Student Learning in Geoscience Courses Incorporating Societal Issues and Grand Challenges Facing Society

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InTeGrate is an NSF-funded, Science Talent Expansion (STEP) Center with goals of …

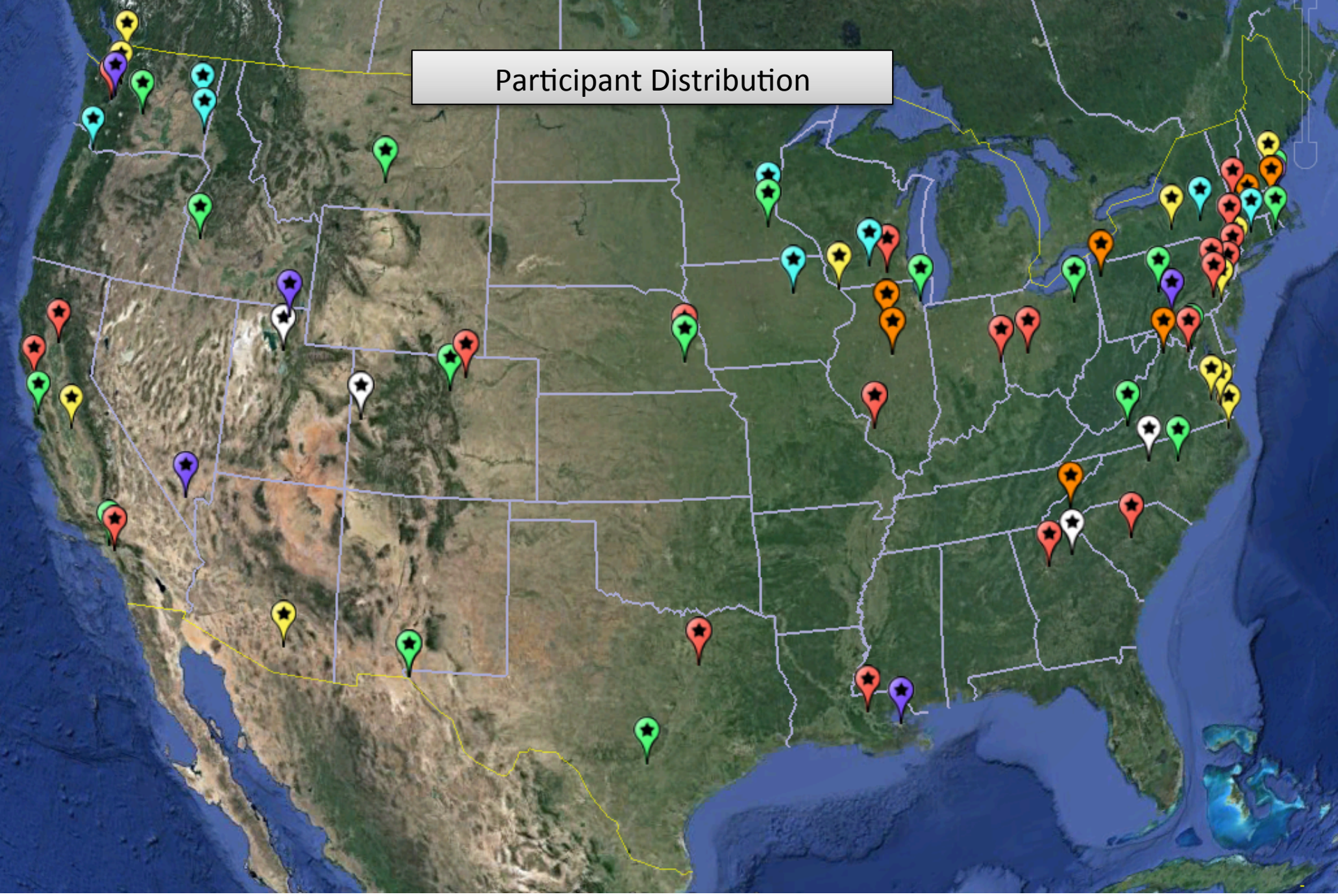
… developing curricula that will dramatically increase Earth literacy of all undergraduate students.

… increasing the number of majors in the geosciences and related fields who are able to work with other scientists, social scientists, business people, and policy makers to develop viable solutions to current and future environmental and resource challenges.

http://serc.carleton.edu/integrate

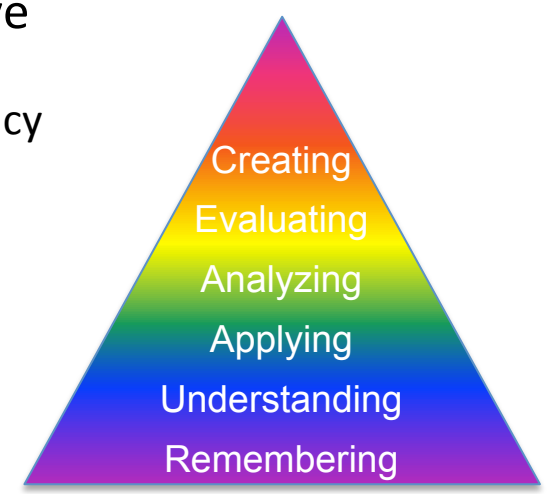
Measuring Student Learning

- Content Framework
  - Provided by Earth, Atmosphere, Ocean and Climate Literacy documents
- Most institutions included one, two-week InTeGrate module in their curriculum
- Data Collection
  - 38 Institutions (2 Year Colleges through Comprehensive)
  - Majority Science InTeGrate participants in Geoscience
  - Controls at three 2 Year Colleges and one comprehensive


Participant Distribution
Leadership
Intro
Distance Learning
Humanities
Teacher Prep
Interdisciplinary
Engineering

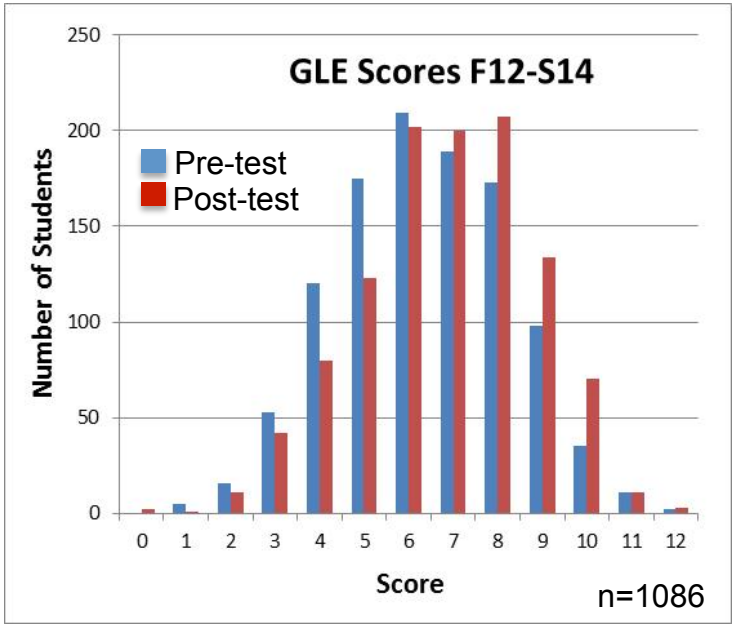
Geoscience Literacy Exam

- Multiple Choice: Focus on "Fundamental Concepts"
  - Level 1: Four, remembering-understanding cognitive level questions target non-majors
    - Have a single answer, link to single sub-concept in literacy documents
      - 1 point correct; 0 otherwise
  - Level 2: Four applying-analyzing cognitive level questions target mid-level geoscience majors
    - Have multiple answers, link to multiple sub-concepts in literacy documents
      - Correct = 2 points;
      - More correct than incorrect = 1 point;
      - 0 otherwise
  - Common 8 questions passed validity and reliability metrics in previous studies ($p<0.0001$)
  - 52 other questions being tested



Project Level Preliminary Results

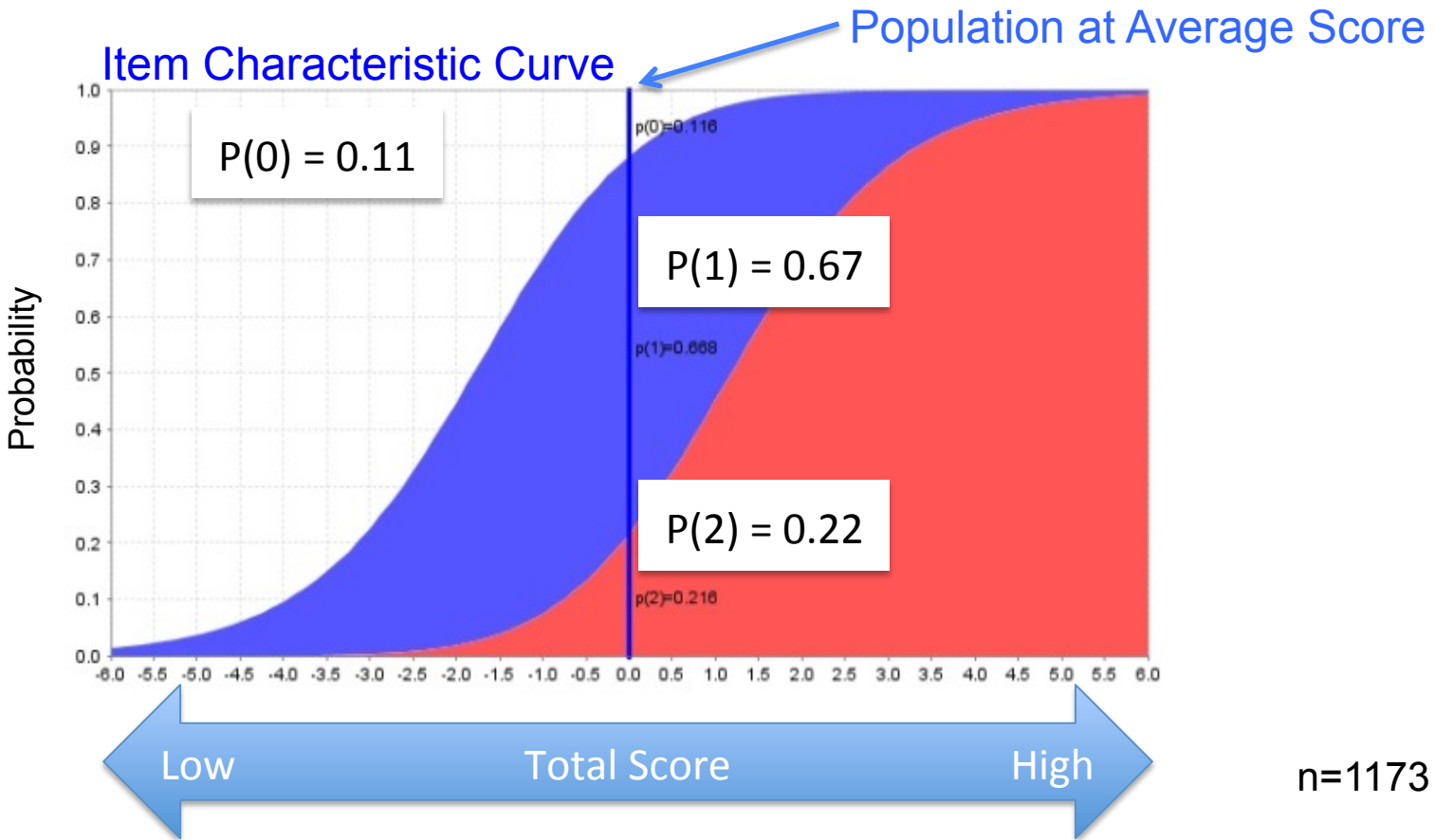
- Baseline pre-course score 6.3 +/- 1.9 of 12.0
- Post-course score 6.8 +/- 1.9
- Normed baseline improvement across a semester = +9%
- Three Level 2 questions dominate improvement
  - Characteristics of plate boundaries
  - Human impact on oceans
  - Sources of carbon to the atmosphere



Similar trends in non-InTeGrate control

Project Level Preliminary Results - Post

Level 2: Human Impact on Oceans - Which of the following ways do humans affect oceans? Select all that apply. (5 choices)



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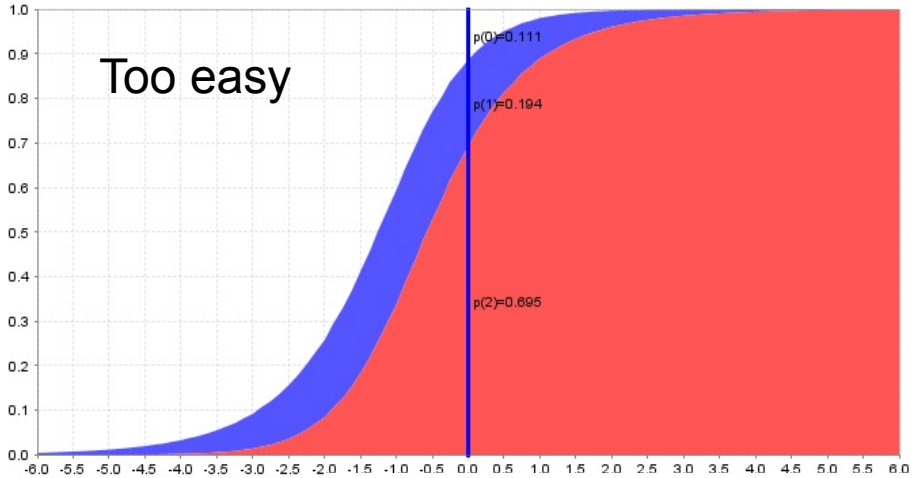
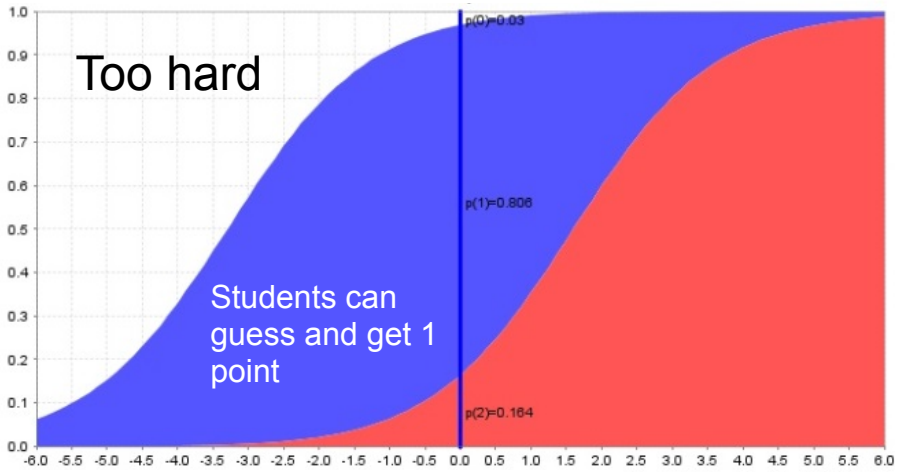
Project Level Preliminary Results

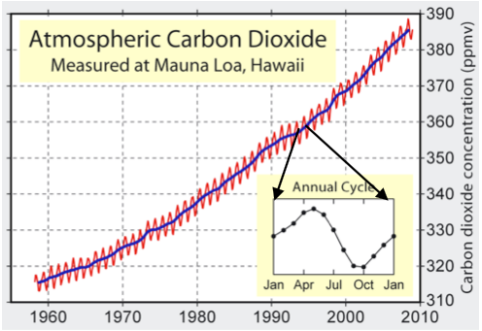
Item Characteristic Curves

Some questions need revision





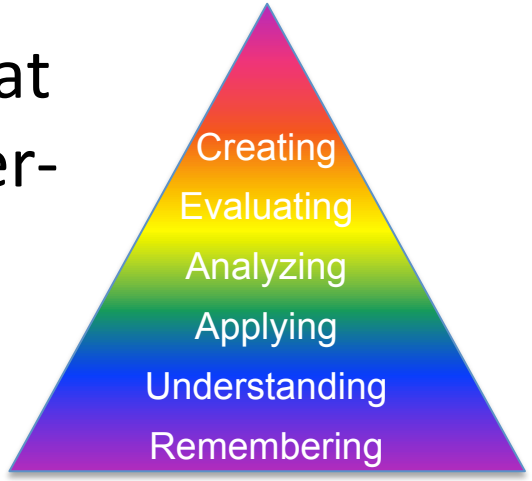
Analyze the atmospheric CO2 concentration graph shown …



Which factors influence large-scale atmospheric circulation? Select all that apply. (4 choices)

The GLE Assessment Model

- Short Essays: Focus on "Big Ideas"
  - Evaluate cognitive level questions that target advanced intro-level and upper-level students
    - Interdisciplinary and Complex System
      - Open-ended
      - Paragraph length responses
      - Rubric for each question (4-5 points)

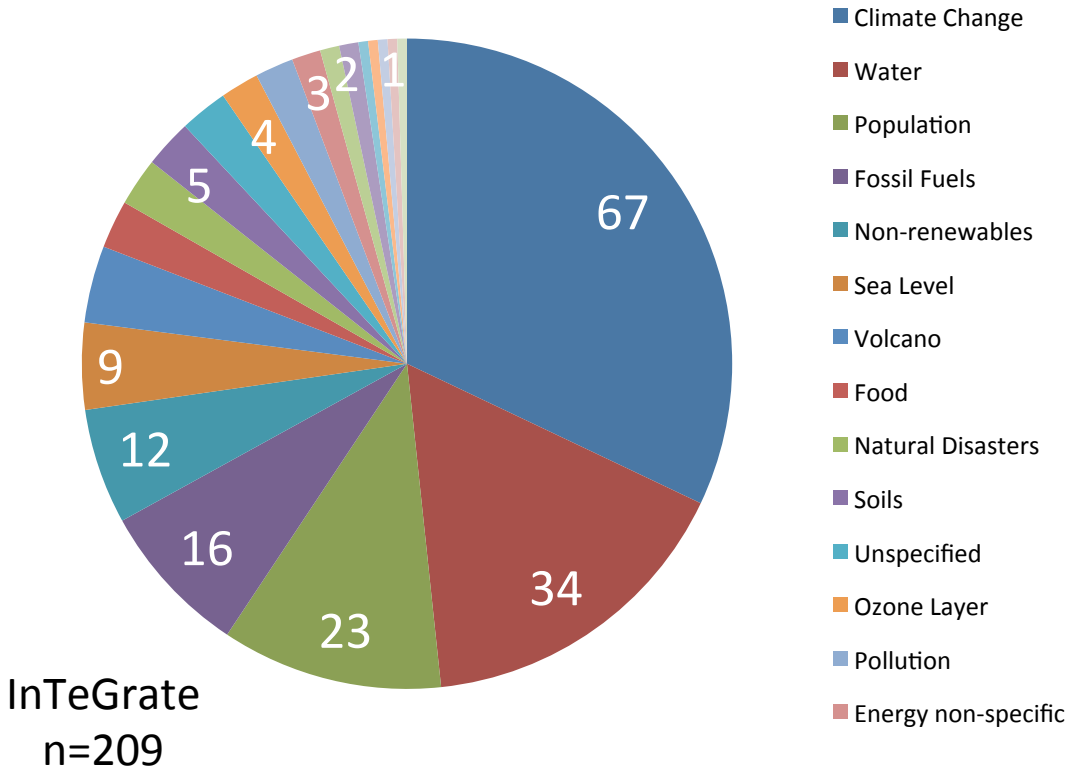


Interdisciplinary Essay

- Knowledge of Earth system interactions can influence how people make decisions about global challenges. Identify and describe a global challenge that society will likely face in the next 50 years. Explain how the science related to that challenge informs economic, social, and/or political decision making related to the global challenge you described.

Interdisciplinary Essay

- Consistent grading from multiple graders
- Range of topics



InTeGrate
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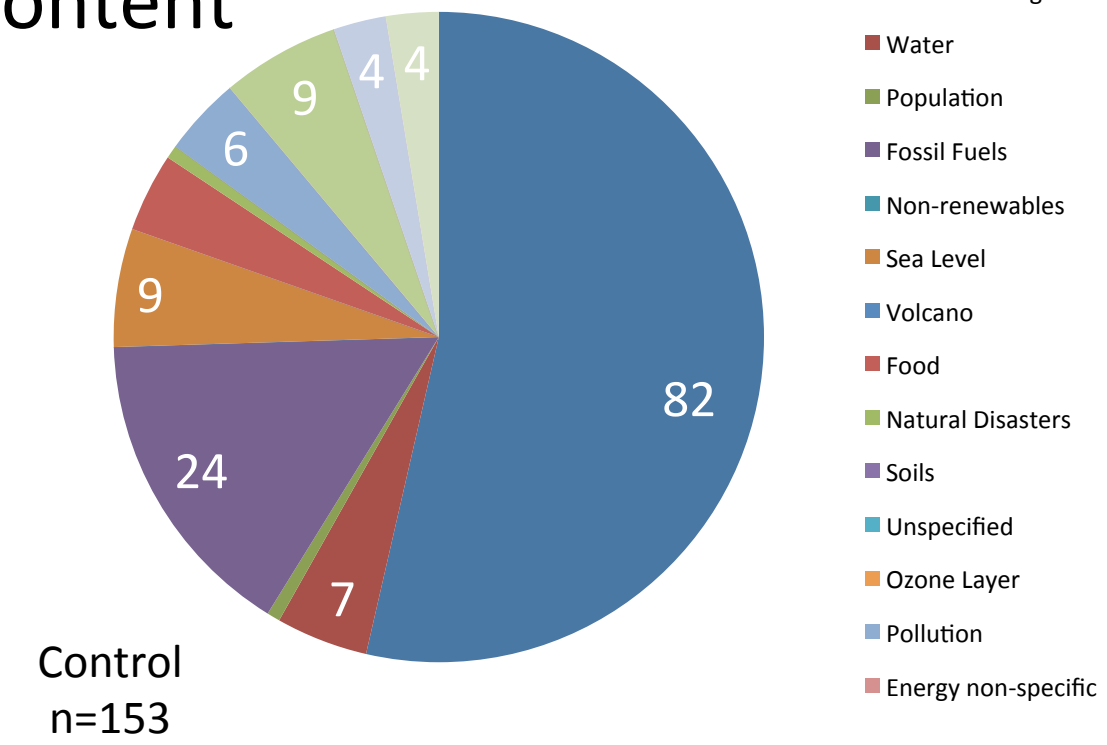
Interdisciplinary Essay

- Control (Non-Integrate at Univ. of Akron) has similar results
- Answers link to content



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Interdisciplinary Essay

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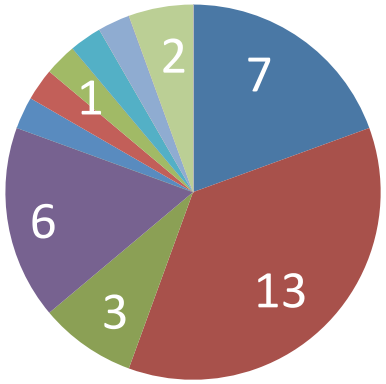

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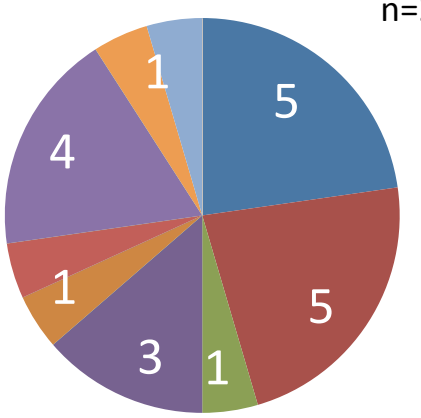

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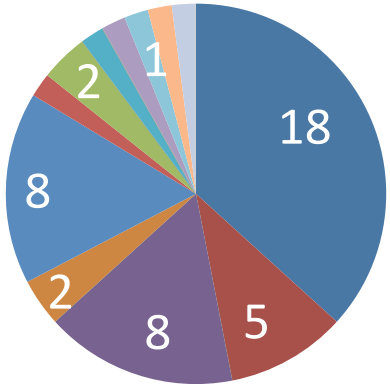

Control
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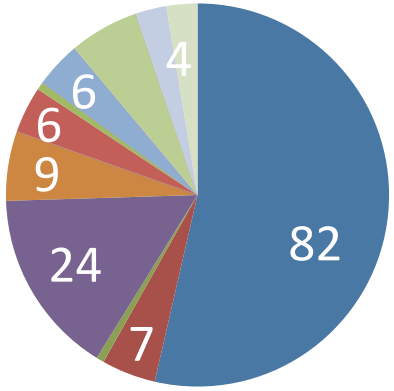


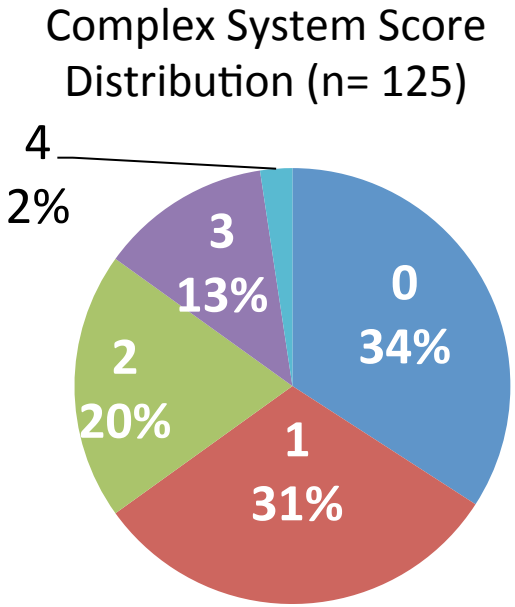
- Climate Change
- Water
- Population
- Fossil Fuels
- Non-renewables
- Sea Level
- Volcano
- Food
- Natural Disasters
- Soils

Complex System

- Earth consists of interacting systems that exchange energy and/or mass. Describe how two components of the Earth System interact with one another, the rate at which they interact and how a change in one system can lead to change in the other system.

Complex System Question

- Issues related to student learning
  - Materials tend to be weak in this area
  - Students do not comprehend the question (in 4th revision)



Conclusions

- Baseline GLE and Interdisciplinary essay data strong
  - Awaiting data from classes where curriculum is majority InTeGate material
  - Most gains in GLE will occur in higher-Blooms level multiple answer questions
  - Data for majority of additional 52 questions promising
- Much work needed on conveying complex systems concepts in curricula and on essay question validity
- Help us with our work - Please go to NAGT table in the exhibition room to edit question language

http://serc.carleton.edu/integrate/index.html