuring Up on College-level Learning, Miller & Ewell, 2005
  - A Culture of Evidence, Dwyer, Millet, & Payne, 2006
  - Voluntary Framework for Accountability, AACC, 2010-2011
  - Accreditation agency pressure for measuring student learning outcomes (SLOs)
General elements of the debate

Assessment: Accountability

- Rising college costs/high debt load
- Few good jobs at the end
- What are students getting for their money and time?
- Instruction with high costs and high risk of failure

How can college achieve more success for more students?
Solution: Get more strategic

- About the design and delivery of student services, courses, curricula, and instruction
- Designing pathways and classroom approaches that ensure greater success for all students in all CC tracks
Our focus:
General education success track

- GE community college instructors face the challenge of covering a wide swath of content.
- Some still consider “gate keeping” or “weeding out” their primary job.
- Students respond by:
  - Not pursuing these majors, not doing well in courses.
  - Not retaining knowledge for everyday application in life.
  - Not succeeding!
- GE courses affect transfers, CTE students.
Strategy: Better assessment in general education to support success

- Assessment that measures:
  - Understanding of foundational “big ideas” in domains
  - Reasoning practices valued in these domains
What’s our goal for big ideas in general education?

- To have students master key content so they can:
  - Look at the world differently
  - Apply domain-specific ideas in everyday lives
- It’s not being an expert in a domain, but it’s “thinking like an expert.”
What are big ideas?

- Non-intuitive concepts and reasoning processes
- Developed over many generations of humanity
- Cannot be figured out through common sense or standard logic
- Not a memorized collection of facts and procedures, but a **schematically organized cognitive system for thinking differently**
Background

• An assessment based on:
  • Cognitive Science:
    • How do people learn?
    • Importance of domain-specific knowledge/skill for building reasoning skills
Background

• An assessment based on:
  • Cognitive Science:
    • How do people learn?
    • Importance of domain-specific knowledge/skill for building reasoning skills
  • Evidence-Centered Design:
    • Method for developing assessments measuring “hard to measure” knowledge/skills
Model 1. Biology
Beginning understanding of energy flow and matter cycling
Model 1. Biology
Advanced understanding of energy flow and matter cycling
Model 2: Biology
Advanced understanding of evolution
Model 3: Economics
Advanced understanding of the supply & demand model

Economic Concepts

Individual Actors
- Producer Behavior
- Production Costs (input prices)
- Technology
- Expectations
- Profit Maximization
- Other Markets
- Substitute Goods
- Complementary Goods
- Relative Price
- Consumer Behavior
- Substitution Effect
- Diminishing Marginal Utility
- Preferences
- Expectations
- Income Effect (budget constraints)

Market
- Perfect Competition
- Homogenous Good
- Multiple Price Takers
- Perfect Information
- Freedom to enter/exit
- Individual Supply Curve
- Individual Demand Curve
- Market Supply
- Market Demand
- Market Surplus
- Market Shortage
- Market Price
- Market Q Supplied
- Market Q Demanded
- Ind. Price
- Ind. Q Supplied
- Ind. Q Demanded

Market Outcome
- Equilibrium Price
- Quantity Supplied
- Quantity Demanded

Graph
- Supply
- Demand
- Price Floor
- Price Ceiling
- Surplus
- Shortage

Real World Narratives
Consumer and producer behaviors, etc
(these may include naïve understandings)
Model 4: Economics
Advanced understanding of opportunity cost and decision making

Level 6

Benefits
Marginal Benefits
- Implicit
- Explicit
Non-Marginal Benefit

Costs
Marginal Costs (Opportunity Cost)
- Implicit
- Explicit
Non-Marginal Costs
Sunk Costs

Real World Narratives
(these may include naïve understandings)

Options:
- Option N
- Option 3
- Option 2

Rational actors make decisions at the margin, choosing an action where marginal benefits exceed marginal costs.
Our work: Designing and validating prototype assessment

- U.S. Department of Education, Institute for Education Sciences (IES) grant
  - This presentation focuses evidence from our first validation study
    - Content validity
  - Design process is discussed in another draft research paper
    - AERA this afternoon
Types of Validity Evidence Gathered

- Design Principles
- Expert Panel Review
- Correlations with other Tests
- Cognitive Processes
- Instructional Sensitivity

Test Validity
Expert panel validity study participants, purpose

- Experts (4 biology, 4 economics) rated the questions of three contrasting examinations:
  - SRI’s prototype domain-specific assessment
  - A college biology or economics content knowledge test
  - A college critical reasoning test
- Purpose:
  - Compare similarities and differences among tests
  - Characterize the knowledge measured by specific items in the tests
Expert panel validity study booklets, conditions

- 2 1-day rating sessions
- Rating booklets with:
  - Either 41 DSA biology test items OR 47 DSA economics test items (Test A)
  - 67 biology test items OR 30 economics test items (Test B)
  - 40 critical reasoning test items (Test C)
- Blocked presentation, alternating different test segments, different ordering per expert
- Experts blind to test/assessment developer
Expert judgments sought

- Experts rated each prompt on following:
Expert judgments sought

- Experts rated each prompt on following:
  
  - What types of knowledge would students use to answer this assessment task?
Expert judgments sought

• Experts rated each prompt on following:

  • **What types of knowledge** would students use to answer this assessment task?

  • **What types of reasoning** would students need to answer this assessment task?
Expert judgments sought

- Experts rated each prompt on following:
  - **What types of knowledge** would students use to answer this assessment task?
  - **What types of reasoning** would students need to answer this assessment task?
  - **When do students learn** the knowledge/reasoning approach in the post-secondary curriculum sequence?
Expert judgments sought

- Experts rated each prompt on following:

  - **What types of knowledge** would students use to answer this assessment task?
  
  - **What types of reasoning** would students need to answer this assessment task?

  - **When do students learn** the knowledge/reasoning approach in the post-secondary curriculum sequence?

  - **How important** is the knowledge/reasoning approach measured by each item?
Expert panel rates items on knowledge, reasoning types

**Quality of Domain Reasoning:**
- Biology: Argumentation; Data interpretation; Field/Lab procedures; Computation; Data representation creation;
- Economics: Use of narrative; graphs; models; argumentation

**Progression of Domain Knowledge Types:**
- Simple and complex discrete knowledge (e.g., facts, terms);
- Simple and complex relational knowledge (e.g., a couple ideas in relation);
- Strategic reasoning (e.g., knowing when and how to apply knowledge to a situation).
Discrete Knowledge - Biology

Percent of Items assigned to Discrete Knowledge Type

DSU

Test B - Bio

Test C - General

Percent of items

Percent of Items

No Discrete

Simple Discrete

Multiple Discrete
Percent of Items assigned to Relational Knowledge Type

- **Relational Knowledge - Biology**
  - **DSA**
  - **Test B - Bio**
  - **Test C - General**

- **No Relational**
- **Simple Relational**
- **Multiple Simple Rel.**
- **Complex Relational**

Percent of items vs. Percent of Items assigned to Relational Knowledge Type.
Reasoning Ratings - Biology

Percent of Items tagged with Reasoning Type

- DSA
- Test B - Bio
- Test C - General

Percent of items

- Analyzing Argument
- Extract Info from Table/Graph
- Do Lab/Field Proc.
- Create Rep.
- Computations
- Produce Arg.
- Reason w/Model
- Apply Model
I would have a good sense of...

Block Ratings - Biology

what a student knows
how a student thinks through problems
Relational Knowledge - Economics

Percent of Items assigned to Relational Knowledge Type

- **DSA**
  - No Relational
  - Simple Relational
  - Multiple Simple Rel.
  - Complex Relational

- **Test B - Econ**
  - No Relational
  - Simple Relational
  - Multiple Simple Rel.
  - Complex Relational

- **Test C - General**
  - No Relational
  - Simple Relational
  - Multiple Simple Rel.
  - Complex Relational
Usefulness of Knowledge - Economics

- DSA
- Test B - Econ
- Test C - General

- Foundational
- Important for Future Study
- Everyday Life
- Interpreting News
I would have a good sense of...

Block Ratings - Economics

How a student thinks through problems
Discussion

• Initial expert review of the assessment questions indicates:
  • Good content validity for biology and economics
  • The items measure:
    • Skills to apply domain-knowledge to everyday problems
    • Reveal student reasoning in the domain
Discussion

- These assessments—and the assessment development process—provide a principled path for:
  - **Program Planning:**
    - What kind of value is a program offering to students, both majors and non-majors
    - Tracking how well students are learning the core knowledge and skills for future study
    - **AND everyday application in life**
Discussion

• These assessments—and the assessment development process—provide a principled path for:
  • **Program Planning:**
    • What kind of value is a program offering to students, both majors and non-majors
    • Tracking how well students are learning the core knowledge and skills for future study
    • *AND everyday application in life*
  • **Classroom Diagnostics:**
    • Include in regular assessment to see what critical content and reasoning skills student are missing
    • Use results to target instruction and focus remediation
What contexts exist for applying this knowledge in everyday life?

Biology

• *Know how evolution affects:*
  • *Issues around environmental quality – natural selection cannot operate fast enough on populations of large organisms to protect them from many human-caused ecosystem changes*
  • *Issues around personal and public health – natural selection can operate very fast on populations of micro-organisms – antibiotic resistance problems*
What contexts exist for applying this knowledge in everyday life?

Biology
• *Know how the carbon cycle affects:*
  • *Issues around environmental quality – carbon being absorbed and emitted in a cycle all the time; human carbon combustive processes can overload the system*
  • *Issues around personal and public health – your health depends on cellular respiration, which depends on oxygen and which produces energy for all cellular processes*
What contexts exist for applying this knowledge in everyday life?

Economics

• *Know how economic principles can improve your reasoning around:*
  • *Issues of personal decision making:* You need to consider the costs of forgone options
  • *Issues around cost of services and goods you buy:* You need to understand prices are not set by individual greed, but by larger systems involving the supply chain
What contexts exist for applying this knowledge in everyday life?

Economics
• *Know how economic principles can improve your reasoning around:*
  • *Issues of government policy: You need to consider the impacts that government decisions can have on a market by changing the incentive structure for buyers and sellers*
Keep in touch!
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