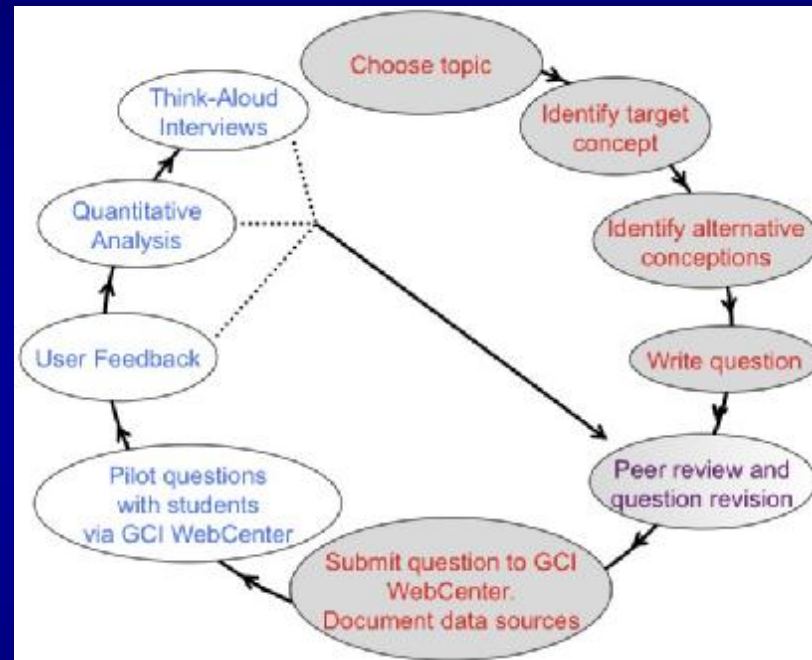


# CONCEPT INVENTORIES IN HIGHER EDUCATION SCIENCE

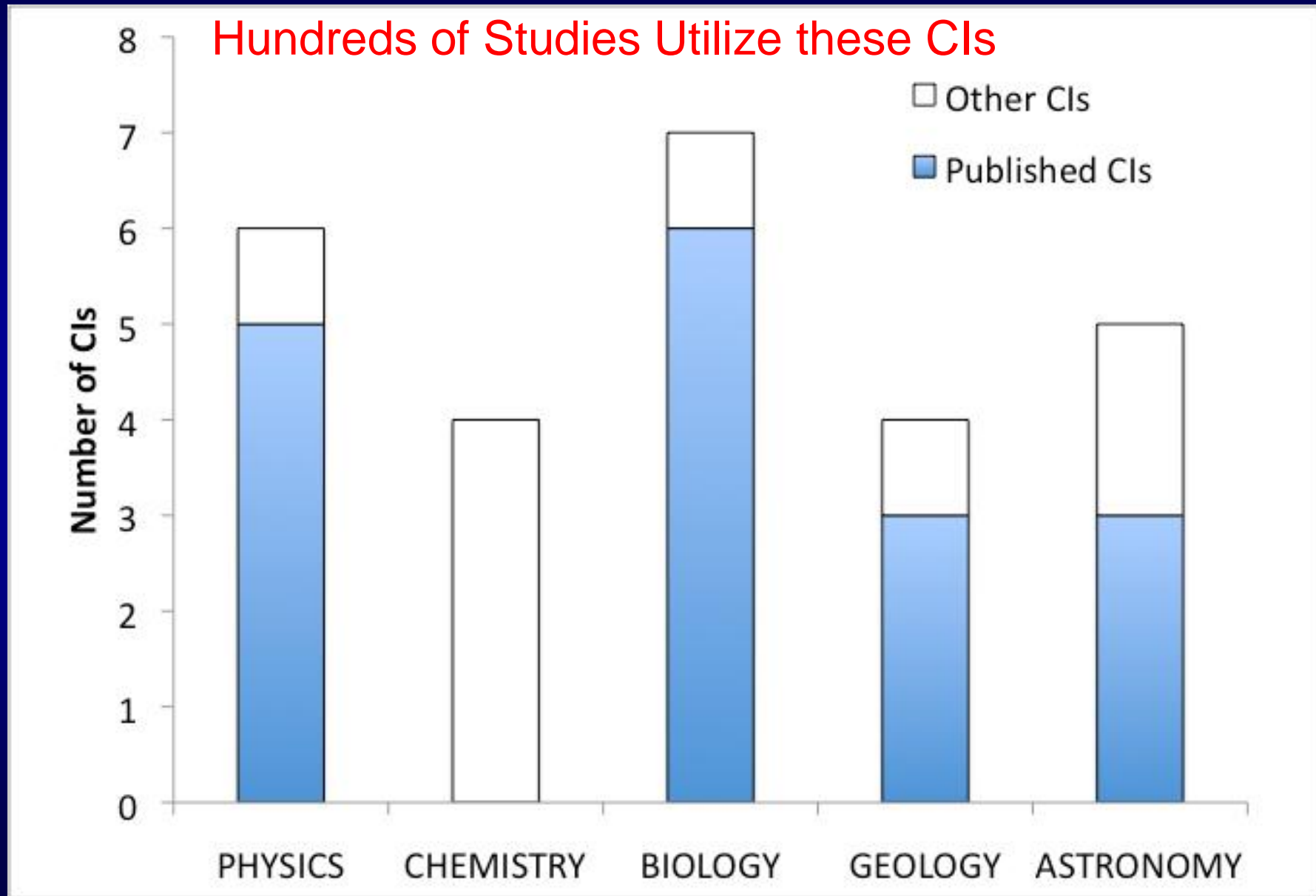
## Examples from the GCI



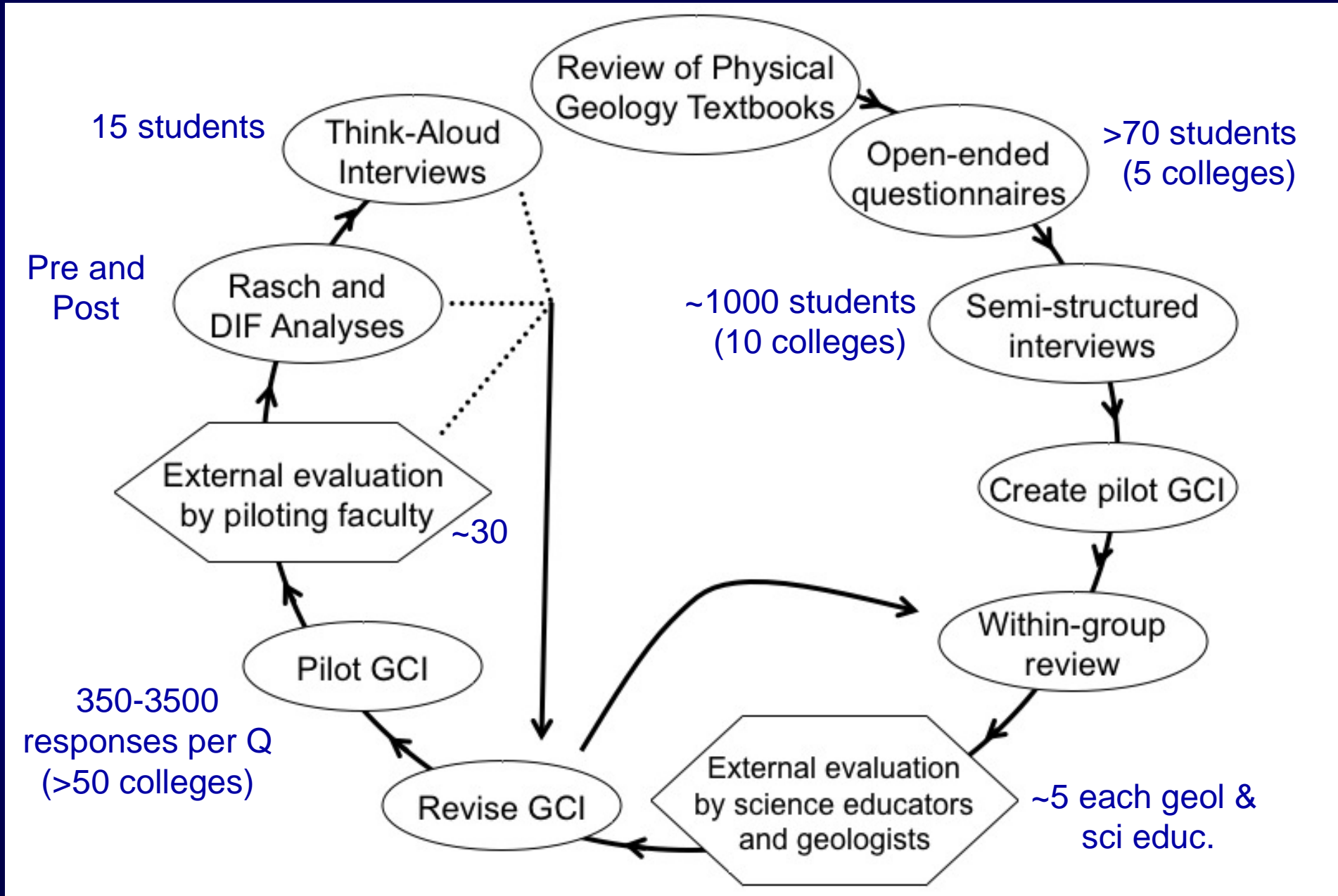
Julie C. Libarkin

MICHIGAN STATE  
UNIVERSITY

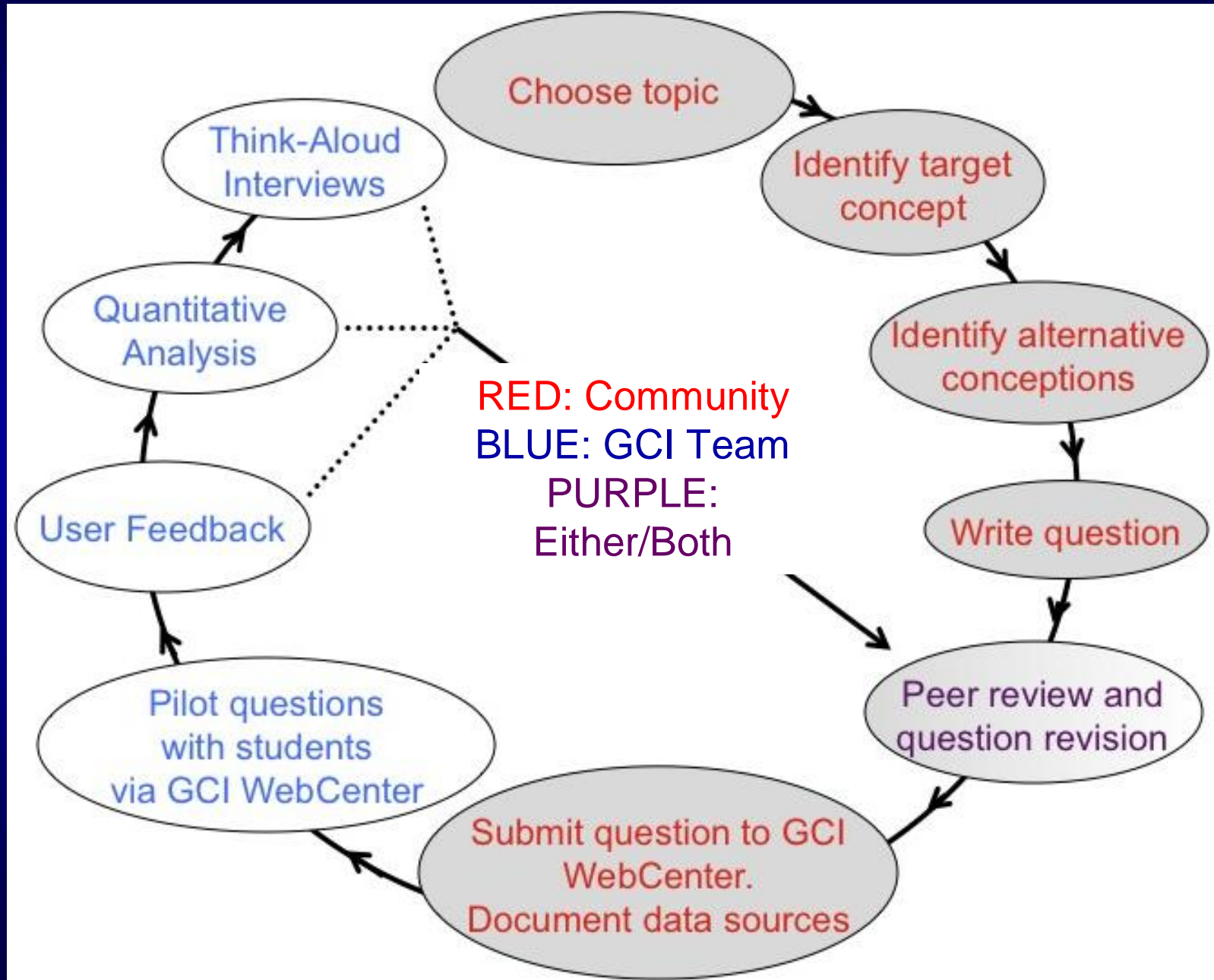
# Current State of CI Development in Science



# EXAMPLE DEVELOPMENT PATH: Geoscience (GCI v.1.0)

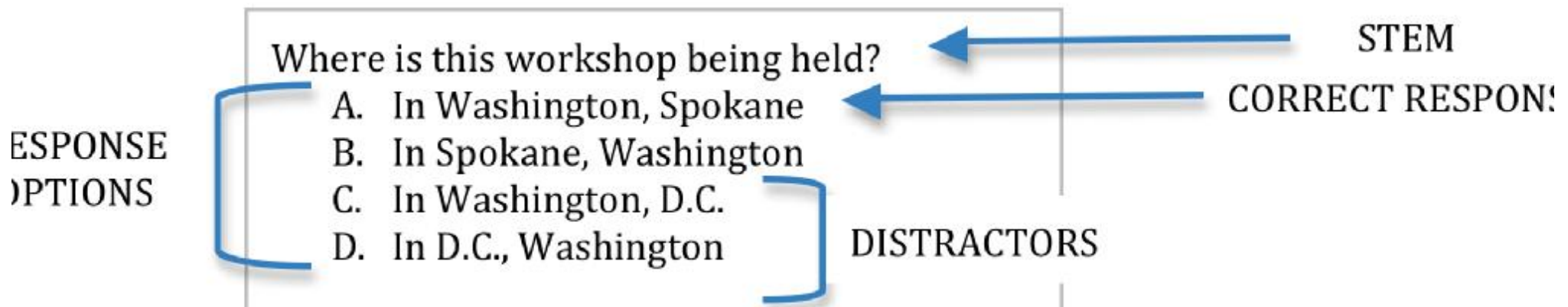


# NEW INITIATIVE: Giving Ownership to the Community



# STRUCTURE OF A MULTIPLE-CHOICE QUESTION

- | ITEM or QUESTION: interchangeable
  - STEM: the statement that precedes options in a multiple-choice question.
  - RESPONSE OPTIONS: choices (A,B,C,...)
  - DISTRACTOR (or DISTRACTER): incorrect response option



DATA ARE ONLY AS GOOD  
AS THE TOOL USED TO  
GATHER THEM!

Need the lens of **VALIDITY** and **RELIABILITY**

How well does a measured value represent the true value of the trait being measured?

Can we reproduce a measurement or repeat a study with this tool?

# A CHECKLIST FOR QUESTION WRITING AND REVIEW

- \_\_\_ Is the topic covered by this question important for geosciences understanding?
- \_\_\_ From the perspective of an expert geoscientist, does the question actually measure some aspect of geoscience understanding?
- \_\_\_ Would a test-taker interpret this question, including both the stem and the response options, **IN THE SAME WAY** as intended by the test developer?
- \_\_\_ **RULE 1:** Structure the stem as a question when at all possible.
- \_\_\_ **RULE 2:** Use unambiguous and simply worded stems.
- \_\_\_ **RULE 3:** Use appropriate vocabulary.
- \_\_\_ **RULE 4:** Use plausible response options
  - \_\_\_ Do the distractors of the multiple-choice question come from authentic student data?
  - \_\_\_ **WHEN REVIEWING QUESTIONS:** Do you agree with the researcher's interpretation of the student data as represented by distractors?
- \_\_\_ **RULE 5:** Use three to five response options.
- \_\_\_ **RULE 6:** Avoid **TYPE K** format questions.
- \_\_\_ **RULE 7:** Avoid absolutes and complexity in response options.
- \_\_\_ **RULE 8:** Keep the lengths and structure of response options similar
- \_\_\_ **Additional Concerns:**

# USE EXISTING QUESTION WRITING “RULES”

## ┆ Rules related to writing STEMS

- 1. Structure the stem as a question when at all possible.
  - ┆ “HOW OLD IS JULIE?” not “JULIE IS \_\_\_\_\_ YEARS OLD.”
- 2. Use unambiguous and simply worded stems.
  - ┆ Necessary sentences only!
  - ┆ “THE MINERAL QUARTZ...” not “QUARTZ (A MINERAL)...”
- 3. Use appropriate vocabulary.
  - ┆ Depends on target population (e.g., non-majors, graduate students)
  - ┆ Non-major example: “MOUNTAIN BUILDING” not “OROGENIC”

# USE EXISTING QUESTION WRITING “RULES”

## I Example rules related to writing RESPONSE OPTIONS

- 1. Use plausible response options.
- 2. Use 3 to 5 response options. NO MORE, NO LESS!
- 3. Avoid THESE format questions (called “type K”).

(1) shoes (2) purses (3) belts

A. (1)

B. (2)

C. (1) and (3)

D. (2) and (3)

# A CHECKLIST FOR QUESTION WRITING AND REVIEW

- \_\_\_ Is the topic covered by this question important for geosciences understanding?
- \_\_\_ From the perspective of an expert geoscientist, does the question actually measure some aspect of geoscience understanding?
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- \_\_\_ **Additional Concerns:**

VIDEO REMOVED

Interviewer: Now there are people that say that the earth, itself, is like a giant magnet. Do you agree with them?

Video courtesy of Julie Dahl

Well there is like a magnetic shield around the earth so I would...I mean, that's probably why the moon sticks around. Because it's smaller than the earth, so it has some force on it.

CI: Early version of question



**19. The Earth probably has a magnetic field because of:**

- (A) Changes in the composition of the Earth's crust
- (B) Gravity
- (C) Liquid metal moving inside the Earth
- (D) The Earth's revolution around the Sun
- (E) None of the above, the Earth does not have a magnetic field

Note: scientists lead CI development

CI: Early version of question

**19. The Earth probably has a magnetic field because of:**

- 12% (A) Changes in the composition of the Earth's crust
- 30% (B) Gravity
- 28% (C) Liquid metal moving inside the Earth
- 27% (D) The Earth's revolution around the Sun
- 4% (E) None of the above, the Earth does not have a magnetic field

N=1383 college students

CI: Early version of question

\_\_\_RULE 1: Structure the stem as a question when at all possible.

**19.** The Earth probably has a magnetic field because of:

- (A) Changes in the composition of the Earth's crust
- (B) Gravity
- (C) Liquid metal moving inside the Earth
- (D) The Earth's revolution around the Sun
- (E) None of the above, the Earth does not have a magnetic field

\_\_\_RULE 8: Keep the lengths and structure of response options similar.

\_\_\_RULE 7: Avoid absolutes and complexity in response options.

**19. Why does the Earth have a magnetic field?**

- (A) The Earth contains crust of different composition
- (B) The Earth has a gravitational force of attraction
- (C) The Earth contains moving liquid metal
- (D) The Earth has an orbit around the Sun
- (E) The Earth does not have a magnetic field

**19. The Earth probably has a magnetic field because of:**

- (A) Changes in the composition of the Earth's crust
- (B) Gravity
- (C) Liquid metal moving inside the Earth
- (D) The Earth's revolution around the Sun
- (E) None of the above, the Earth does not have a magnetic field

# NECESSARY STEPS!

9. The Earth probably has a magnetic field because of:

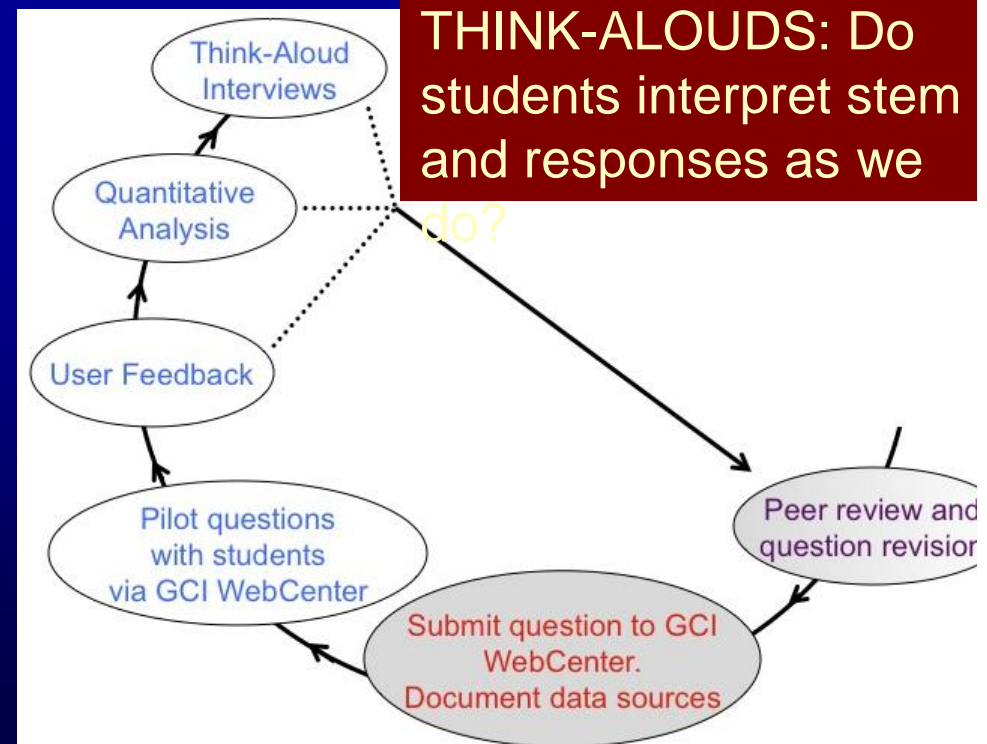
- (A) The Earth contains crust of different composition
- (B) The Earth has a gravitational force of attraction
- (C) The Earth contains moving liquid metal
- (D) The Earth has an orbit around the Sun
- (E) The Earth does not have a magnetic field

Can response lengths be constrained even more? Do scientific words (“force”) encourage response?

PEER REVIEW: What do scientists, science educators, scale developers think of the item?

PILOT: Quantitative data & What do faculty/researchers and students think of the item?

PSYCHOMETRICS: Item response theory: Rasch, partial credit model, etc.



# DOES “purifying” THE QUESTIONS MATTER?

- | CIs serve several purposes
  - IF purpose is to DOCUMENT alternative conceptions to “wake up” faculty
    - | Ok, exact style of question may not matter
  - IF purpose is to EVALUATE learning for instruction
    - | Probably matters a bit
    - | Good test-takers will do well
  - IF purpose is to ASSESS for research
    - | Quality of the tool dictates the quality of the data....
    - | USERS play a key role in determining usability!

*Many thanks to NSF. The development of the GCI was made possible through grants DUE-. The new GCI initiative is financially supported by grants DUE-0717790/0717589*