ASSESSING STUDENT UNDERSTANDING OF PLATE TECTONICS

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Introduction

The work that is described here is part of a larger project to develop student assessment items in science and mathematics that are precisely aligned with content standards. In this poster, we focus on how pilot test data can be used to determine the appropriateness of specific terminology in clarification statements and related assessment items.

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Pilot Test Methods

Students in grades 7 – 8 from three school districts across the country were pilot tested. (1) A middle school in a northeastern suburb having a student population that is 40% White, 48% African American, and 8% Hispanic, with 25% of the students eligible for free and reduced lunch; (2) a middle school in a northeastern suburb having a student body that is 95% White, where 10% of the students are eligible for free and reduced lunch; (3) a middle school in a small southern town with a student body that is 70% White and 24% African American, where 33% of the students are identified as economically disadvantaged.

Pilot Test Instrument

During pilot-testing, students responded in writing to the following questions for each assessment item:

1. Is there anything about this test question that was confusing? Explain.
2. Circle any words on the test question you don't understand or are not familiar with.
3. Is answer choice A correct? Yes No Not Sure
4. Is answer choice B correct? Yes No Not Sure
5. Is answer choice C correct? Yes No Not Sure
6. Is answer choice D correct? Yes No Not Sure

(For questions 3-6 above, students were asked to explain why an answer choice is correct or not correct or why they were "not sure.")

Students were sometimes also given a more targeted follow-up question that asked them to draw a picture, define a term in their own words, or explain what a descriptive phrase meant to them.

In this poster we focus on examples of pilot test results to help us determine the appropriateness of certain terminology in clarification statements and assessment items aligned to the ideas in those clarification statements.

Student Responses to Terminology Example #1

Student understanding of "bedrock."

Although *Benchmarks for Science Literacy* uses the term "bedrock" at grades 3-5, concern about how familiar this term is to students and how useful it is in test item development led to the writing of two items that are identical except that one uses the term "bedrock" and the other uses the descriptive phrase "solid rock." The students who were tested had had typical instruction related to this content, i.e., instruction that was not necessarily targeted to the meaning of the word "bedrock." In the pilot test, half of the students in each class were randomly given the "bedrock" version of the test item and half were given the "solid rock" version.

Item Version 1 with "solid rock"

Which of the following are part of earth's plates?
A. Solid rock of continents but not solid rock of ocean floors
B. Solid rock of ocean floors but not solid rock of continents
C. Solid rock of both the ocean floors and the continents
D. Solid rock of neither the ocean floors nor the continents

Is Answer Choice Correct?	A (continents only)	B (ocean floor only)	C (both)	D (neither)	% Correct N=51
Yes	11	5	26	1	51%
No	28	34	14	39	
Not Sure	12	12	10	11	

Version #2 with "bedrock"

Which of the following are part of earth's plates?
A. Bedrock of continents but not bedrock of ocean floors
B. Bedrock of ocean floors but not bedrock of continents
C. *Bedrock of the ocean floors and the continents*
D. Bedrock of neither ocean floors nor continents

Is Answer Choice Correct?	A (continents only)	B (ocean floor only)	C (both)	D (neither)	% Correct N=64
Yes	5	7	29	5	44%
No	32	30	11	32	
Not Sure	27	27	23	27	

Students who answered the "bedrock" question were also asked a follow-up question**: What is bedrock?**

35 of 57 (61%) students responded that they did not know. Six students (11%) responded with explanations that are correct.

Students who attempted to define the term wrote explanations such as:

"The bed of rocks on the ocean floor"
"Like the ocean floor"
"The deep rock of the crust"
"Rocks on the bottom of the ocean"
"The bottom layer of a rock"
"It is the part that supports the ocean floor"
"Bedrock is rock that is in the ground"
"Rock Maybe"
"It is the rock that is on the bottom of an ocean plate"
"A type of layering of loose pebbles that have been fused together"

Analysis:

•There were more "unsure" responses when "bedrock" was used. The item using "bedrock" had an average of 41% "unsure" responses to the answer choices, while the item using "solid rock" had an average of 11% "unsure" responses.

•Fifty-one out of fifty-seven students (90%) wrote comments indicating that they did not know what bedrock is. Despite this lack of understanding of the term, 29/64 (44%) of the students were able to correctly answer the bedrock item, compared to 26/51 (51%) of students who answered the item using "solid rock." Students apparently translated "bedrock" to the intended meaning of solid rock of the plates without knowing for sure what it means.

•We have decided not to include the term "bedrock" for assessment purposes because it is not needed to test students' understanding of what plates are made of and because it has the potential to confuse students, as evidenced by the large percentage of students who said they were unsure of their answers.

Student Responses to Terminology Example #2

Use of the descriptive phrase "plates press together" instead of the term "converge."

Although instruction typically uses technical terms such as convergent, divergent, and transform to refer to types of interactions at plate boundaries, these terms are often confused by middle school students. Even in everyday usage, the meaning of these words is not understood by many middle school students. Therefore, we have not held students accountable for these terms in assessment, and instead we use descriptive phrases that are scientifically accurate, promote mental models of processes, and are less likely to encourage misconceptions.

Using the item below, we probed student understandings of "plates press together."

What happens as two plates press together over many millions of years?
A. The solid rock at the edges of the plates is pushed upward and forms mountains.
B. The solid rock at the edges of plates grinds into small rocks and is eroded away.
C. The plate material stops moving and nothing else happens.
D. The plate material moves so slowly that nothing noticeable happens.

Is Answer Choice Correct?	A (form mountains)	B (erodes away)	C (stops moving)	D (nothing noticeable happens)	% Correct N=48
Yes	38	3	1	1	79%
No	3	38	40	34	
Not Sure	7	7	7	12	

Of the 48 students who responded to this item, only one indicated being confused by the phrase "plates press together." In a follow-up question, students were explicitly asked: "What does it mean when we say that plates press together"? Their responses fall into 5 categories:

1) Plates converge, or converge and subduct. 7/42 students (17%)
2) Plates collide, crash, or run into…each other. 9/42 students (21%)
3) Plates collide, but slowly. 2/42 students (5%)
4) Plates push, come, move, or are forced…together. 23/42 students (55%)
5) Don't know. 1/42 students (2%)

The use of the phrase "press together" is intended to promote a mental model of a slow process rather than the misconception of plates crashing into each other at a fast pace. It also draws on students' understanding of pushes and pulls as forces. In the student responses to the follow-up question, 52% explained "plates press together" with words that suggest they were thinking of a slow process, but 21% of students wrote explanations that could mean fast collisions. Further work is needed to determine exactly what the phrases "press together" and "collide" mean to students.

Conclusions

In assessing student understanding of science ideas, the words that are chosen matter. Technical terms (bedrock or convergent boundary) may not be needed for students to develop accurate models of natural processes. To determine which terminology best accomplishes these goals, it is important to look carefully at how students interpret these technical terms as well as how they interpret more descriptive non-technical words and phrases.