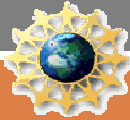# A Protocol for Classifying Sophistication of Students' Reasoning

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K SU PER

Project

2

NSEUS[1] is looking at:

- Impact of reformed undergraduate science courses on student outcomes

  - Reformed $\Rightarrow$ Inquiry oriented strategies with elementary education majors

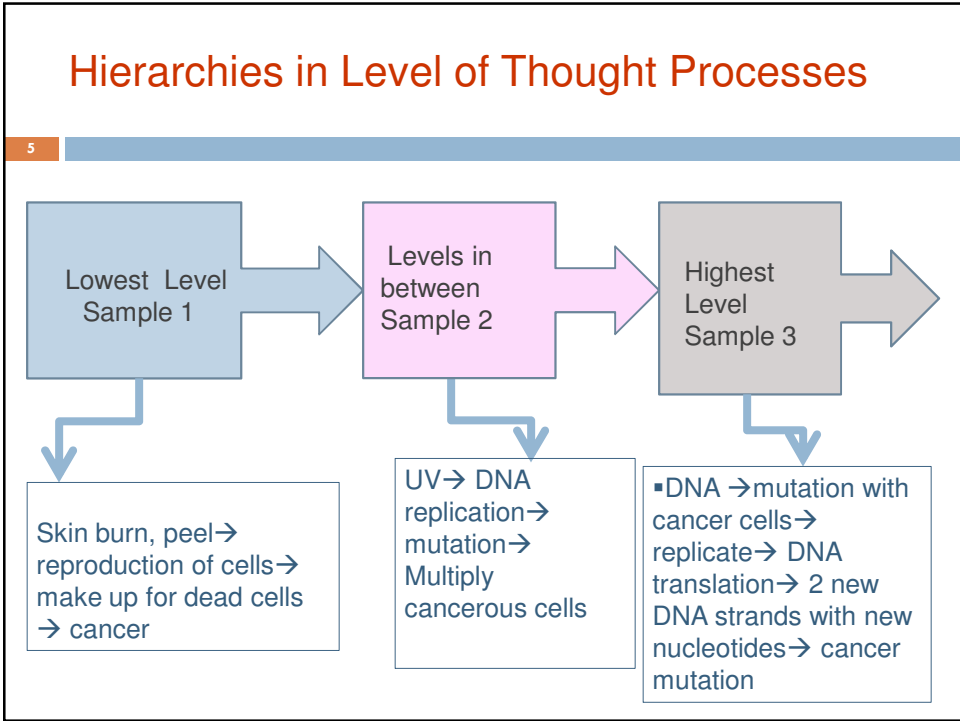[1]National Study of Education in Undergraduate Science

Research Questions

3

- ❑ Can we classify students' reasoning in terms of their responses to written content questions? (Questions with special features)

- ❑ Can students' reasoning across the disciplines be compared?

Example from Biology

4

- ❑ Use Central Dogma of Biology:

  DNA → RNA → Protein

  to describe the series of events that would follow the loss of ozone from the atmosphere and subsequently lead to cancer.

Hierarchies in Level of Thought Processes

5

| Lowest Level Sample 1 | → | Levels in between Sample 2 | → | Highest Level Sample 3 | → |

Skin burn, peel→ reproduction of cells→ make up for dead cells → cancer

UV→ DNA replication→ mutation→ Multiply cancerous cells

▪DNA →mutation with cancer cells→ replicate→ DNA translation→ 2 new DNA strands with new nucleotides→ cancer mutation

Classify Knowledge and Cognitive Processes

Revised Taxonomy (Anderson & Krathwoll, 2001):				
Knowledge Dimension		**The Cognitive Process Dimension**		
		Remember	**Understand**	**Apply**
			Infer, Compare, Explain, Interpret	New situation
Factual Knowledge				
Conceptual Knowledge	Schema Classification Principles, Theories			
Procedural Knowledge	Skills, Tools, Rules, Methods			

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Rubric-Analyze students' Responses[2]

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Factual	Poor Performance
	Developed
	In-depth
Conceptual	Poor Performance
	Developed
	In-depth
Procedural	Poor Performance
	Developed
	In-depth

Compare	Poor Performance
	Developed
	In-depth
Infer	Poor Performance
	Developed
	In-depth
Apply	Poor Performance
	Developed
	In-depth

2-Wiggins and McTighe (1998)

Example: Moon Phases

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□ You look outside and see a first quarter moon. Suppose that an astronaut were on the moon looking at Earth. Make a sketch of The Earth as seen by the astronaut. How will the illuminated portion of the Earth appear different three days later?
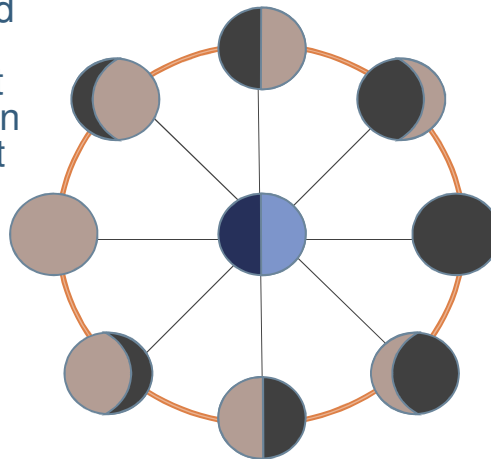
Response1

"The astronaut would see a 3rd quarter, waning moon. The moon will have moved slightly more in its evolution, making earth see the moon as slightly more than 1st quarter. In contrast the earth would appear less full to the astronaut on the moon."
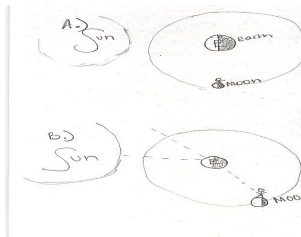
9

Compare	• In-depth
Infer	• In-depth
Apply	• In-depth

Response2

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"The earth illuminated portion would decrease same, it would be a waning gibbous instead of a third quarter. It be even a waning crescent almost a full earth, depending on the rotation."
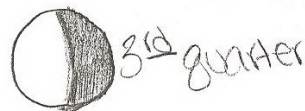
Factual knowledge	• In-depth
Conceptual Schema	• Developed
Procedural Knowledge	• Poor

Response3

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"The earth would appear less illuminated because the Sun to Earth to moon angle would decrease since the Earth moves in a counterclockwise direction to the Sun"
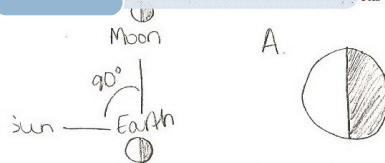

Compare • Developed

Infer • Developed

Apply • Developed

Data Analysis

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	Factual			Conceptual			Procedural		
	P	D	I	P	D	I	P	D	I
Bio (N=56)	27%	48%	25%	34%	45%	21%	73%	16%	11%
Moon (N=50)	26%	36%	38%	42%	34%	24%	78%	16%	6%

P=Poor, D=Developed, I=In-depth

Data Analysis

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	Compare			Infer			Apply		
	P	D	I	P	D	I	P	D	I
Bio (N=56)	57%	25%	18%	47%	37%	16%	54%	30%	16%
Moon (N=50)	62%	30%	8%	76%	16%	8%	74%	18%	8%

P=Poor, D=Developed, I=In-depth

Conclusions

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- Coding scheme that captures specific aspects of students' reasoning
- Pattern in students' reasoning (N=700):
  - The occurrence of higher levels of cognitive processing was rare
  - Procedural knowledge is the least prevalent of all types of knowledge
- Comparison across discipline (N=700)
  - Some differences (Knowledge type)
  - No significant differences (Cognitive process)

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Thank You

Poster session
**A Method for Classifying
Students' Understanding of
Conceptual Structures**
PST2B-11
Tue 01/11, 8:30PM - 9:15PM