pICT Project 2006
Assessing your experiment

A blended course for introductory geology at San Diego State University: Choosing and implementing an assessment tool

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- **Give a very brief background or description of your innovation so we can orient ourselves.**

I have developed a blended course for introductory geology. The main purpose for the course was to maximize flexibility in a student's schedule. To meet this goal, the course is offered online. During the normal academic year exams take place at SDSU and are scheduled on Saturdays from 9:00 to 10:00 am. Material for the online course includes (1) an electronic text book that includes interactive illustrations, (2) a set of video lectures, (3) a set of laboratory exercises, and (4) practice exams (i.e., study guides). The electronic textbook is also offered as a CD through the Aztec bookstore. Since its first offering in 2005, the web site, as of August 2007, has received over 130,000 hits.

- **Describe your assessment approach.**

As documented by Libarkin (2006) many students enrolling in introductory earth science courses across the United States have varying misconceptions about how our planet works. For example, 38% of 997 college students enrolled in entry-level geology courses believed that clouds are empty containers that eventually filled with water and/or pollution, while others thought that the interior of our planet consisted of a series of horizontal layers, and that if we turned off the magnetic field, then all objects on the planet's surface would fly into space.

In order to assess the conceptual framework of entry level students in my blended course, I have selected the Geoscience Concept Inventory (GCI) developed by Julie C. Labarkin and colleagues. The GCI is a multiple-choice assessment instrument developed specifically for use in entry-level Earth Science courses. Test items cover topics related to general physical geology concepts, as well as underlying fundamental ideas in physics and chemistry (e.g., gravity and radioactivity). Each question has gone through rigorous reliability and validation studies (Libarkin et al., 2005; Libarkin and Anderson, 2005; in review).

The set of 15 questions from the GCI that I will use is attached as an appendix. This set of questions was first given during the introductory meeting for the summer 2007 online Geology 100 course. Of the 28 students completing the 15 questions, 9 were female and 19 were males. The average high school GPA is 3.40. Most of the students (23 out of 28) are non-science majors, while 5 listed a science or mathematics major in one of the following fields: biology, mathematics, oceanography, psychology. Out of the 28 students completing

the pre-course CGI, 9 had completed a physics course, 26 a chemistry course, 26 a biology course, and 14 an earth science course in middle or high school (grades 8 – 12).

The resulting pre-course GCI scores ranged from 2 to 13, with an average score of 6.6. Using the Rasch model provided by Libarkin and Anderson (in review), these scores ranged from 20.3% to 81.6%, with an average Rasch Model score of 45.5%. However, one student verbally indicated that he had just completed an Earth Sciences course in high school, and his unusually high pre-course Rasch Model score of 81.6% was 20% higher then the next highest score of 61%. His scored of 81.6% is treated as an outlier. Removing the 81.6% score resulted in an average Rasch Model score of 44.1% (see Figure 1). These results are comparable to an average nation wide Rasch Model score of 41.5% (2493 students and 43 courses) (Libarkin and Anderson, in review), and suggest that students enrolled in the summer 2007 online Geology 100 course have a similar conceptional understanding of planet Earth as do other college students across the nation enrolling in an entry level Earth Science course.

Only 24 students completed the post-course GCI survey. The average Rasch Model score was 48.1%. Taken at face value, this result matches the average 4% gain observed in 29 post-testing courses described by Libarkin and Anderson (in review). However, the distribution of Rasch Model scores for the post-course GCI appears to be bimodal rather than unimodal as in the pre-course survey (Figure 1). For example, in the pre-course GCI 14 of the 28 students scored lower than 50% while 14 scored 50% or higher (Figure 1). In contrast, in the post-course GCI, 9 (37.5%) scored lower than 50% while 15 (62.5%) scored 50% or higher (Figure 1). Hence, more than half of the students completing the GCI exceeded the national average of a 4% improvement on the Rasch Model score.

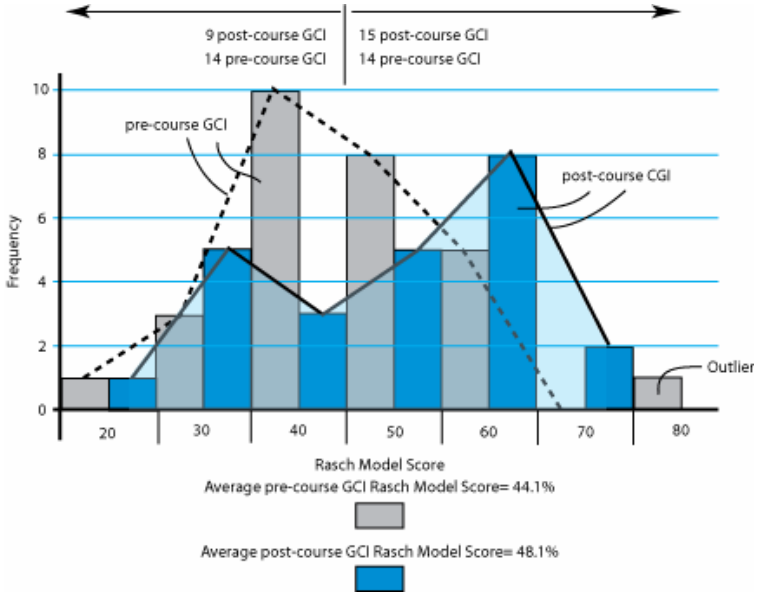


Figure 1. Results from GCI web-based Geology 100 Summer 2007

- **What factors (environmental, logistical, *etc.*) contributed to you choosing that approach?**

The CGI is the only valid and reliable assessment instrument that can be used to quantitatively evaluate learning in entry-level college geoscience courses. It has the power to be both a diagnostic and an assessment instrument.

- **What conclusions about your intervention have you drawn from the feedback you've collected?**

In reviewing the pre- and post-course GCI results on a question by question basis, it is clear that some students after completing the course do not have a clear understanding of the age of the Earth and its origin within the solar system, and when life, oceans, and an atmosphere first appeared. For example, questions 1, 7, and 28 deal with (1) how the age of the Earth is determined, (2) what the Earth looked like when it first formed 4.6 billion years ago, and (3) the relative temporal framework between the first appearance of life, the dinosaurs, and man on planet Earth. Only one person in both the pre- and post-course GCI realized that the age of the Earth is determined by U-Pb isotopic data, while only 5 in the post-course survey recognized that early Earth was molten and lacked water. Though most students (i.e., 12) completing the post-course GCI realized that the Mesozoic, the era in which the dinosaurs evolved and became dominant, represents only ~4% of Earth history, 9 thought it represented over 50%. In order to remedy this and a few other misconceptions recognized in the GCI survey I have extensively revised written materials dealing with these issues, and have added a complete set of video lectures (screencasts). I now place a greater emphasis on the history of the planet then I did in the past, and discuss 12 major Earth events beginning with its accretion from a cloud of hot gas and dust orbiting the Sun 4.6 billion years ago, and ending with the Great Ice Age, 1.8 million to 10,000 years ago.

- **How does the feedback you've received differ from your observations and/or expectations of your innovation's *impact/success*?**

I had placed considerable emphasis on geochronology in my web and CD material. For example, the second part of Chapter 8 deals entirely with how geologists use isotopes to provide an absolute framework in which to view Earth history. In addition, I specifically discussed the oldest dated material on our planet (4.4 billion years old) and the specific technique (U-Pb zircon) used to obtain that information. I therefore was surprised to see that only one person gained from this and other material on the web site and CD that U-Pb geochronology is the primary technique for estimating the age of the Earth. On a more positive note, the initial results from the GCI suggest that most students are able to understand and retain critical scientific information about their planet from the web-based and CD materials that I provide them.

- ***Describe/List/Identify* the changes you *will/would* make as a result of this process.**

I have already discussed the most important changes that I have made (see above). In addition, I will continue to use the GCI in my Fall and Spring Geology 100 courses, and will continue to respond to the results reflected in pre- and post-GCI results.

- **If you had anticipated problems implementing your intervention, how might they be reflected in the results of your assessment?**

I had no problems in implementing my intervention.

References

Libarkin, J.C., 2006, College student conceptions of geological phenomena and their importance in classroom instruction; Planet, no. 17, p.6-9.

Libarkin, J.C., and Anderson, S.W., in review, The Geoscience Concept Inventory: Application of Rasch Analysis to Concept Inventory Development in Higher Education

Libarkin, J.C., Anderson, S.W., Science, J.D., Beifuss, M., and Boone, W., 2005, Qualitative analysis of college students' ideas about the Earth: Interviews and open-ended questionnaires: Journal of Geoscience Education, v. 53, p. 17-27

Appendix – Geoscience Concept Inventory used during Summer 2007

DEMOGRAPHICS:
Please answer the following questions about your background.

Gender____ High School G.P.A._____

Birthdate: Day_____ Month_____ Year_____

Anticipated Major_____

Racial Background: ___White ___Hispanic ___Asian
___African-American ___Pacific Islander
___American Indian ___Other_____

In which high school grade did you take:

Physics	8	9	10	11	12	Never
Chemistry	8	9	10	11	12	Never
Biology	8	9	10	11	12	Never
Earth Science	8	9	10	11	12	Never

Highest degree of:

Female Parent:
___Elementary School
___some High School
___High School
___some College
___Bachelor's Degree
___some Graduate School
___Master's Degree
___Doctoral Degree

Male Parent:
___Elementary School
___some High School
___High School
___some College
___Bachelor's Degree
___some Graduate School
___Master's Degree
___Doctoral Degree

GCI TEST QUESTIONS
Please answer the following questions to the best of your ability.

1. Some scientists claim that they can determine when the Earth first formed as a planet. Which technique(s) do scientists use today to determine when the Earth first formed? **Choose all that apply.**

(A) Comparison of fossils found in rocks
(B) Comparison of different layers of rock
(C) Analysis of uranium and lead in rock
(D) Analysis of carbon in rock
(E) Scientists cannot calculate the age of the Earth

2. Which of the following can greatly affect erosion rates? **Choose all that apply.**

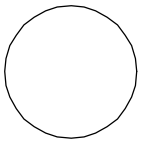
(A) Rock type
(B) Earthquakes
(C) Time
(D) Climate

3 (6). Which is the best definition of a tectonic plate?

(A) All solid, rigid rock beneath the continents and above deeper, moving rock
(B) All solid, rigid rock beneath the continents and oceans and above deeper, moving rock
(C) All solid, rigid rock that lies beneath the layer of loose dirt at the Earth's surface and above deeper, moving rock
(D) All solid, rigid rock and loose dirt beneath the Earth's surface and above deeper, moving rock
(E) The rigid material of the outer core

4 (7). What did the Earth's surface look like when it first formed?

A

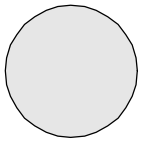


B

A. One large landmass surrounded by water

B. All water and no land

C



D

C. Similar to today

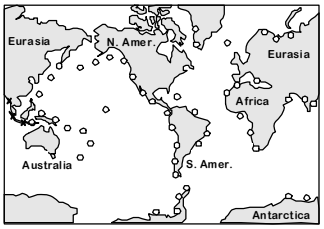
D. Mostly molten rock and no water

E

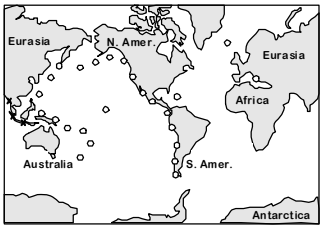
E. We have no way of knowing

5 (13). The following maps show the position of the Earth's continents and oceans. The circles's on each map mark the locations where volcanic eruptions occur on land. Which map do you think most closely represents the places where these volcanoes are typically observed?

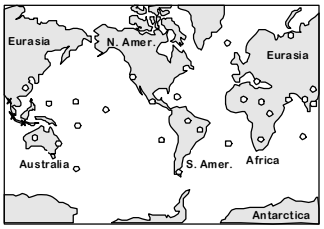
Circle one: **A** **B** **C** **D** **E**



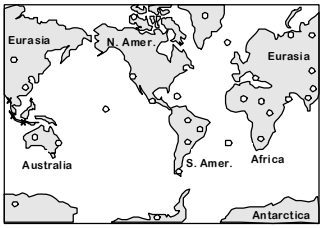
A. Mostly along the margins of the Pacific and Atlantic Oceans



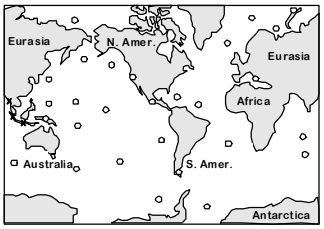
B. Mostly along the margins of the Pacific Ocean



C. Mostly in warm climates



D. Mostly on continents



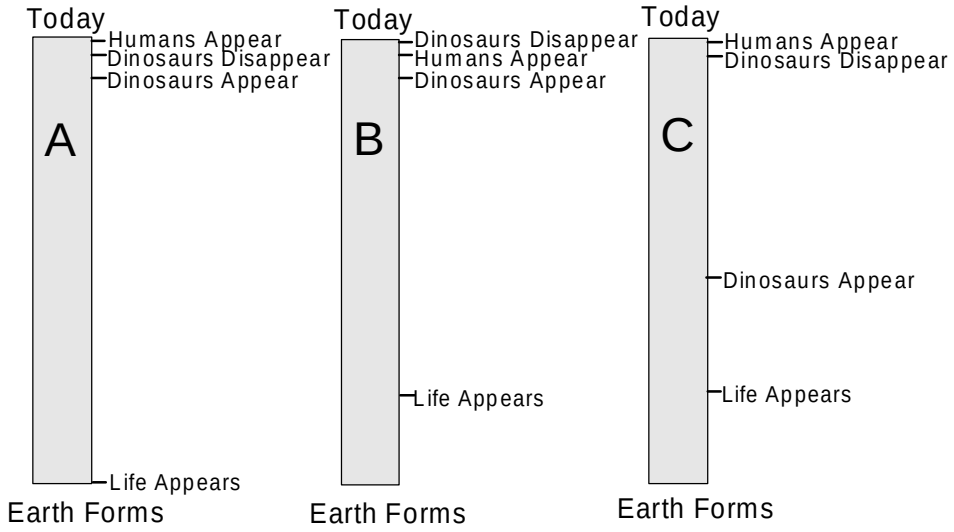
E. Mostly on islands

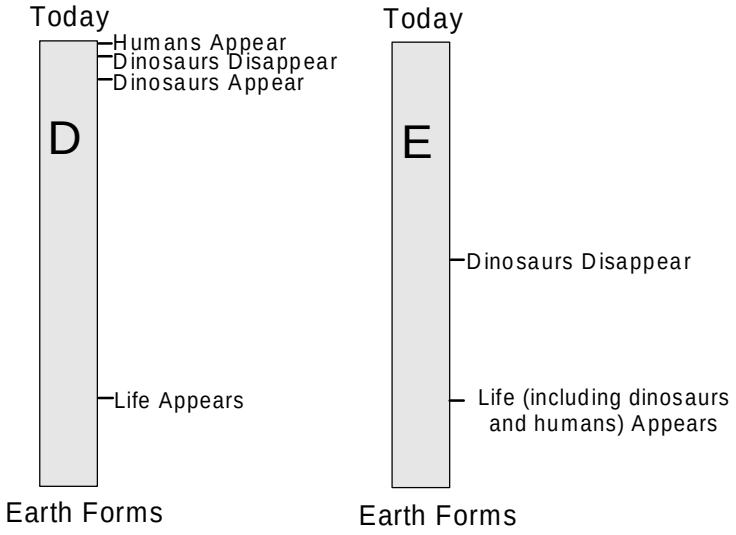
6 (19). The Earth probably has a magnetic field because of:

(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

7 (28). Which of the figures below do you think most closely represents changes in life on Earth over time?

Choose one: **A** **B** **C** **D** **E**





8 (34). What causes most of the waves in the ocean?

(A) Tides
(B) Earthquakes
(C) Wind
(D) Tsunamis

9 (37). If the single continent in #73 did exist, how long did it take for the single continent to break apart and form the arrangement of continents we see today?

(A) Hundreds of years
(B) Thousands of years
(C) Millions of years
(D) Billions of years
(E) It is impossible to tell how long the break up would have taken

10 (46). Which of the following describes what scientists mean when they use the word "earthquake". **Choose all that apply.**

(A) All earthquakes create visible cracks on the Earth's surface
(B) When an earthquake occurs, the earth shakes at least once every 10 seconds for a period of at least 1 minute
(C) All earthquakes damage man-made structures
(D) When an earthquake occurs, energy is released from inside the Earth
(E) When an earthquake occurs, the gravitational pull of the Earth increases

11 (51). Which of the following responses best summarizes the relationship between volcanoes, large earthquakes, and tectonic plates?

(A) Volcanoes are typically found on islands and earthquakes typically occur in continents. Both volcanoes and large earthquakes occur near tectonic plates.
(B) Volcanoes and large earthquakes both typically occur along the edges of tectonic plates.
(C) Volcanoes mostly occur in the center of tectonic plates and large earthquakes typically occur along the edges of tectonic plates.
(D) Volcanoes and large earthquakes both typically occur in warm climates near tectonic plates.
(E) Volcanoes, large earthquakes, and tectonic plates are not related, and each can occur in different places.

12 (58). Why do tectonic plates move?

(A) The eruption of underwater volcanoes pushes the tectonic plates
(B) Currents in the ocean push against the tectonic plates
(C) Earthquakes push the tectonic plates
(D) Material is moving beneath the plates
(E) Magnetism moves the tectonic plates

13 (63). How big was the planet Earth when dinosaurs first appeared?

(A) Smaller than today
(B) Larger than today
(C) Same size as today
(D) We have no way of knowing

14 (68). If you could travel back in time to when the Earth first formed as a planet How many years back in time would you have to travel?

(A) 4 hundred years
(B) 4 hundred-thousand years
(C) 4 million years
(D) 4 billion years
(E) 4 trillion years

15 (73). Some people believe there was once a single continent on Earth. Which of the following statements best describes what happened to this continent?

(A) Meteors hit the Earth causing the continent to break into smaller pieces
(B) The Earth lost heat over time and cracked, causing the continent to break into smaller pieces
(C) Material beneath the continent moved, causing the continent to break into smaller pieces
(D) The Earth gained heat over time and cracked, causing the continent to break into smaller pieces
(E) Only a small number of people believe there was once a single continent, and it is more likely that the continents have always been in roughly the same place as they are today