



Supported by NSF  
Grant ESI-055454

# Investigating the relation between students' reasoning and the pedagogy in university science content courses for future grades 1-6 teachers

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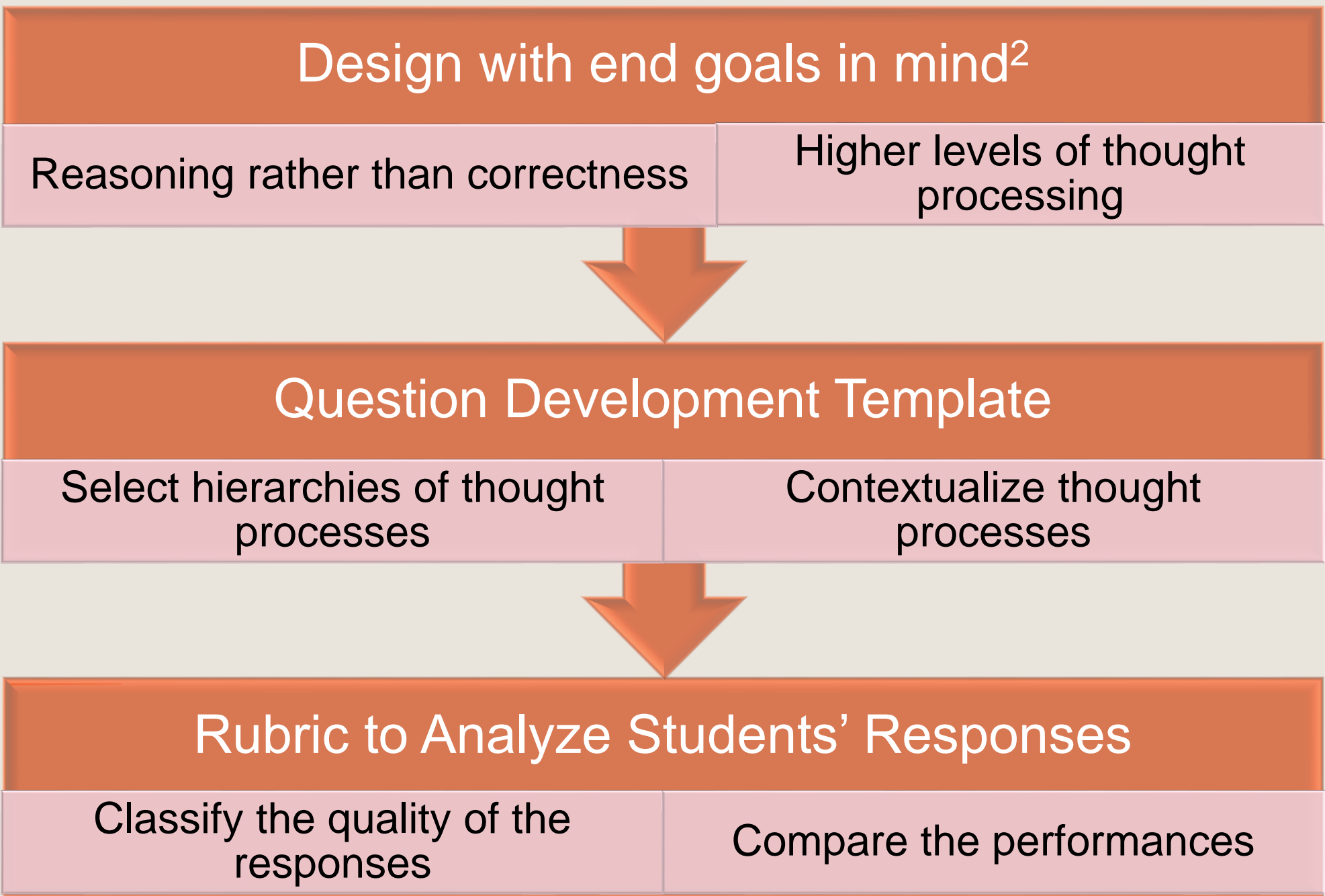
## Introduction

- The National Study of Education in Undergraduate Science<sup>1</sup> investigates the effects of interactive engagement teaching-learning strategies in science content courses on elementary education students.
- As a part of this study we classify students' reasoning based on their responses to written content exam questions.

### Research Question

What is the relation between the quality of students' reasoning as displayed on written content questions and the degree to which the course is considered to use interactive pedagogy?

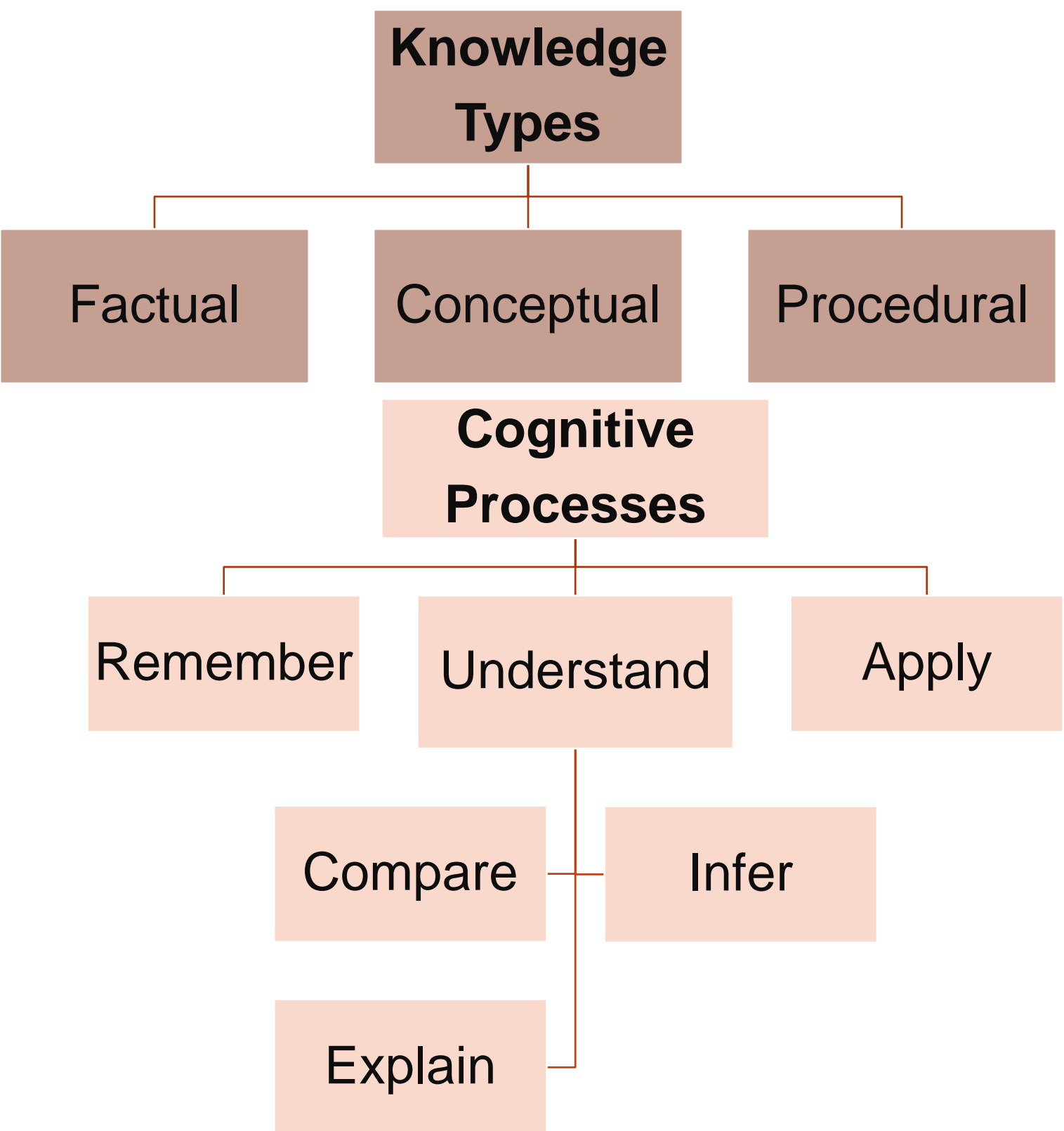
## Process of Assessment Design



## Question Design and Rubric

- Design a protocol for question development that combines two different classification schemes.
  - ❑ Anderson's<sup>3</sup> revision of Bloom's Taxonomy (discussed here)
  - ❑ Concept classification scheme to determine levels of abstraction & connection.
- Develop a rubric based on Anderson's taxonomy to classify student reasoning levels.

## Part of Anderson's Revision of Bloom's Taxonomy<sup>3</sup>



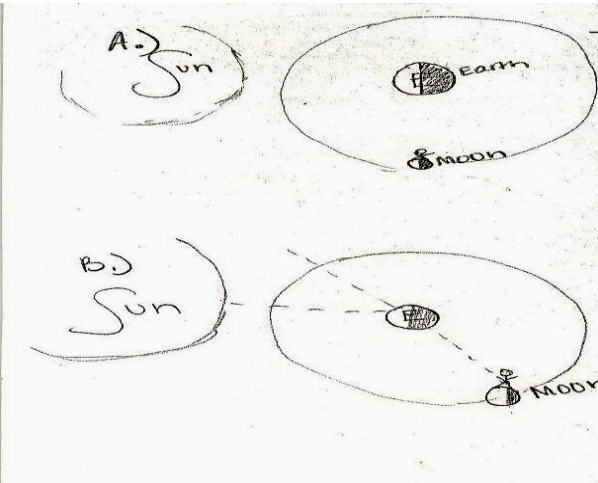
## Sample Question<sup>4</sup>

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?

Cognitive processes	<b>Understand</b> (Compare, Infer, Explain) <b>Apply</b>
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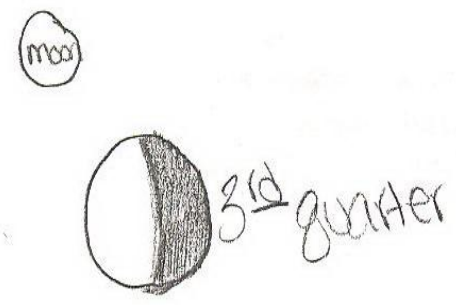
## Rubric and Coding Responses

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



Compare✓ Infer✓ Apply✓

"The earth illuminated portion would decrease same, it would be a waning gibbous instead of a third quarter. It would be even a waning crescent almost a full earth, depending on the rotation."



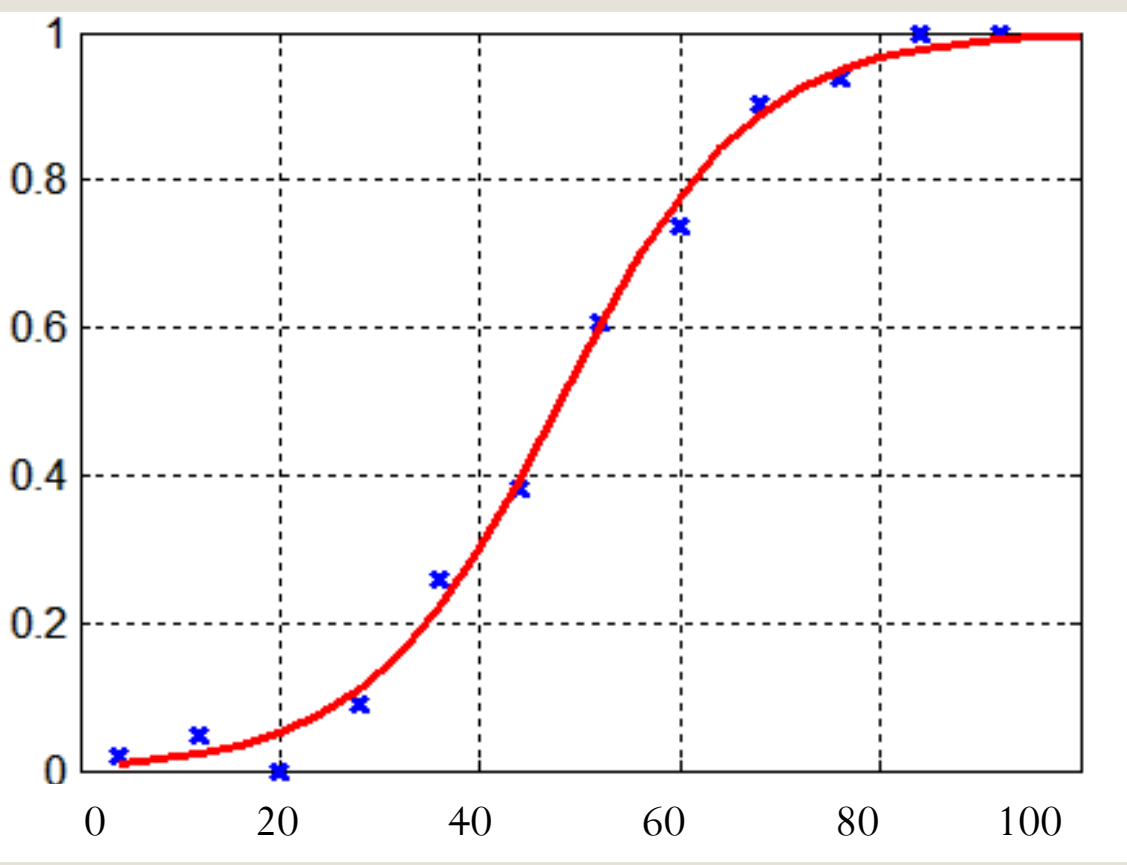
Compare✓ Infer X Apply X

## Analysis

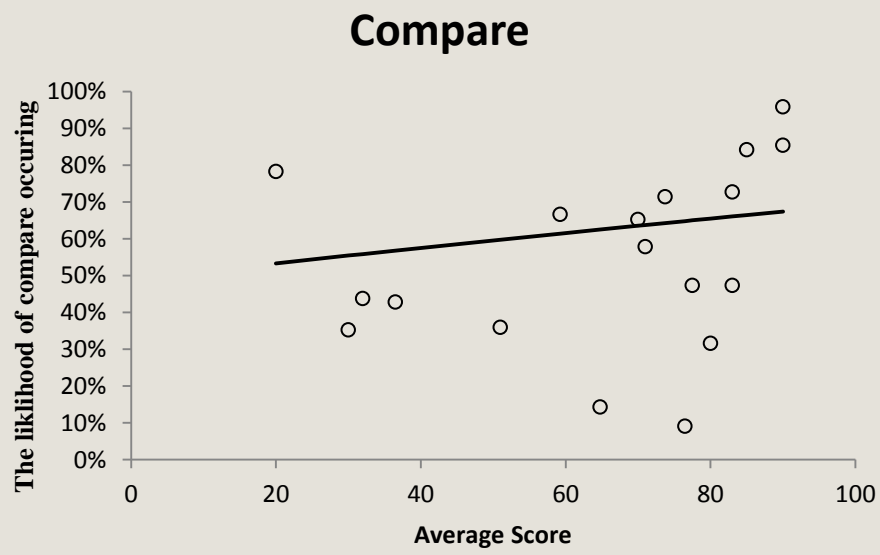
Apply Logistic Regression using RTOP Score as independent variable versus scores (0 or 1) on each of the following as dependent variable.

- Compare-contrast
- Infer
- Explain
- Apply

$$f(x) = \frac{1}{1 + e^{-(ax+b)}}$$



## Trends



<b>Compare</b>	As the RTOP score increases, the likelihood of the evidence for compare in student responses increases.
<b>Infer</b>	No relationship is measured between the RTOP average score and evidence in student responses for inference.
<b>Explain</b>	No relationship is measured between evidence of students' ability to explain and the increase in RTOP average score.
<b>Apply</b>	Likelihood of evidence in their responses of students' ability to apply slightly increases as the RTOP average score increases .

## Conclusions

Evidence of cognitive process depends on RTOP in the favor of higher RTOP scores for some but not all processes

Other results show similar patterns

Some traits decrease with higher RTOP component scores

### References

- 1- <http://nseus.org>
- 2- G. Wiggins and J. McTighe "Understanding by Design", Association for Supervision and Curriculum Development, Virginia (1998)
- 3- L.W. Anderson and D.R. Krathwohl, *A Taxonomy for Learning, Teaching, and Assessing*, Longman, New York (2001)
- 4- L.C. McDermott, *Physics by Inquiry*, New York: John Wiley & Sons, 1996