Protocol for Analysis of Content Questions

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Introduction to NSEUS [1]

- What is the Impact of Undergraduate Science Course Reform[2] implemented by NOVA[3] on elementary education majors?

1-National Study of Education in Undergraduate Science

2- Inquiry based, student centered, collaborative, base on prior knowledge

3- (NASA opportunities for Visionary Academics),103 higher education institutions participated in the reforming science courses to enhance the education of elementary teaching majors

Research Design

Comparing reform (NOVA) and traditional (non-NOVA) course in terms of,

- Students' beliefs and perceptions
- Learning environment
- Course structure characteristics
- Pedagogical content
- Collaboration and teaching methods
- Students' reasoning skills across disciplines

Data Collection

❑ Written content questions

❑ Observations
- University courses (Reformed and traditional)
- Elementary schools #

❑ Structured interviews
- Faculty (reform and traditional)
- Elementary teachers #
- Focused groups with # elementary education majors

How to design written extended questions?

A structured task, that includes various levels of reasoning skills and requires following steps;

Step1: Starting with concrete facts

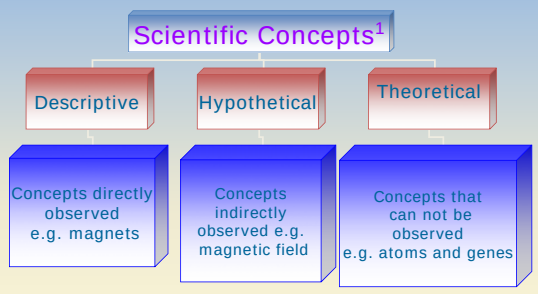
Step2: Making higher order concepts from concrete facts

Step3:Connecting the facts or higher order concepts by reasoning (Cause-effect, compare and comparison)

Step 4:Applying the concepts in a new context or analyzing a scenario

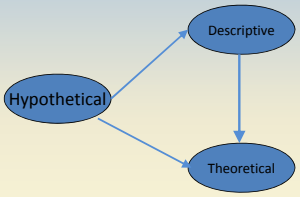
Step 5:Putting together in a well organized explanation

Concept levels



[1]Lawson et. al (2000)

Level of abstraction of content questions



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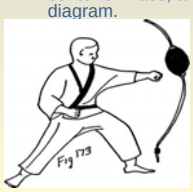
Example of a content question

- Explain how the stability relates to the width of the base and the height of center of mass above the base? Explain in terms of forces and rotational forces (torque) applied around the center of mass, also draw a diagram.



- To protect against attacks, the man takes on particular fighting stances. Explain why this fighting stance makes it difficult for opponents to knock him down?
- "Man stands with one leg in front of him, one leg behind him, and bends his knees down".

The Knowledge Dimension	The Cognitive Process Dimension					
	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual Knowledge						
Conceptual Knowledge						
Procedural Knowledge						
Meta-Cognitive Knowledge						

Across disciplines

Appropriate facets to our goals

Categories &	Cognitive process
Remember	Recognize, Recall
Understand	Interpret, Infer, Exemplify, Classify, Explain, Summarize Compare and contrast, Generalize
Apply	Execute Implement
Analyze	Differentiate Organize Attribute
Evaluate	Checking Critiquing
Create	Generate Plan Produce

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The knowledge Dimension	
Factual knowledge	Knowledge of terminology Knowledge of elements and essential facts
Conceptual Knowledge	Knowledge of classification of categories, knowledge of principles and generalizations, knowledge of theories and structures
Procedural knowledge	Knowledge of subject-specific skills, algorithms, techniques, methods and determining when to use appropriate procedures
Cognitive Knowledge	Strategic Knowledge (why, when to use), Knowledge about cognitive tasks, Self Knowledge

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Data analysis: written extended questions

- Apply the taxonomy to the content question
- Define the characteristics of best and poorest quality of response
- Define levels of quality accomplishment between two anchor points
- Identify clearly what distinguishes the different levels of accomplishment

Using learning taxonomies in developing rubrics (1)

Six Facets of Wiggins and McTigh

Levels of accomplishments

	Explain	Interpret	Apply	Perspective	Empathy	Self-knowledge
Sophisticated						
In-depth						
Developed						
intuitive						
Naive						

Assessment tool for evaluating mathematical knowledge [1] which students transfer to their lives

Cognitive →	Factual	Procedural	Schematic	Strategic	Epistemic	Social
Assimilation						
Competence						
Proficiency						

Affective →	Interest	confidence
Assimilation		
Competence		
Proficiency		

1-Curtis Bennett and Jackie Dewar (2007)

Rubric and definitions of levels

- **Factual knowledge**

  0= Unaware of basic premises and factual knowledge that one must know to be acquainted with the problem, or start to be aware of th facts

  1= Lacking the facts needed to justify a reasonable explanation, or account with irrelevant facts

  2= Access to the basic facts required for tackling the problem

- **Conceptual Knowledge**

  0= Wrong concepts and wrong connections

  1= Fragmentary collection of concepts or adding incomplete and irrelevant concepts to appropriate schemas, using concept out of the context or presenting multiple answers

  2= Correct and complete set of concepts with correct connections

Example question

A toy metal ship is floating in a container of distilled water.

a) Using the physics you learned in this class, explain why a metal ship can float.

A mark is placed upon the side of the ship to indicate the water line. Salt is now added to the distilled water.

b) How will the mark made on the hull of the ship now compare to the water line? Why?

How to employ the rubric to the content question

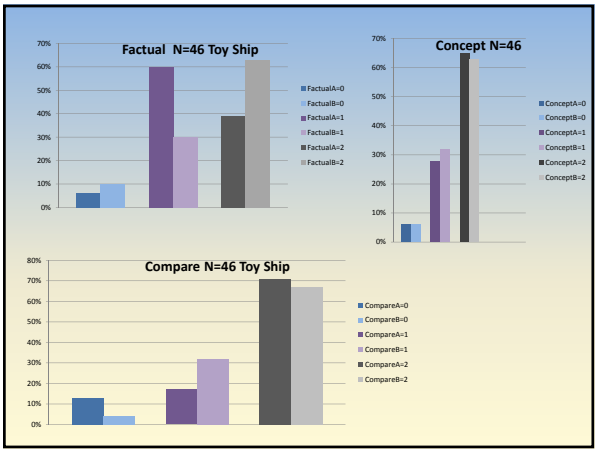
a) When the metal encases a volume of air, the mean density of the object (metal and air) is less than the density of the metal alone. If this object composed of metal and air is less dense than the liquid around it, then it will float.

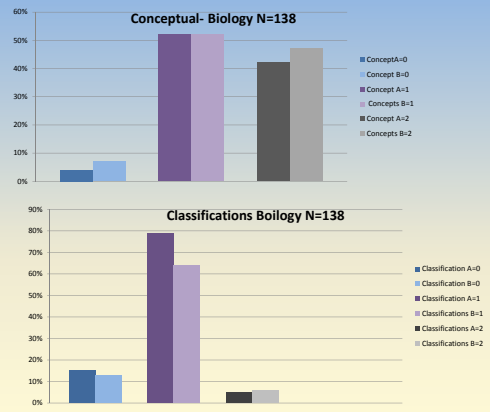
b) By adding salt to the distilled water, the density of the water increases. Because the water is now d the density of the ship has not changed, the s float higher in the salt water than it did in the distilled water. Therefore, the water line on the ship will be below the mark made on the

Factual knowledge

Infer, relational reasoning

omparison





Conclusion

- This method can provide a way to define the reasoning level of the question
- The objective was comparing students' reasoning skills across disciplines. In this way one can compare students thinking levels with different majors by;
  - Keeping knowledge level, cognitive level and level of abstraction similar between the comparing questions

- Thank you