College Students' Conception of Volume

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Purpose

- College students' common pattern of conceptions about volume in different task?
- Identifiable patterns of their reasoning in their answers?
- Scope of Understanding?
- Implications for teaching the concept of VOLUME?

Methodology

Sample: **Group 1-** 4 Preservice Elem. Teachers Group 2-3 College Students (1 Elem. Ed., 1English and Spanish, 1 Special Ed.) Data Collection – Individual Interview in the last Fall 2005 Instrument: Four Different Tasks about Volume

Both cups are the same size but different thickness.



Compare volume of cups A and B. Which cup has more volume between A and B and why?

Both clay balls below are the same size.



Compare volume of balls A and B. Which ball has more volume between A and B and why?

Compare the volume of two bowls.



Compare volume of bowls A and B. Which bowl has more volume between A and B and why?

Compare the volume of two balloons



Compare volume of balloons A and B. Which has more volume between balloons A and B and why?



Students' Conceptions of Volume

Q	College (P) N=4	College (O) N=3
Q1-A	4	3
Q2-A	2	2
Q3-A	2	1-Not Sure
Q4-A	2	1-Not Sure

Q	College (P) N=4	College (O) N=3
Q1-B		
Q2-B	2	1
Q3-B	2	2
Q4-B	2	1 & 1 (Same)

Students Conceptions of volume - Definition

Categories	College (P) N=4	College (O) N=3
Space Occupied	2	1
Capacity	2	2

Reasoning in Students' Explanation

Categories	College (P) N=4	College (O) N=3
	(16 responses)	(12 responses)
Space Occupied	Filled space -3*	Filled space-3
	Empty space -3	Empty space-1
Capacity	9	3
Others (not sure, same)	1	5 (Same-2 not sure-3)

* The number means number of individual responses

Sample Group 1

- 4 Elem. Ed. Majors
- Seniors,
- All females,
- 12 semester hours of science,

"Volume is the amount of something in an object - capacity

- Task 1- "Cup A is going to have a greater volume because it can hold more space inside"
- Task 2- "Ball B will have a greater volume holding capacity.
- Task 3- "Bowl B has a greater volume because it's holding water in it. Well, ... It has more optional volume space. It has more opportunity to fill up because everything in it is the volume and right now there's only air in it..... Both have the same volume only if they're both filled up with the same thing."
- Task 4- "Baloon B has a greater volume because of the water in it. The other one has the opportunity to hold the volume and if it had to stay the exact same size, you could fill it up with the exact same amount."

"Volume is the space that is taken up inside of an object - space occupied

- Task 1- "Cup A would be more space inside, so there's more volume."
- Task 2- "I really don't know which one has more volume. A has a higher volume. But B has a high volume because there's only air in it so there's more room."
- Task 3- "Bowl B has more volume .. because you can measure the volume that's in there because there's substance in there."
- Task 4- "I think I would say the same thing. I would say the water-filled one (B) has more volume because you can measure the space taken up"

"Volume is the space inside of an object that is occupied – space occupied

Task 1- "Cup A has more volume because it can hold more space inside"

Task 2- "Ball A is going to have more volume because it has more space than Ball B that all the space is occupied."
Task 3- "Bowl A has more volume."
Task 4- "Ballon A has more volume."

"Volume is how much space is inside of an object - capacity

Task 1- "Cup A has more volume because there's more space that can be taken up." Task 2-"I think maybe Ball A will have more volume because there's more room." Task 3-"I would say Bowl A has more volume because there's a lot more space in it available." Task 4- "Baloon A would have a bigger volume because the water takes up space

and nothing else would fit in there."

Sample Group 2

Student A-

- Gender: Male
- Year in School: Senior
- Major: Elementary Education
- Science Background: Some high school and 12 hours of college courses in science

Student B-

- Gender: Female
- Year in School: Senior
- Major: English and Spanish
- Science Background: High school and 18 hours of college courses in science (Physics, Biology, Chemistry)

Student C-

- Gender: Female
- Year in School: Senior
- Major: Special Education
- Science Background: Biology and Chemistry class in high school and Chemistry class in college

"Volume is how much mass something is, I guess. How much, like, let's see, it is occupied by." – Space occupied

Task 1- "Cup A has more volume. There is more space for liquid than B"
Task 2- "Ball B, because it occupies more space. There is no room for air compared to A."

Task 3- "B has more volume. Something is occupying more space- other than air inside of it."

Task 4-"B has more volume. That's because water has more mass than air."

"Volume is how much can fit in something; how much of something there is in something." - capacity

- Task 1- "A has a greater volume because it is bigger. There is a 12mm difference. 144 times height of difference of volume times pi."
- Task 2- "A has more volume of air and B has more volume of clay."
- Task 3- "A has more volume of air and B has more volume of water."
- Task 4- "A has more volume of air and B has more volume of water. Actually, they are probably all equal. (Referring to volumes of all objects presented)"

Student # 3 "How much something can hold." - capacity

Task 1-"I don't remember! (Pauses for about 62 seconds and thinks) (Asks me) So A would be because it can hold more?"

Task 2–"A, I don't know why, maybe more open areas."

Task 3-"I'm confused if it's how much fits in or how much open space."

Task 4- "A and B are the same because they hold the same amount."

Conclusion

- The students were not confident with their answers and responses to the questions.
- Many of their ideas were misconceptions or not fully developed ideas about volume.
- The student have multiple dimensions of understanding about the concept of volume.

Model of Understanding Structure

- Nominal Understanding Students often come to class with.
- Functional Understanding Students can describe a concept but have a limited understanding of it.
- Structural Understanding Students (a) develop personal relevance and are interested in the study of a concept, and (b) constructed appropriate meaning of the concept from experiences.
- Mature Understanding Students obtain additional knowledge or skills, and (c) apply knowledge of a concept to related subjects and to solve a problem or answer a question.

Modified from Developing Biological Literacy, BSCS, 1993.

Teaching Goal?

How far could/should/must we teach in terms of the Understanding Model?

How far are we able to achieve the teaching goal in light of the Model?

Strategy of Teaching for Understanding

