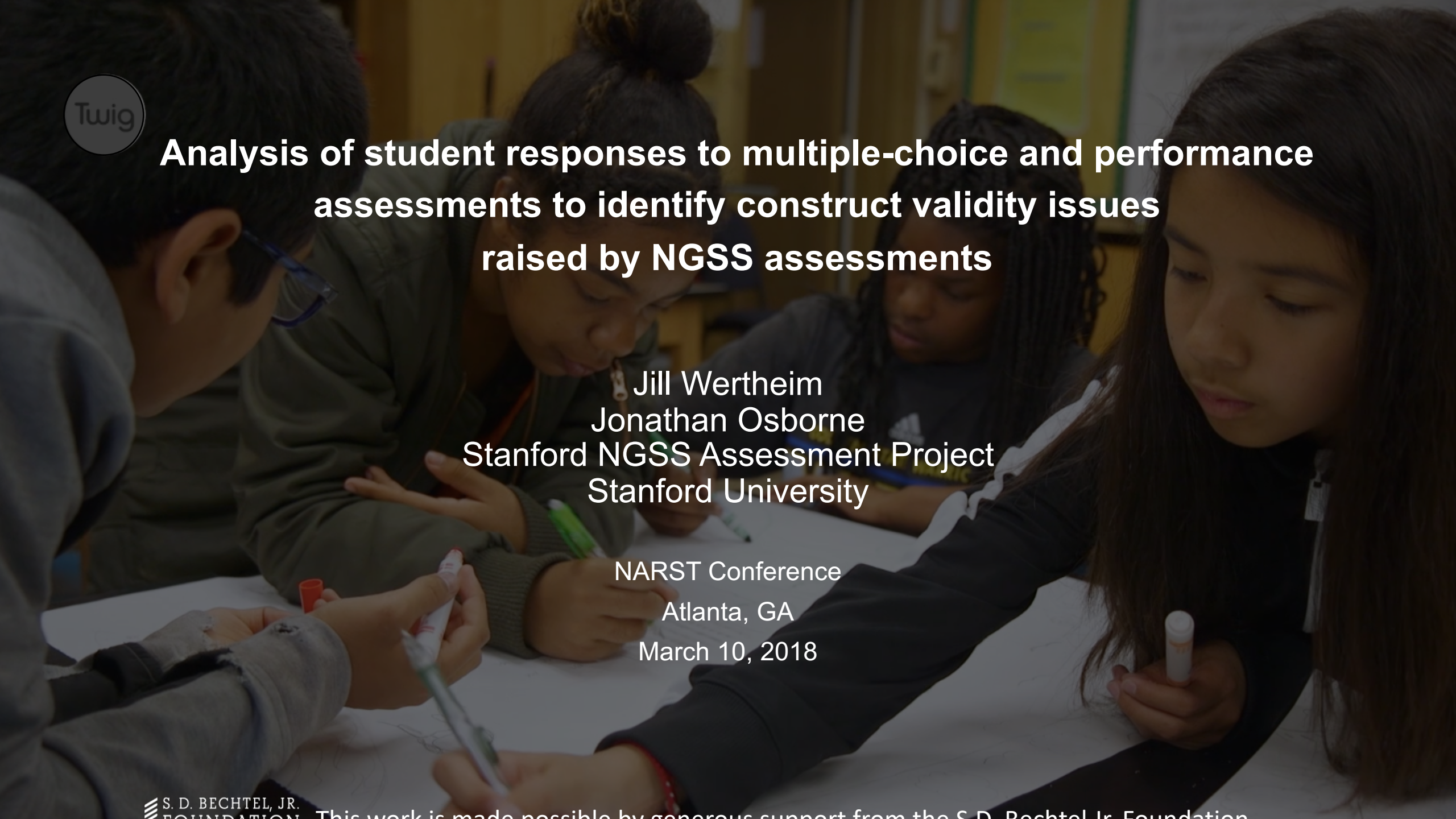

Analysis of student responses to multiple-choice and performance assessments to identify construct validity issues raised by NGSS assessments

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Jonathan Osborne
Stanford NGSS Assessment Project
Stanford University

NARST Conference

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Overview

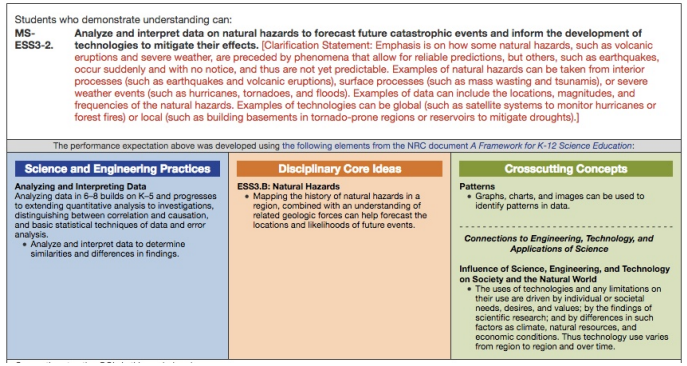
1. Using cognitive labs for qualitative construct validation
2. Illustrative student responses from cognitive labs on earth science multiple-choice items
3. Comparison with responses to earth science performance assessments
4. Implications for rapidly approaching operational NGSS summative assessments

Construct Validity

"…to accrue empirical evidence that the ostensibly sampled processes are actually engaged by respondents in task performance"

Messick, 1996

Construct validity: multiple choice



Students who demonstrate understanding can:

MS-ESS3-2. **Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.** [Clarification Statement: Emphasis is on how some natural hazards, such as volcanic eruptions and severe weather, are preceded by phenomena that allow for reliable predictions, but others, such as earthquakes, occur suddenly and with no notice, and thus are not yet predictable. Examples of natural hazards can be taken from interior processes (such as earthquakes and volcanic eruptions), surface processes (such as mass wasting and tsunamis), or severe weather events (such as hurricanes, tornadoes, and floods). Examples of data can include the locations, magnitudes, and frequencies of the natural hazards. Examples of technologies can be global (such as satellite systems to monitor hurricanes or forest fires) or local (such as building basements in tornado-prone regions or reservoirs to mitigate droughts).]

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Analyzing and Interpreting Data
Analyzing data in 6–8 builds on K–5 and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.
- Analyze and interpret data to determine similarities and differences in findings.

Disciplinary Core Ideas

ESS3.B: Natural Hazards
- Mapping the history of natural hazards in a region, combined with an understanding of related geologic forces can help forecast the locations and likelihoods of future events.

Crosscutting Concepts

Patterns
- Graphs, charts, and images can be used to identify patterns in data.

Connections to Engineering, Technology, and Applications of Science

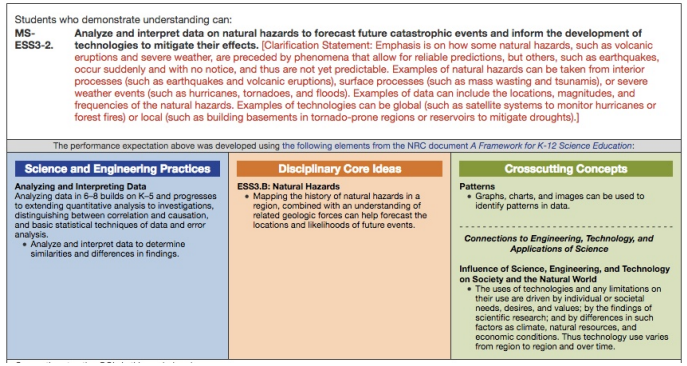
Influence of Science, Engineering, and Technology on Society and the Natural World
- The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time.

→

2D constructs

E.g. Interpret earthquake data to forecast locations and likelihood of future events

Construct validity: multiple choice



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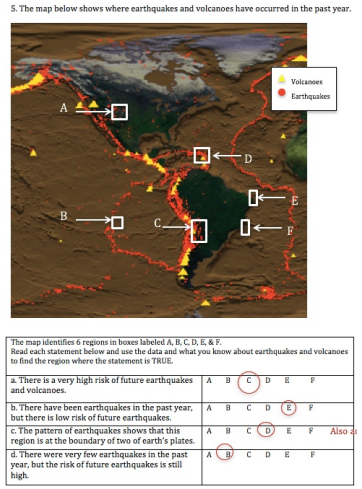
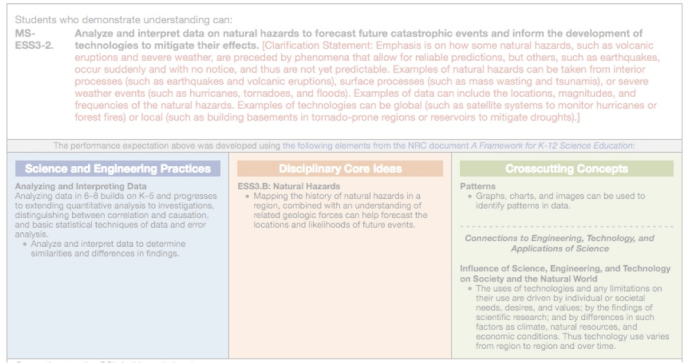


5. The map below shows where earthquakes and volcanoes have occurred in the past year.

The map identifies 6 regions in boxes labeled A, B, C, D, E, & F.
Read each statement below and use the data and what you know about earthquakes and volcanoes to find the region where the statement is TRUE.

a. There is a very high risk of future earthquakes and volcanoes.	A B **C** D E F
b. There have been earthquakes in the past year, but there is low risk of future earthquakes.	A B C D **E** F
c. The pattern of earthquakes shows that this region is at the boundary of two of earth's plates.	A B C **D** E F Also a
d. There were very few earthquakes in the past year, but the risk of future earthquakes is still high.	A **B** C D E F

Construct validity: multiple choice



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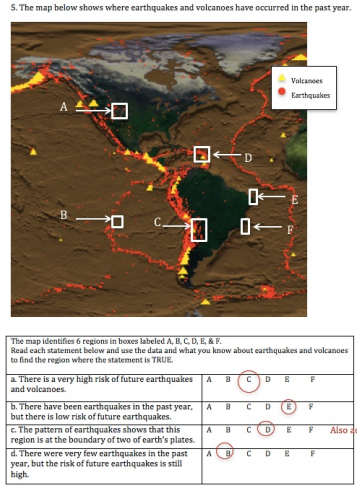
2D constructs

E.g. Interpret earthquake data to forecast locations and likelihood of future events

How are you making decisions about which answer to choose?

Did you use these data/model to answer the question? How?



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d. There were very few earthquakes in the past year, but the risk of future earthquakes is still high.	**A** B C D E F

Sample population

	NGSS PE assessed	# of student respondents
Multiple-choice assessments (cognitive lab data)	Natural Hazards (MS-ESS3-2) Rock cycle (MS-ESS2-1)	36 42
Short performance tasks (pilot test data)	Natural Hazards (MS-ESS3-2) Rock cycle (MS-ESS2-1)	574 144

Construct: Analyze and interpret a pattern of earthquakes and use the pattern to make a prediction about the location and likelihood of future earthquakes.

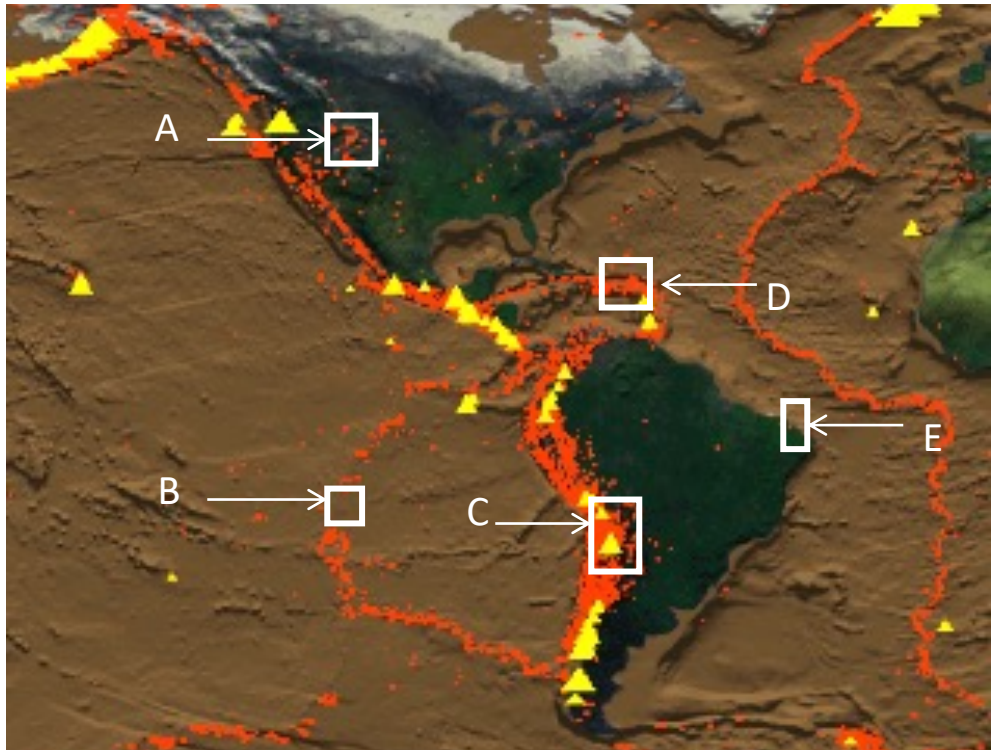
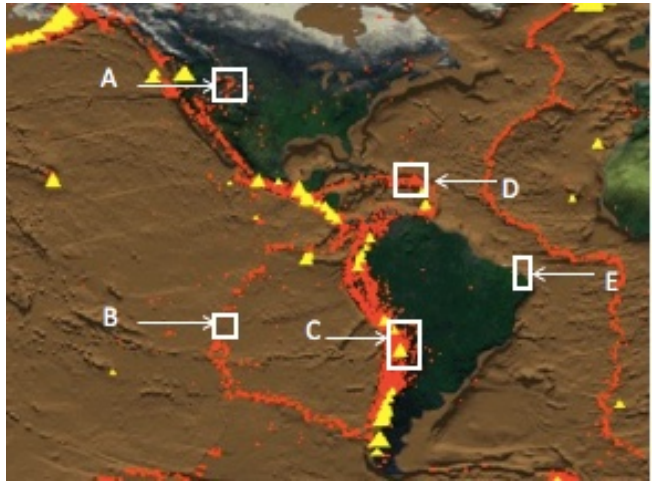


Image credit: NASA data adapted from PBS Learning Plate Tectonics interactive

There were earthquakes in the past year, but there is low risk of future earthquakes.

A B C D E



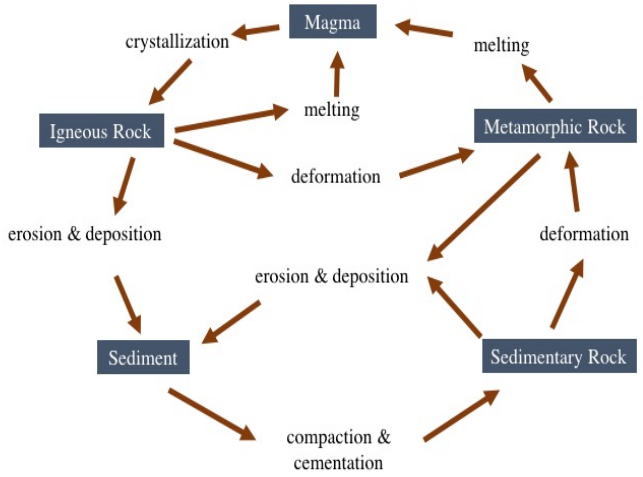
“A - the only fault line I know is the San Andreas"

“I remember learning earthquakes mostly happen along the plates, when tension builds over time there are larger earthquakes...I can’t remember where the plates are”

“plates rub up against each other and tension builds over time, and that’s when earthquakes happen but I can’t remember where the plate boundaries are”

- Seek answers closely related to their learning experiences even if it requires ignoring the data and/or prompt
- Did not engage in novel reasoning tasks even if they have the relevant knowledge

Construct: use a model to describe changes to Earth's materials.



"I used the model but not the parts in the middle"

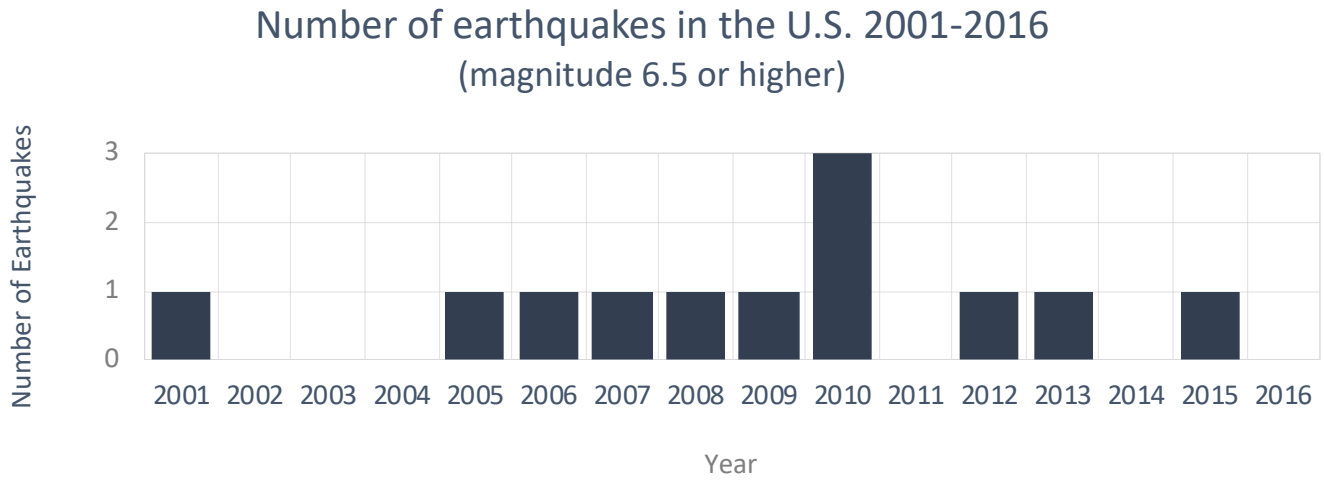
"I didn't use the model because it was too confusing. I don't know where it starts or ends."

"I just looked through answers to see which ones I understood and which ones I didn't"

- Students ignore parts of the model that seem too complex and use the rest
- Students choose answers based on words that are familiar but irrelevant to the prompt

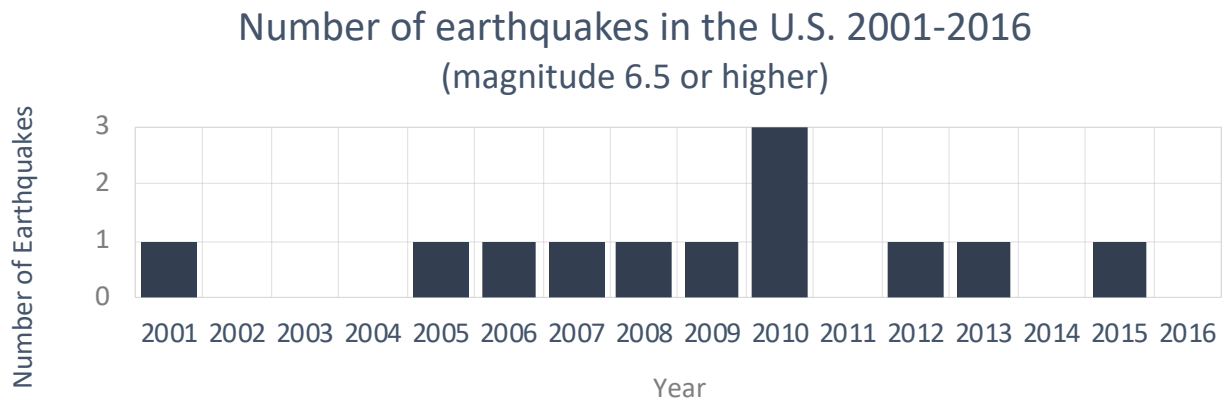
Construct: Use data analysis and reasoning to support a claim about how data could help forecast the likelihood of future earthquakes

One of the city leaders has claimed that the graphs showed that it was not necessary to plan for earthquakes



The graph above shows additional data on earthquakes in the U.S. Use the data and what you know about earthquakes to explain why you agree or disagree with this claim.

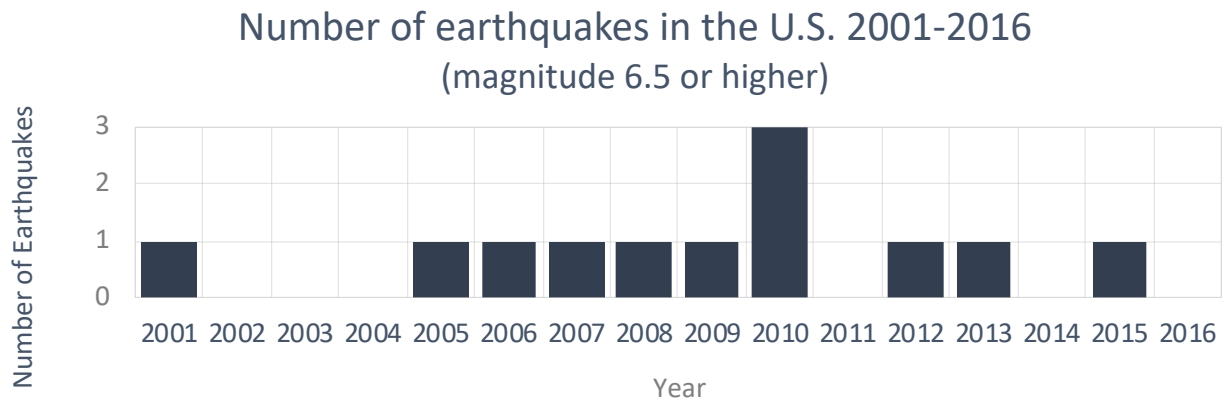
One of the city leaders has claimed that the graphs showed that it was not necessary to plan for earthquakes



The graph above shows additional data on earthquakes in the U.S. Use the data and what you know about earthquakes to explain why you agree or disagree with this claim.

I disagreed because earthquakes are the one natural disaster that can't be predicted but when they do happen they cause a lot of harm. In 2011, there were 341 earthquakes that occurred but by looking at the graphs you can see they were smaller ones because they cost no money and didn't take any lives. Just because the earthquakes that occurred in 2011 weren't at the threatening stage people should still be ready for a dangerous one because you never know when one might happen.

One of the city leaders has claimed that the graphs showed that it was not necessary to plan for earthquakes



The graph above shows additional data on earthquakes in the U.S. Use the data and what you know about earthquakes to explain why you agree or disagree with this claim.

[I disagree because] *In all of the graphs earthquakes are very low*

[i agree because] *in the graphs it says the earthquakes killed nobody and they cost very little to prevent or fix so an earthquake would be unnecessary to plan for.*

What does this mean?

1. 2D multiple choice items introduce a new level of complexity to response process
2. Cognitive labs are even more essential to validity arguments for NGSS multiple-choice items than ever before
3. States are now implementing tests without conducting cognitive labs!!!

Questions?

Contact: Jill Wertheim
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