Hybrid Visual-Tutorial Instruction Model to Learn the Concept of Density

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Problem of investigation

• Most of Physical Science II students have important understanding difficulties related to the concept of density
• Future elementary teachers
• Average age: 34 years
• First exposition to physics concepts for most of students
• Female 95%
Objectives

• To design and implement a lab-visual understanding proposal of the concept of density in the contexts of solids and liquids
• To expose Physical Science II students to this proposal
• To compare the number of students from treatment and control groups answering correctly pretest and posttest questions
• To compare the corresponding gain from treatment groups
Context of investigation

• Treatment group N=29 students
• Control group N=20 students
• Instructor A 3 sections
• Instructor B 1 section
• Two 1 hr 50 min sessions per week
Curriculum

• A 30-min video projected at the beginning of the first session and available for students through the development of the lab (both sessions)
• A conceptual-numerical based lab
• The video shows 90% of the section of the lab
• The video also includes conceptual questions mostly related to proportional reasoning situations
• A homework
• Pretest and posttest
Lab approach

<table>
<thead>
<tr>
<th>Volume ml</th>
<th>Mass gr</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>50</td>
</tr>
<tr>
<td>100</td>
<td>150</td>
</tr>
<tr>
<td>200</td>
<td></td>
</tr>
</tbody>
</table>
Video snapshots

c. Estimate the mass of volume values by filling in the blanks of the table. Explain your reasoning. You may use your own method.

d. Use the graduated cylinder to find the number of little cubes you need to displace an approximated volume of water equal to the volume of a 1-in cube.

Now, submerge the cube displaced water in a graduated cylinder. Wait for the last drop of water.
Lab approach and snapshots

Aluminum cubes

How many little cubes could you locate in a space equal to the volume of a 1\text{in}^3\text{ cube}? See the figure.

d. Calculate the slope of the straight line traced on the aluminum mass-volume graph. Remember that you have to pick any two points P1(v1,m1) and P2(v2,m2) as shown at right.
Figures at right show four identical buckets full of liquid. The density of liquid 1 in case 1 is twice the density of water. The density of liquid 2 in case 2 is ½ the density of water. Which of following statements is true? Explain your reasoning.

The mass of liquid 1 in case
a) 1 is twice the mass of liquid 2 in case 2.
b) The mass of liquid 1 in case 1 is 4 times the mass of liquid 2 in case 2.
c) The density of liquid 1 in case 1 is twice the density of liquid 2 in case 2.
d) None of them.
Homework question # 2

Two cork spheres are shown at right. The left sphere has twice the radius of the right sphere. Which of the following statement is correct?

a) The mass of the left sphere is twice the mass of the right sphere.
b) The mass of the left sphere is four times the mass of the right sphere.
c) The mass of the left sphere is eight times the mass of the right sphere.
d) The mass of the left sphere is $1/8$ the mass of the right sphere.
Treatment and control groups results

**Treatment group (video)**

N = 29

**Control group (No video)**

N = 20
Conclusions

• It seems that the video-lab combination approach is better than the lab by itself
• Students used the video through the complete lab
• Homework was too difficult for some students
• Hake’s normalized gain:
  – Treatment group: 0.15
  – Control group: -0.09