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A Method for Classifying Conceptual Structure

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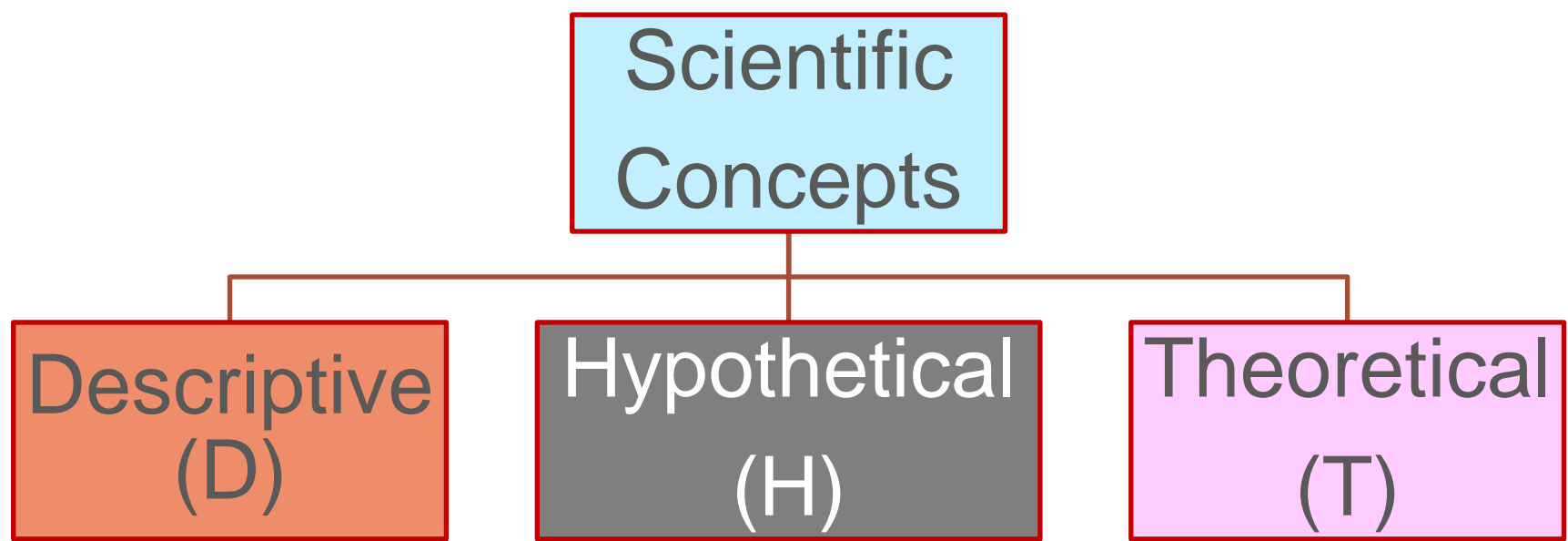
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Introduction

- NSEUS (National Study of Education in Undergraduate Science) investigates the effect of interactive engagement teaching-learning strategies in traditional and treatment courses (<http://nseus.org>)
- As a part of NSEUS we are comparing students' (Elementary Education majors) reasoning skills in a scientific context across disciplines

Modification to Lawson's¹ Concept Classification Scheme

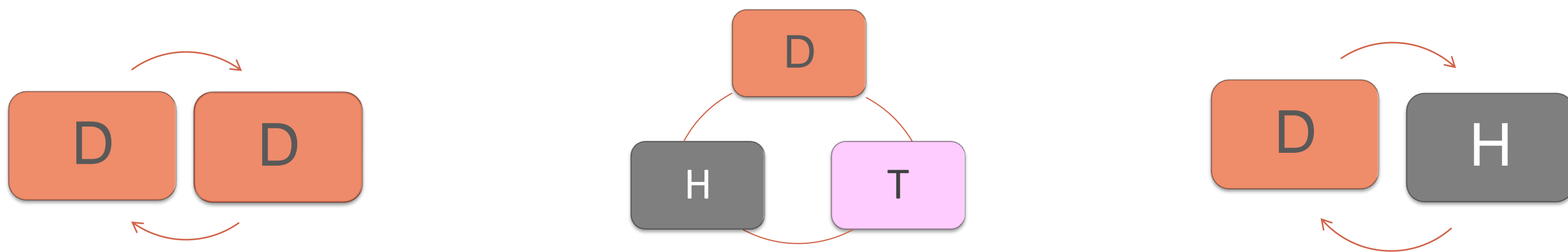


Descriptive Concepts: Concepts can be directly sensed or observed

Hypothetical Concepts: Concepts can be indirectly sensed or observed

Theoretical Concepts: Concepts cannot be sensed or observed but comprehended from logic or theories

Classifying Concept Link Structure²



One Concept Level Link: Linking concepts of the same level such as D-D

Cross Concept Level Link: Linking concepts of two different levels such as T-H or H-D

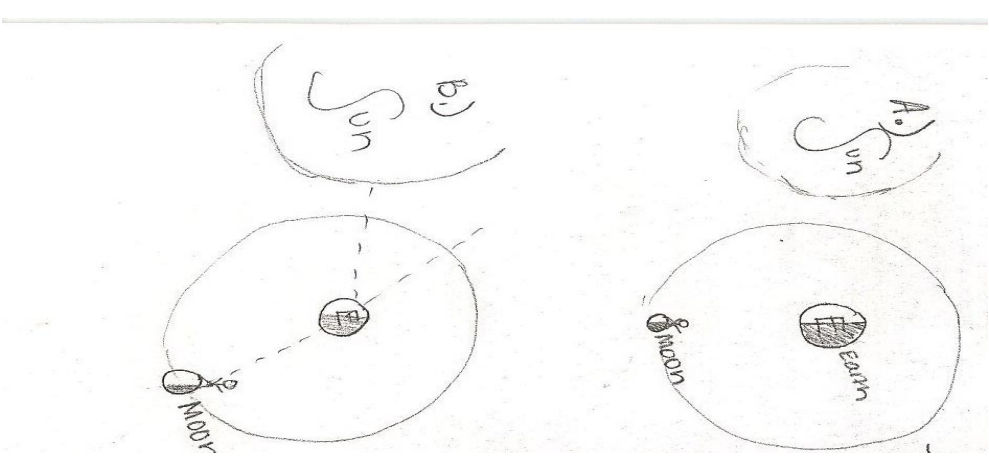
Multi concept Level Link: Linking concepts of all three levels such as T-H-D

Sample types of conceptual structure for moon phase question

Suppose it's the first quarter of the moon and an astronaut were on the moon looking at the Earth. Make a sketch of the Earth as seen by the astronaut. Three days later, how will the illuminated portion of the Earth appear different?

Sample 1

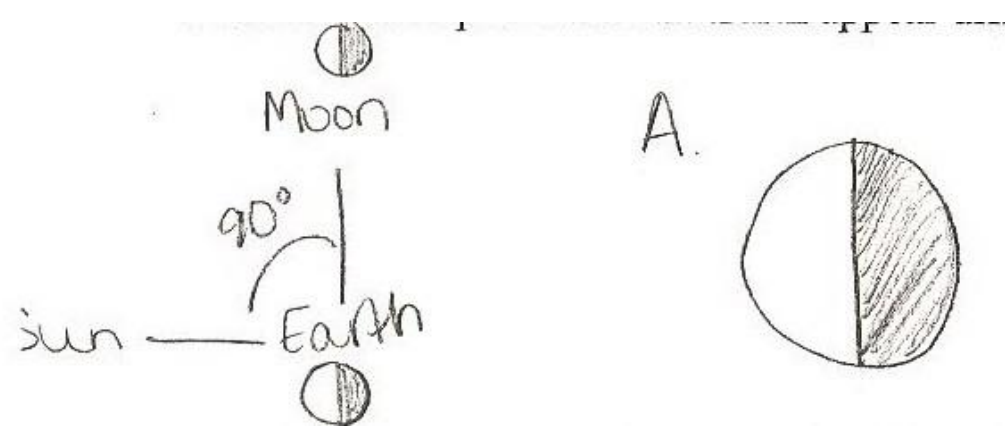
The astronaut would see a 3rd quarter, waning moon. The moon will have moved slightly more in its revolution, making earth see the moon as slightly more than 1st quarter. In contrast the earth would appear less full to the astronaut on the moon



D-H-H

Sample2

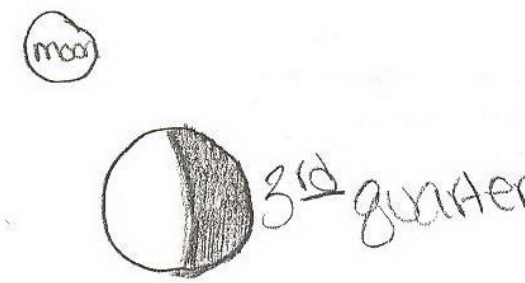
The earth would appear less illuminated because the Sun to Earth to moon angle would decrease since the Earth moves in a counterclockwise direction to the Sun



H-D

Sample 3

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



D-D

Examples of scientific concepts and level of complexity

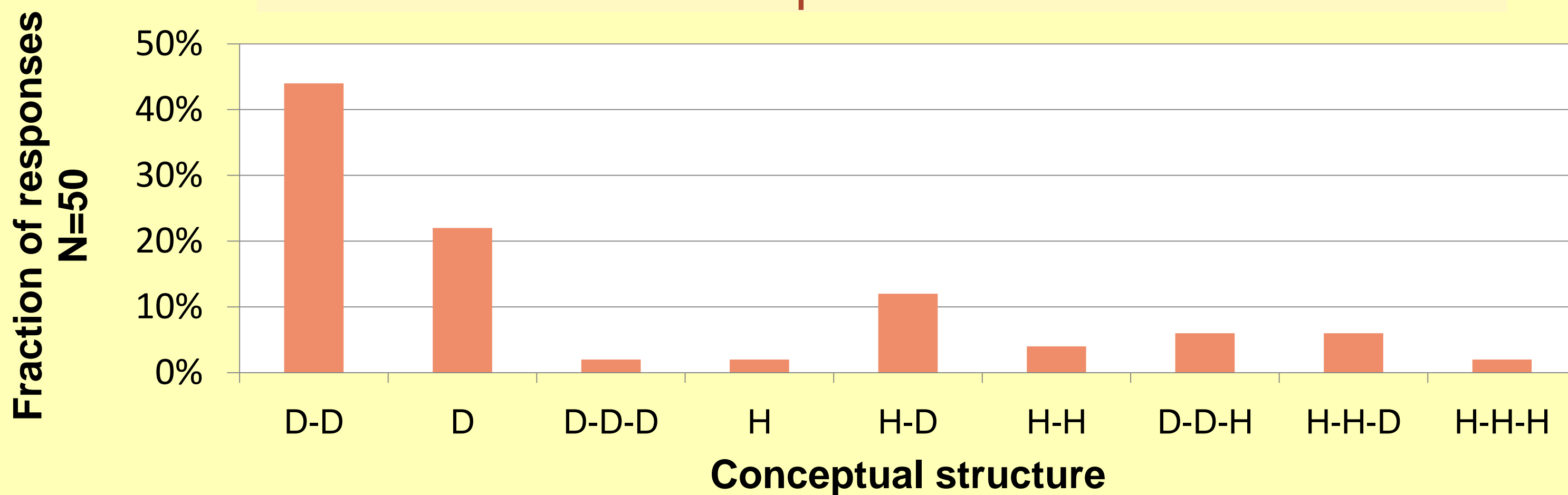
Observation of moon phase, temperature, magnets, focal length, objects	D
Human anatomy, electric circuits	D
Moon cycle geometry, evolution, voltage, magnetic field, potential barrier, UV, ozone layer	H/H analogy
Uncertainty principle (recall)/ tiny molecules, law of acceleration (imaginary)	T/T ad-hoc
Cell reproduction, atomic collisions	T/T analogy
Conservation of energy, mutation	T

Increased Complexity

References

- 1- M. Nieswandt & K. Bellomo, J. Res. Sci. Teach, 46(3), (2009)
- 2- A.E. Lawson *et al.*, J. Res. Sci. Teach, 37 (2000)

Conceptual structure distribution for moon phases question



Conclusions

- Students' reasoning mostly involved lower level concept links
- Multi-level and cross concept links were rare
- Cross concept linkages can be encouraged by including non-observables in question design