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Earthquakes Haven't Shaken College Students' Cognitive Structure

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On the morning of June 28, 1992, many individuals experienced the devastating power of a 7.5 magnitude earthquake in the middle of the Mojave Desert. Subsequently, even the popular press (Nash, 1992) described in detail how the Landers and associated earthquakes were possibly impacting the southernmost section of the San Andreas fault. The triangular segment that was uplifted 2m vertically and 5m horizontally had not been predicted. For the next few weeks, words such as fault, epicenter, seismograph, and Richter scale appeared in many news reports. Once again, the populace became interested in earthquakes and plate tectonics. Did they have an adequate cognitive structure to understand these events?

Philips (1991) provided a brief overview of more than 50 earth science misconceptions. There were two that relate directly to the study of earthquakes. First, in the near future Chicago would not be severely damaged by an earthquake. If the famous 1811 and 1812 New Madrid earthquakes occurred again today with the same intensity, Chicago would be in the V1 region on the modified Mercalli scale. Second, continents are not moving which illustrates a major misconception about the theory of plate tectonics. Earlier, Hoz, Bowman, and Chayoth (1987) concluded that instruction was the major source for numerous geology misconceptions about erosions, weathering and environmental interactions.

Table 1 summarizes National Assessment for Educational Progress (NAEP) items related to earthquakes. For the three items that were utilized at more than one grade level, performance improved.but, the response to the item on earth's crustal motion was very similar for grades 8 and 12. This earthquake item had the least demonstrated understanding. Except for fourth-grade item on continents changing position, boys outperformed girls. Only 36% of the teachers

did not consider themselves prepared to teach about the theory of plate tectonics (Jones, Mullis, Raizen, Weiss and Weston, 1992).

Table 1

Performance on earthquake related questions on 1990 NAEP

Item description	Grade	National % correct	Female % correct	Male % correct
Seismograph Function	4	56.7	54.9	58.3
	8	82.4	81.5	83.4
Continent's Position Change	4	42.9	43.3	42.5
	8	63.9	61.5	66.4
	12	73.5	70.0	77.3
Earth's Crust Motion	8	13.8	11.9	15.8
	12	14.8	13.8	15.9
Diagram: New Crust	12	29.2	26.7	31.9
Diagram: Subduction	12	51.4	46.5	56.8

Rutherford and Ahlgren (1990) provided a brief overview of how the theory of plate tectonics has been accepted. They have utilized the study of earthquakes as an example for the patterns of change. Mayer and Armstrong (1990) summarized a conference of geoscienctists, science teachers, and science educators to identify major earth science concepts for high school students. One of these concepts concerned that the crust is composed of plates that are and have been in motion. The American Geological Institute (1991) recommended that the study of earthquakes would be introduced first at grades 3 - 6 with the building of an understanding of the theory of plate tectonics in grades 6 - 12.

Ross and Shuell (1993) investigated elementary students' conceptions about earthquakes in the states of New York and Utah. They conducted interviews with K-6 students. It was concluded that students had information about earthquakes regardless of whether they studied about them in school or

not. After studying about earthquakes, students generally added technical terms to their responses, while still retaining misconceptions. Students who observed the television coverage of the 1989 Loma Prieta earthquake had a feeling of helplessness. They concluded that students who had experienced an earthquake did not have a better understanding of earthquakes. Bezzi (1989) conducted an interview study of secondary students in Italy. He reported that one third who lived in a seismic region related earthquakes to the occurrence of volcanoes.

Turner, Nigg and Paz (1986) interviewed almost 1,500 adults in California. Interviewees were to respond as true, false, or don't know to statements. In response to the statement about causes of earthquakes, 53.5% answered true that the movement of one or more tectonic plates as the cause, 4.7% replied false, and 41.8% answered don't know.

The purpose of this study was to ascertain college students' understanding about earthquakes at the start of an introductory geology course.

METHOD

A total of 186 college students at a land grant midwestern university voluntarily participated in a questionnaire on the first day of an introductory geology course.

Posner and Gentry (1982) recommended general open-ended questions for ascertaining students' cognitive schema. The resulting questionnaire was composed of four sections of open-ended questions to determine the college students' knowledge about earthquakes. The first question had three components to assess personal experiences regarding earthquakes. The students were to respond to whether they had experienced earthquake or not and what they remembered about the experience. Also, they were to describe what they remembered about mass media reports on earthquakes. Finally, they were to rate their personal knowledge about earthquakes where 1 was low and 5 was high. In addition, the students were to indicate whether they had studied about earthquakes prior to enrolling in the geology class. The second question poses a situation where a perspective employer wanted the student to assist the employer's child by identifying causes of earthquakes. The third question was to seek reasons why earthquakes and volcanoes are studied together. The final

question concerned the potential of earthquakes occurring in the New Madrid region of southeastern Missouri. The results were coded and analyzed by SAS.

RESULTS

Slightly over 25% of the students had experienced an earthquake and about 97% were familiar with mass media resources about earthquakes responded regarding movement/tremor, location, landscape, and damage in relation to duration. The mass media information was more diversified. For example, students mentioned destructive impact, locations of famous earthquakes, high death toll, plate movement, specific terms (i.e., epicenter, etc.), aftershocks, safety tips, and unpredictability of earthquakes (Table 2).

Table 2

Frequencies about personal experiences and mass media reports about earthquakes

	Yes		No		No response
	n	%	n	%	
Experienced	49	26.3	135	72.6	21.1
Movement	41	22.0	8	4.3	
Location (specific)	42	22.6	7	3.8	
Landscape impacted	3	1.6	46	24.7	
Rapid event	8	4.3	41	22.0	
Mass Media	178	91.2	6	3.3	6.5
Destructive impact	120	64.5	54	29.0	
Location (specific)	54	29.0	120	64.9	
Impact upon human lives	19	10.2	155	83.3	
Plate movement	25	13.4	149	89.1	
Landslide / disaster	20	10.8	155	83.3	
Safety survival tips	1	.05	174	93.5	
Unpredictable	9	4.3	166	89.2	

A total of 10 concepts were listed for the perspective employer. These concepts included plate movements, safety precautions, wave transmissions, predict potential recorded by seismograph, intensity on 10-point scale (Richter),

landslides causes and faults. Even though responses were limited, individuals who had not experienced an earthquake were more limited (Table 3).

Table 3
Frequencies about characteristics regarding earthquakers from students who had experienced an earthquake

	Reported		Not Reported	
Characteristics	n	%	n	%
Plate movement reated to stress and strain	20	4.1	40	81.6
Tremors due to ruptures	4	8.2	38	77.6
Wave movement pattern	3	6.1	39	79.6
Difficult to predict	2	4.1	40	81.6
Seismograph records	3	6.1	39	79.6
Richter scale	2	4.1	40	81.6
Fault defined	4	8.2	38	20.4
Cause major damage	7	14.3	35	71.4
Most not felt	3	6.1	39	79.6

The only concept about the relationship between earthquakes and volcanoes that had more than 30% frequency was underground pressure. Students' lacked background about theory of plate tectonics so they reported no relationship for these tectonic activities (Table 4).

Table 4

Frequencies about why earthquakes and volcanoes are studied together

	Reported		Not Reported	
Concept	n	%	n	%
Plate boundary occurrences	5	2.7	181	97.3
Rock forming process	15	8.1	171	91.9
Natural disasters	17	9.1	169	90.9
Surface and subsurface movement	18	9.7	168	90.3
Underground pressure	57	30.6	129	69.4
Effects surrounding areas	11	5.9	175	94.1
Moving plates	3	1.6	183	98.4
Effects surrounding areas	11	5.9	175	94.1
Moving plates	3	1.6	183	98.4
Earthquakes cause volcanoes	31	16.7	155	83.3
Volcanoes and mountains formed	11	5.9	175	94.1
When plates collide	6	3.2	180	96.8
Study at surface	4	2.2	182	97.8
Lava beneath plates	2	1.1	184	98.9
Earthquakes force lava upward	1	0.5	185	99.5
Cause damage	9	4.8	177	95.2
Precautions	2	1.1	184	97.8

Students who had experienced an earthquake had an unusual understanding about the New Madrid seismic zone. The most common comment was that another earthquake was going to happen soon. No student demonstrated any understanding about causes of intraplate earthquake such as New Madrid (Table 5).

Table 5

Frequencies about New Madrid seismic zone information of students' who had experienced an earthquake.

	Reported		Not Reported	
	n	%	n	%
One largest earthquakes	4	8.2	35	91.4 ???
Going to happen soon	31	63.3	8	16.3
Will be severe	10	20.4	29	59.2
Not easy to predict (Browning)	7	14.3	32	65.3
1811-12 caused Mississippi to flow backwards	3	6.1	36	73.5
Tremors occassionally occur	2	4.1	37	75.5

Discussion

In this study, we set out to determine whether personally experiencing an earthquake and/or mass media influences college students' understanding about earthquakes. Overall, mass media provided greater previous knowledge base than personal experience. The recent Loma Prieta and Andes earthquakes of California resulted in depth coverage both visual and print media. Therefore, students could identify more characteristics about earthquakes. About 70% of students who had experienced an earthquake mentioned plates or plate tectonics. Although, students lacked the broad understanding about the theory of plate tectonics.

Iben Browning's projection that a massive earthquake would occur December 3, 1990 was the most dominant response from the college students. The mass media's exploiting the climatologist tidal causes for earthquakes tended to confuse students when referring to the New Madrid region. However, tidal activity was not mentioned on the other questions. Less that 7% of the students' perceived their earthquake knowledge to be good or excellent (Table 6).

Table 6

Perceived knowledge about earthquakes when comparision between students' who had and had not experienced an earthquake

	Excellent		Good		Average		Poor		Few	
	n	%	n	%	n	%	n	%	n	%
Experienced			5	10.2	18	36.7	16	32.7	10	20.4
Not Experienced	1	.7	6	4.4	28	20.7	59	43.7	39	28.9
No Response									2	1.1

The NAEP results showed precollege students lack background on earthquakes. They seem to have similar background as Bezzi (1989) and inferior to the adults interviewed by Turner et. al. (1986). It is hypothesized that college students at the conclusion of the introductory geology class would have a better understanding about causes of earthquakes. But, they will still have numerous misconceptions.

In preparing to teach about earthquakes, instructors should be aware that students have diverse cognitive structures. The sensationalism of mass media causes the destructive impact upon humans to receive the greatest attention. However, the background needed to comprehend specific concepts will be absent. For example, an increase by one on the Richter Scale is actually a ten fold increase with a 30 times greater release of energy. This will help students in comprehending that a 6.5 earthquake is considerably stronger that a 5.5 earthquake. Future studies are needed to see how students' cognitive structures are activated for specific earthquake concepts.

RESOURCES

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