NSEUS

TPC 0554594

Students' Reasoning and the Level of Interactivity in Science Content Courses

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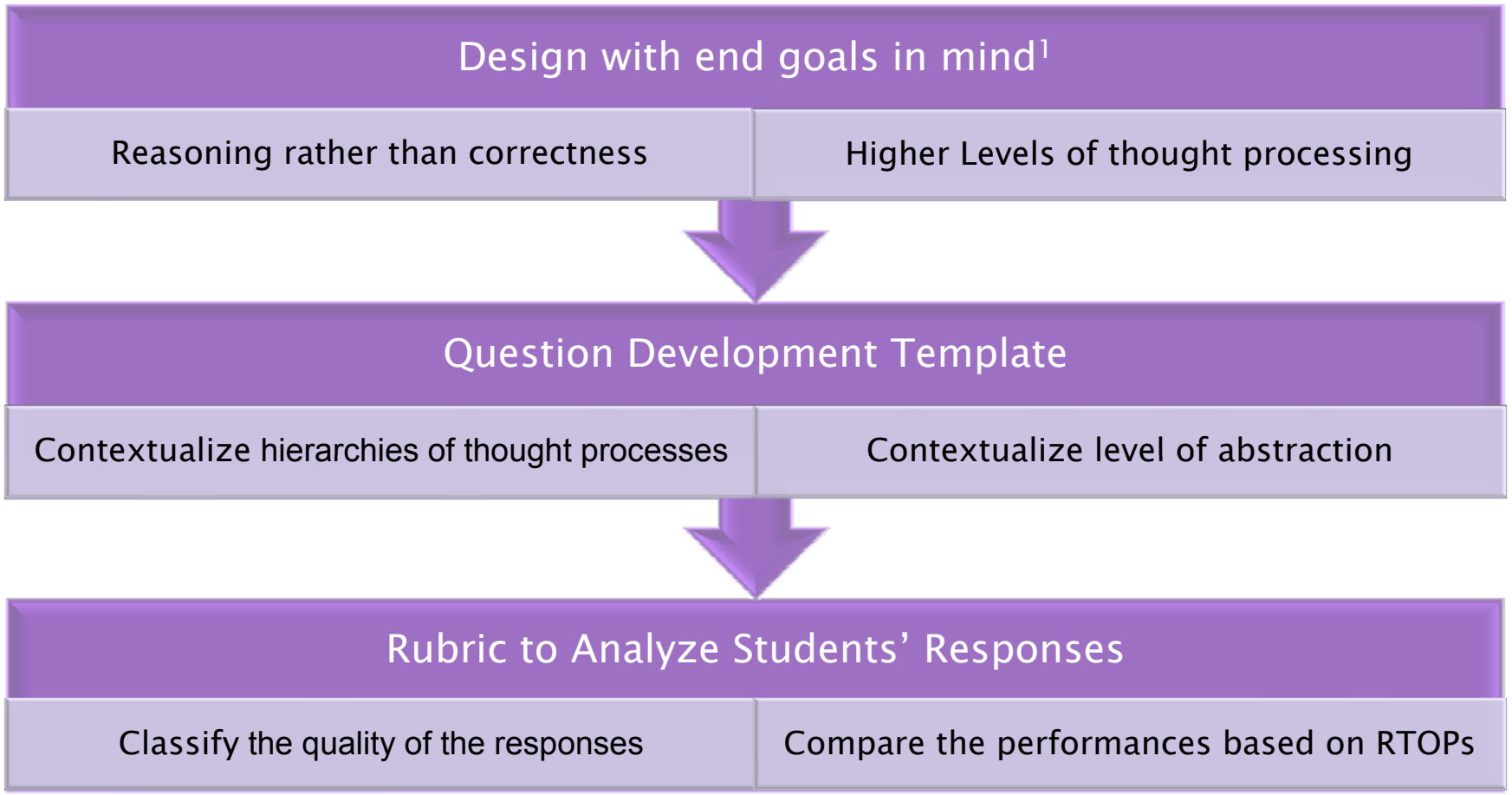
Supported by National Science Foundation Grant ESI-055494

Focus of Our Work

- Question: Do students learn differently from different pedagogies?
- Difficulty:
  - Need to compare across disciplines
  - Need to study a large number of students in many different universities (900)
- Solution: Analyze evidence of students' reasoning as exhibited in their responses to *written content questions*.

Process of Assessment Design



1-Wiggins and McTighe (1998)

Traits Selected from Bloom's Revised Taxonomy

Knowledge Dimension

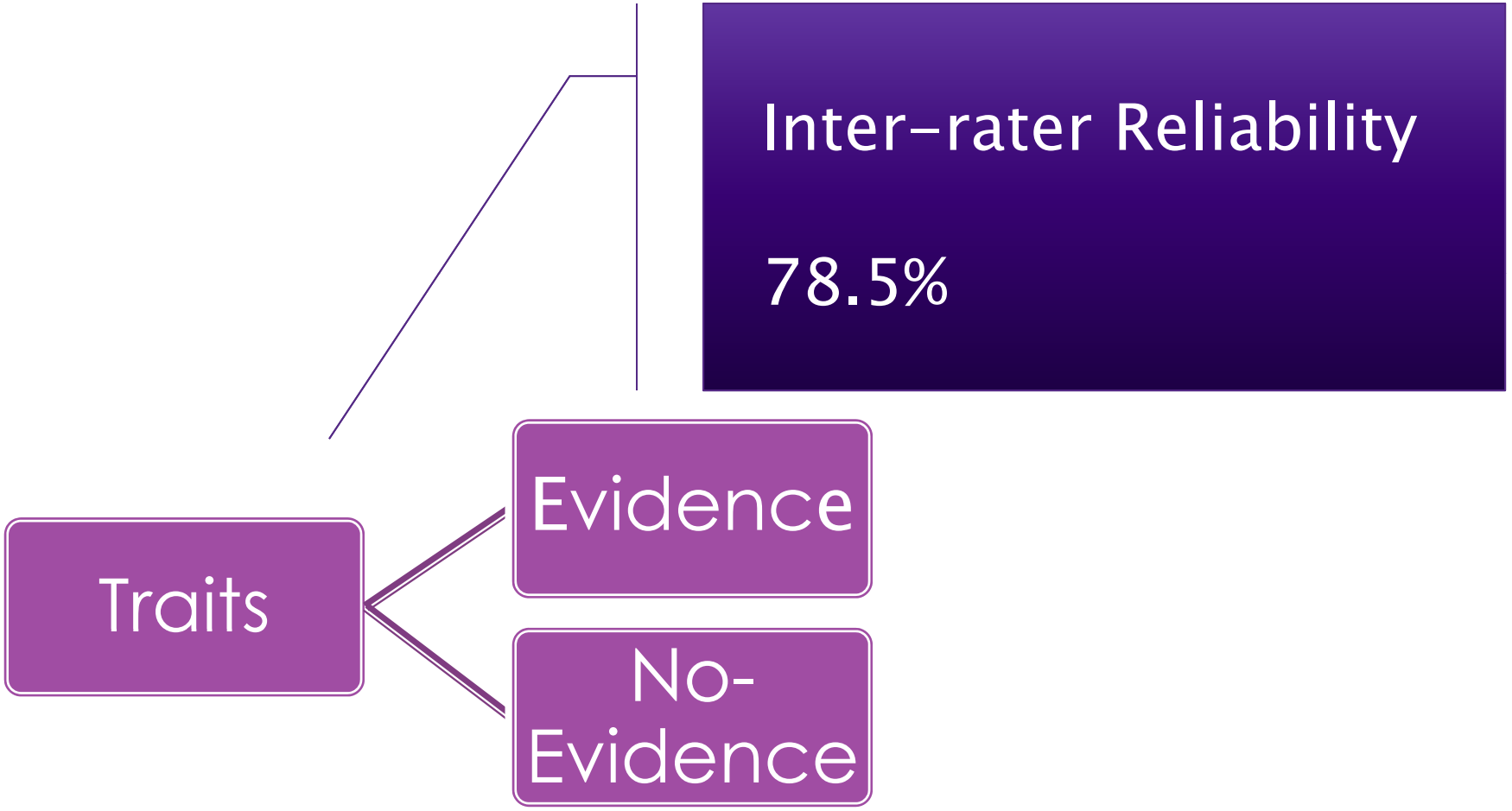
- Factual Knowledge
- Conceptual Knowledge
- Procedural Knowledge

Cognitive Processes Dimension

- Understand
  - Compare
  - Infer
  - Explain
- Apply

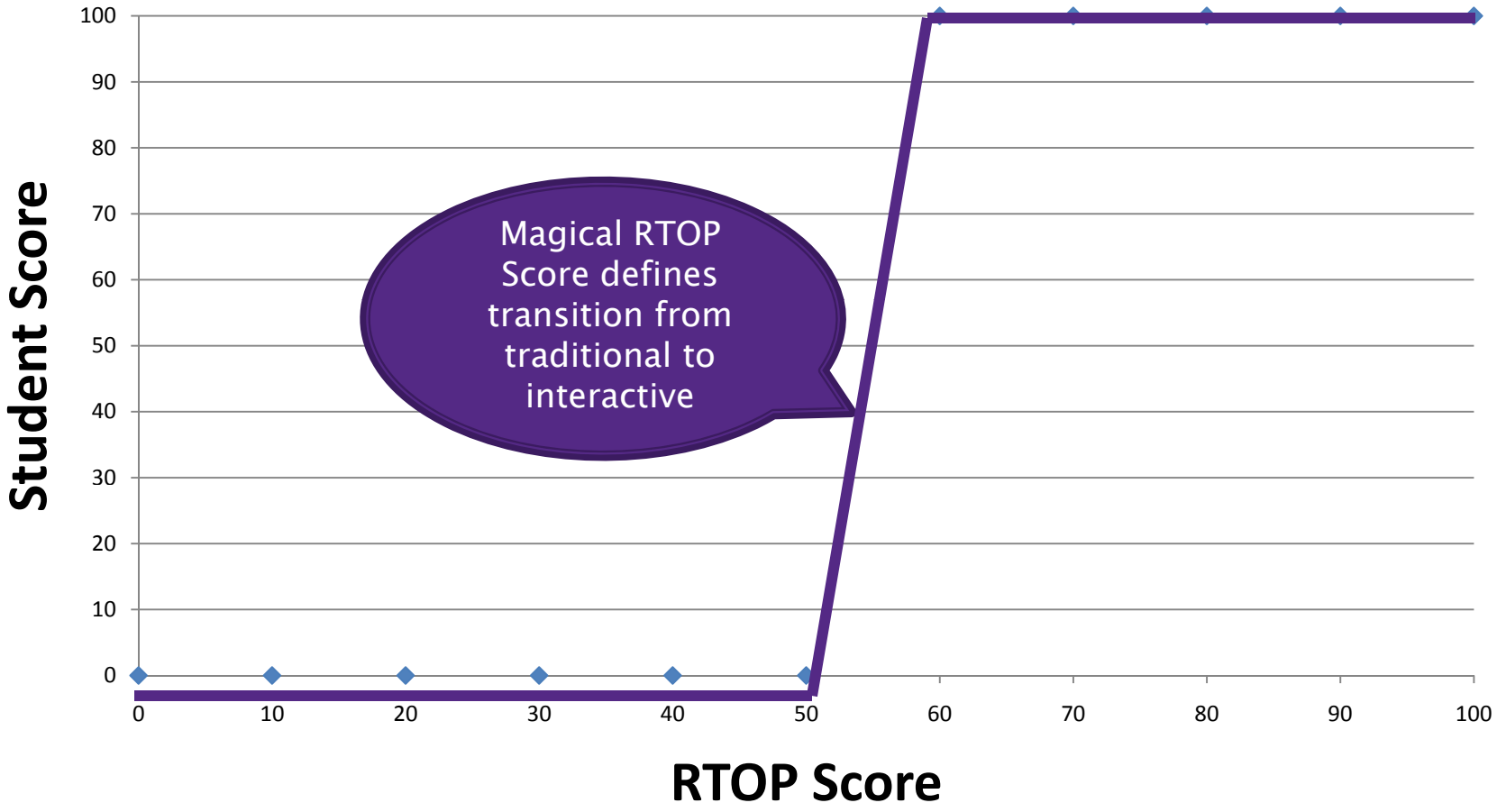
2-Anderson & Krathwoll (2001)

Rubric-Analytical Trait Scoring vs. Holistic Scoring [3]



3-Wiggins & McTighe (1998)

Analysis (in the ideal world)



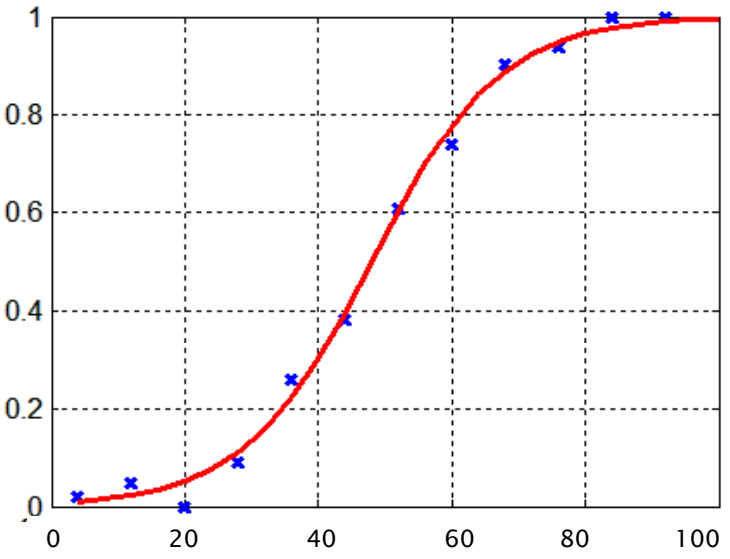
Logistic Regression

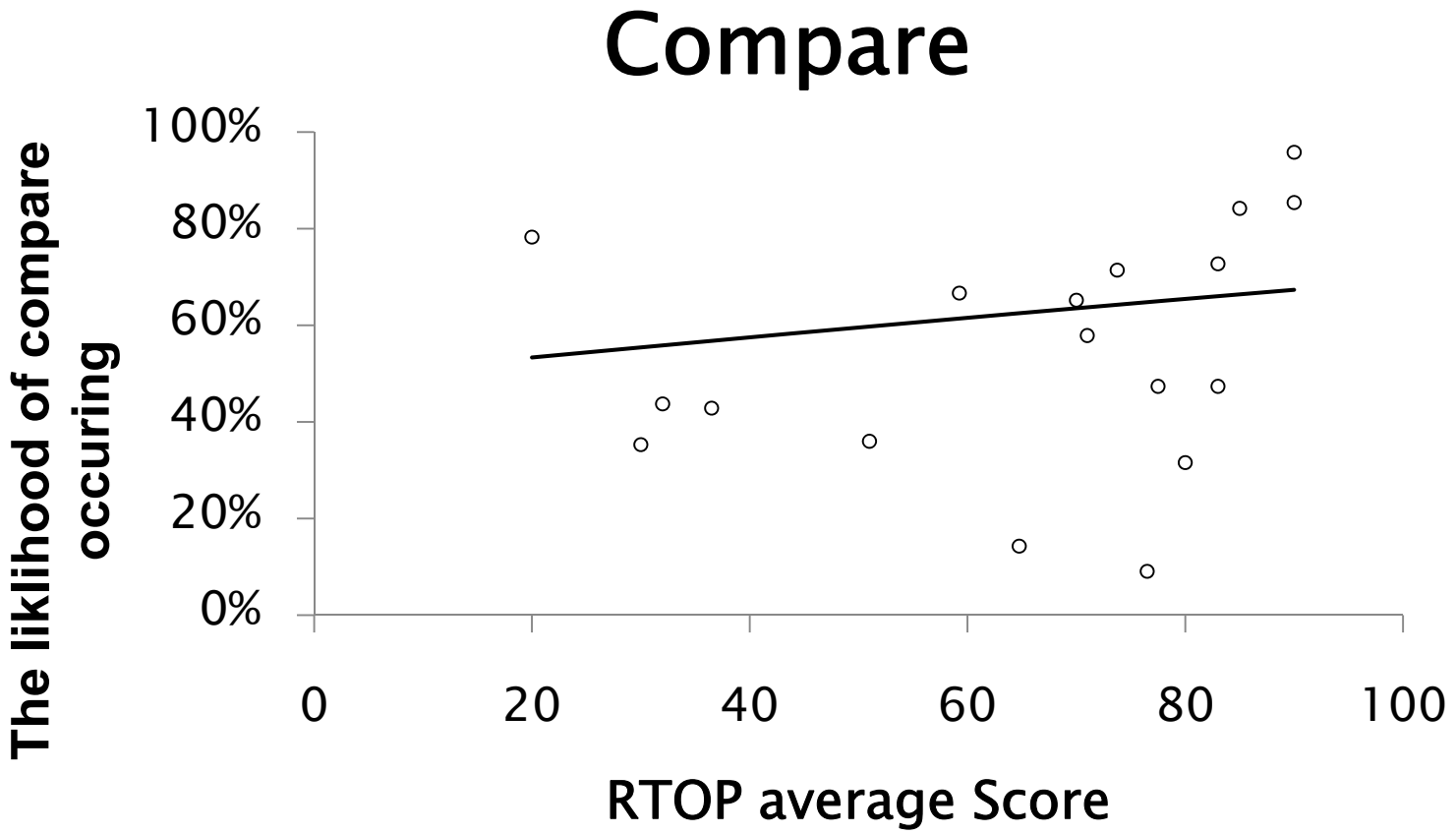
***a, b**:* Coefficients that fit the regression model

***x**: RTOP scores*

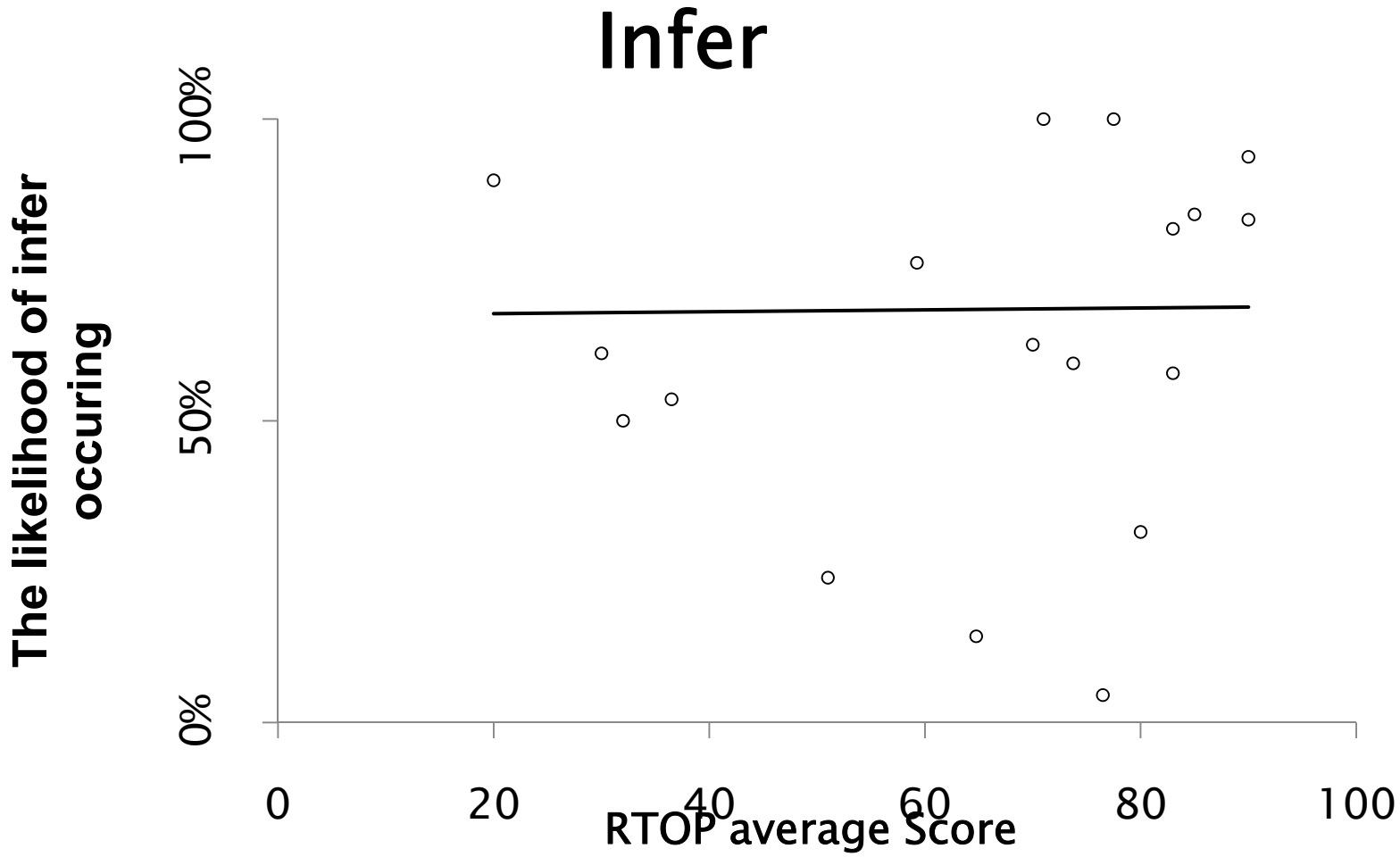
f(x) : Probability of evidence that certain component of taxonomy occurred

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

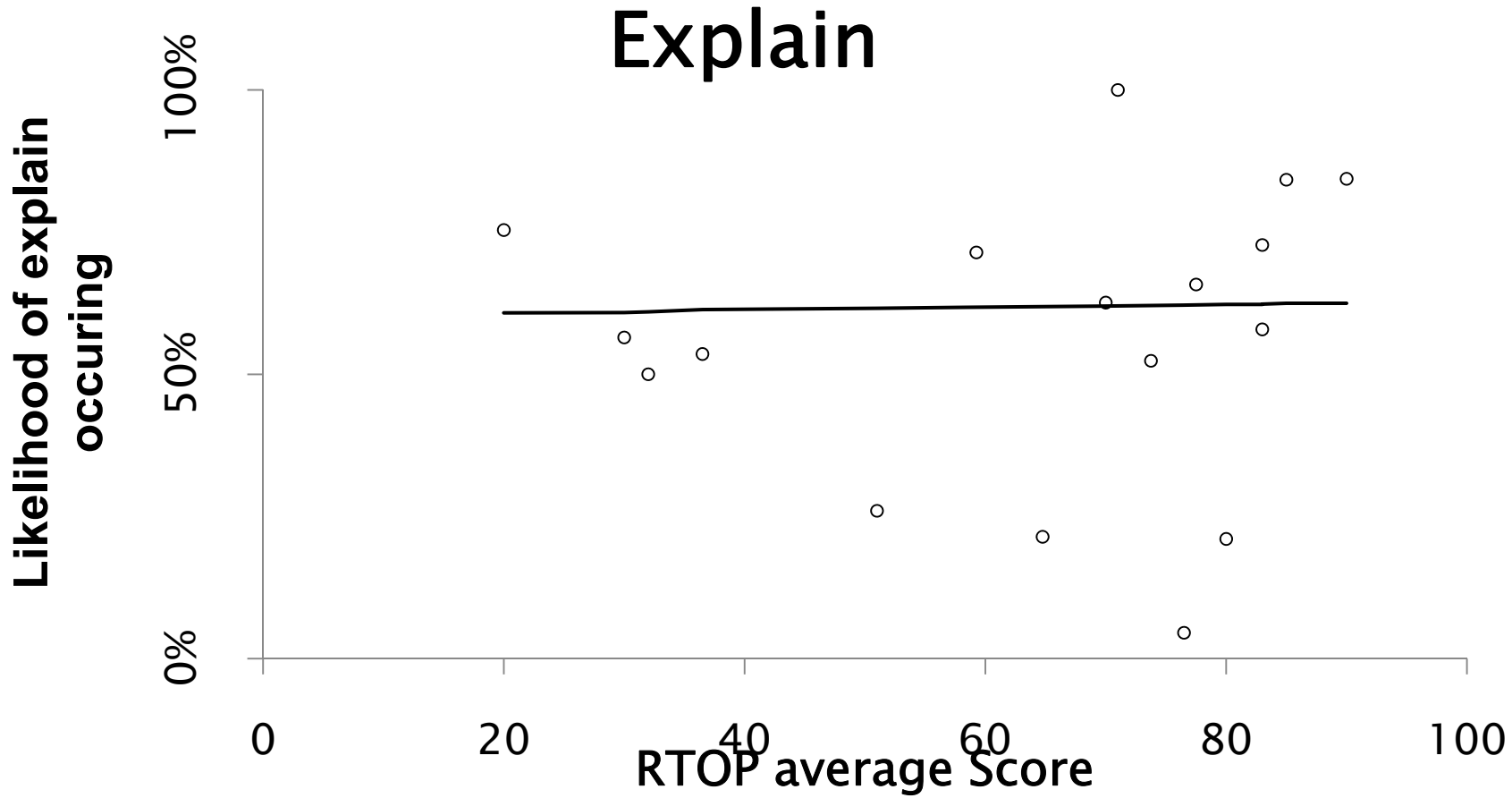




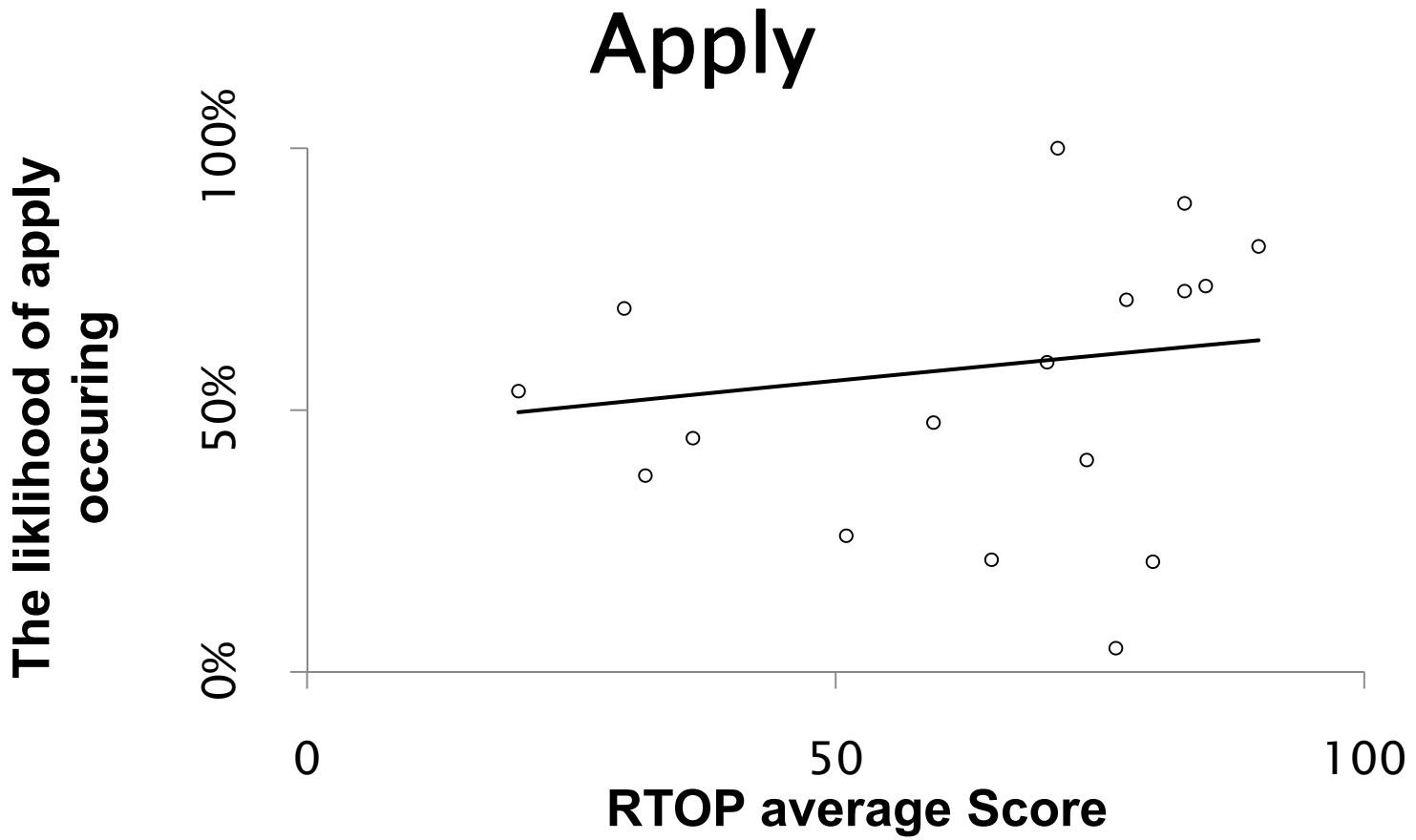
$$p_{Compare} = \frac{1}{1+e^{-(0.035+0.008x)}}$$



$$p_{Infer} = \frac{1}{1+e^{-(0.73)}}$$



$$p_{Explain} = \frac{1}{1+e^{-(0.4)}}$$



$$p_{Apply} = \frac{1}{1+e^{-(0.18+0.008x)}}$$

RTOP Sub-scores
Generalized Logistic Regression

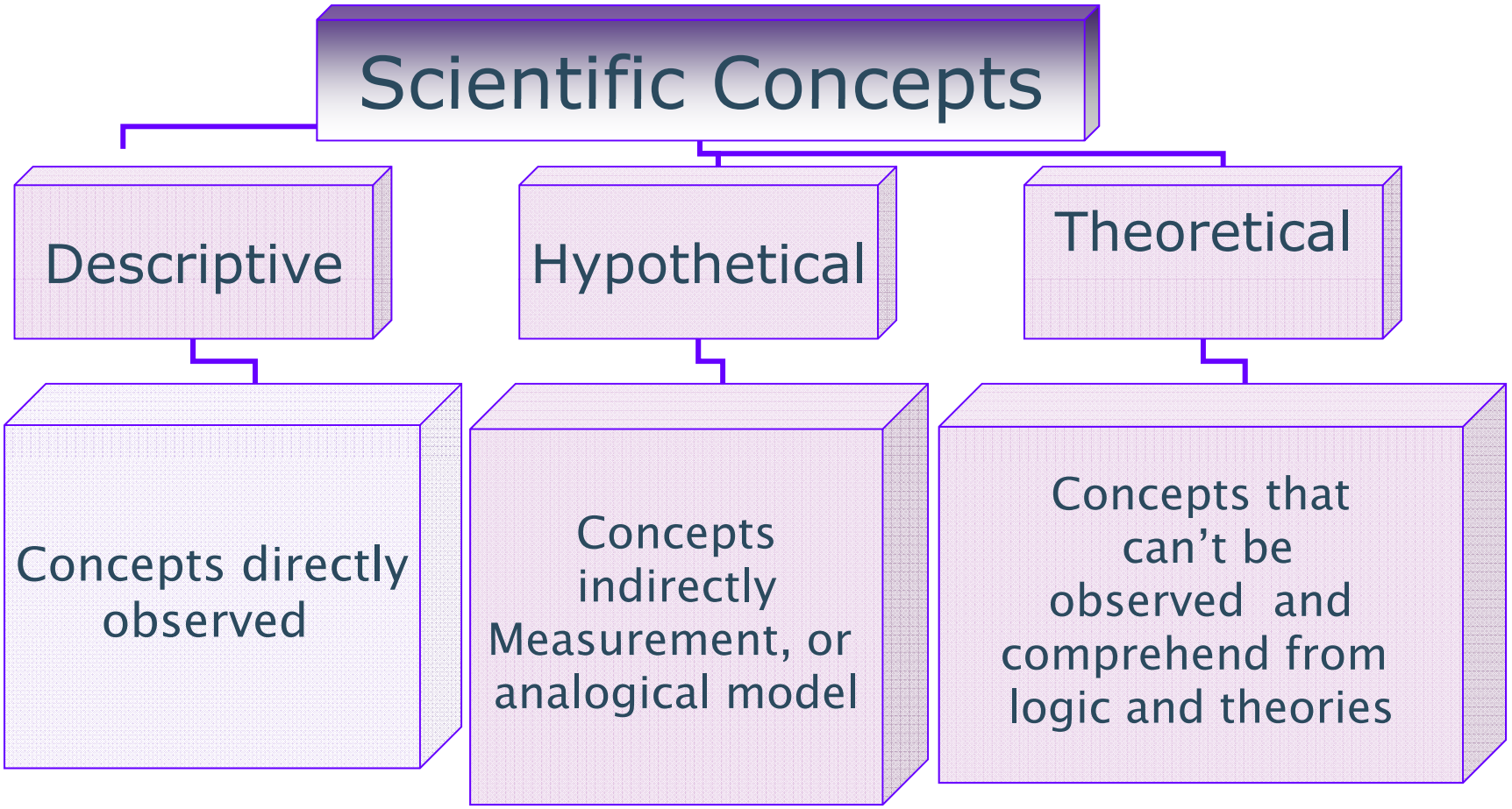
$$p_{Compare} = \frac{1}{1+e^{-(2.08-0.84\,\mathrm{Prop}+0.41\,Combination)}}$$

$$p_{Infer} = \frac{1}{1+e^{-(1.82-0.45\,\mathrm{Prop})}}$$

$$p_{Explain} = \frac{1}{1+e^{-(1.47-0.44\,\mathrm{Prop})}}$$

$$p_{Apply} = \frac{1}{1+e^{-(0.23\,\mathrm{Prop})}}$$

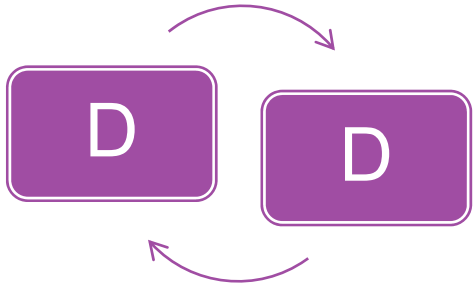
Level of Abstraction[4]



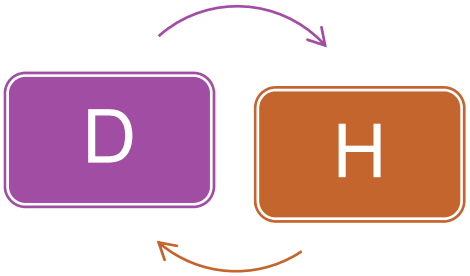
4-Lawson et al. (2000)

Classifying Concept-link Structures[5]

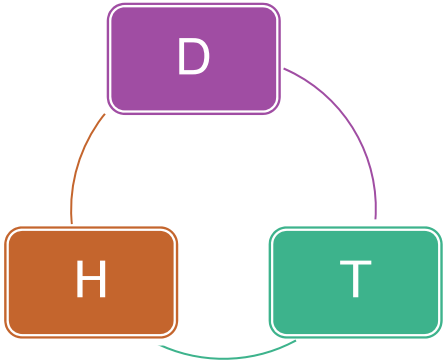
One concept-level-links



Cross concept-level-links



Multi-concept-level-links



5-Nieswandt & Bellomo (2009)

Clustering Conceptual Structure

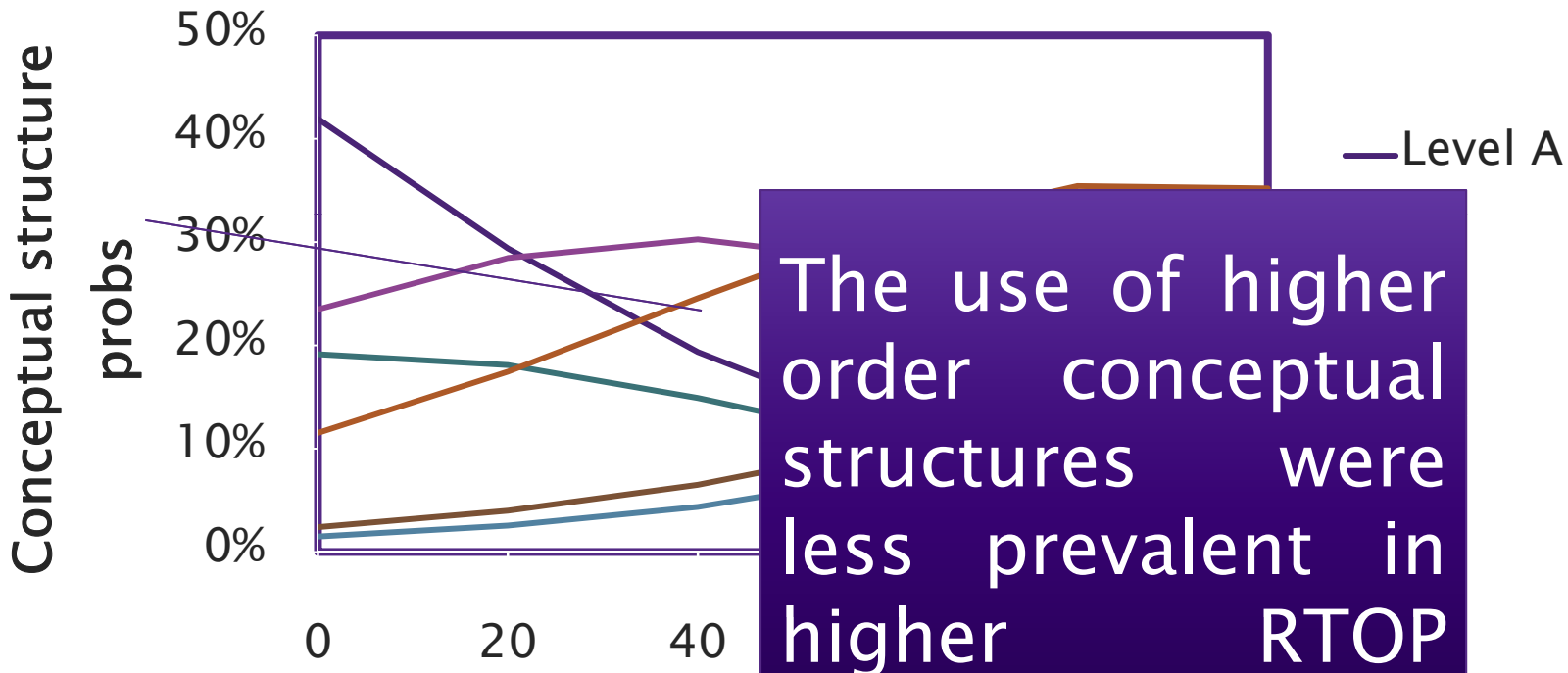
- **Group A**= Two or more High-level links[1]
- **Group B**= One High-level-link with Middle-level-links[2]
- **Group C**= Two or more Middle- level- links
- **Group D**= One Middle-level-link
- **Group E** = Low- level links[3]
- **Group F**= Discrete concepts with no links

1-<u>High-Level-link :</u>D-H-T, T-T-T, H-H-H, T-H-T, T-H-H & T-T-T-T

2-<u>Middle-level-link:</u>T-T, T-H, H-H & D-H

3-<u>Low-level-link</u>: D-D, D-D-D

Conceptual Analysis Graph



The use of higher order conceptual structures were less prevalent in higher RTOP courses

Trends-Cognitive Dimension

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

Trends for RTOP Sub-scores

Propositional knowledge	As the propositional knowledge score increases, the likelihood of the evidence for the most of the traits decreases.
Combination score	The combination score positively affects the likelihood of knowledge dimension traits. The effect is positive for Compare and negligible for other cognitive processes.

Thank You

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