Levels of Inquiry Model of Science Teaching: The Buoyancy Learning Sequence

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Levels of Inquiry Method of Science Teaching

Discovery Learning	Interactive Demonstration	**Inquiry Lesson**	Inquiry Lab	Real-world Application	Hypothetical Explanation

* Each level of inquiry has associated with it different intellectual and scientific process skills. For instance:
  * Discovery learning – developing concepts
  * Interactive demonstration – predicting and testing
  * Inquiry Lesson – designing a controlled experiment
  * Inquiry Lab – collecting and analyzing data
  * Real-world Application – solving authentic problems
  * Hypothetical Explanation – developing testable explanations

Level 1 – Discovery Learning

* Students reflect on their mental models associated with floating and sinking (boats, ships, wood, rock, etc.)
* Students personally experience the buoyant force for perhaps the first time.
  * Floating objects (wood, Styrofoam)
  * Sinking objects (metals, plastics, rock, clay)
  * Not to be confused with surface tension
* Terms are applied only after new concepts are developed.

Level 2 - Interactive Demonstration

* Students, based on their prior knowledge of density, predict if certain objects will float or sink.
* Students are asked to predict the difference between weight in air and weight in water for a given object, the difference being the buoyant force.
* Using force diagrams, students suggest the following relationship: $F_b = T_a - T_l$

Level 3 – Inquiry Lesson

* Guiding question: “What affects the amount of buoyant force on an object?”
* Students make various suggestions.
* Students design and conduct whole-group experiments to determine which named factors are significant.

Level 4: Inquiry Lab

* Students "jigsaw" the problem to determine how the volume of the object, V, and the density of the liquid, ρ, individually affect the buoyant force.
* Students independently find that $F_b = k_1 V$
* Students independently find that $F_b = k_2 \rho$
* Conclusion $F_b = k \rho V$
* Furthermore, $k = F_b / \rho V = 9.8 m/s^2 = g$

Level 5: Real-world Application

* Having derived from experience that $F_b=\rho Vg$, students:
  * predict and test buoyant forces for a variety of different objects.
  * predict what percentage of an iceberg will be found beneath the surface of the water.
  * determine how much weight a small paper boat can hold before sinking (a competition based on a limited amount of poster board/cardboard and tape).

Level 6 – Hypothetical Explanation

* Selected students explain the source of buoyant force
* Teacher conducts demonstration with 3-holed bottle:
  * showing that pressure increases with depth, *d*.
  * students conclude that $P = F/A = mg/A = \rho Vg/A = \rho gd$
* Hypothesis: Pressure differences between the top and bottom of a cube of dimension *h* account for F_b.
* $\Delta F = (\Delta P)A = \rho g(\Delta d)A = \rho ghA = \rho Vg = F_b$

To learn more about the Levels of Inquiry Method of Science Teaching

* Levels of inquiry: Hierarchies of pedagogical practices and inquiry processes. *Journal of Physics Teacher Education Online*, 2(3), February 2005, pp. 3-11.
* Levels of inquiry: Using inquiry spectrum learning sequences to teach science. *Journal of Physics Teacher Education Online*, 5(4), Summer 2010, pp 11-19.
* The Levels of Inquiry Model of Science Teaching. *Journal of Physics Teacher Education Online*, 6(2), Summer 2011, 9-16
* Sample learning sequences based on the Levels of Inquiry Model of Science Teaching including Appendix (with Manzoor Ali Khan). *Journal of Physics Teacher Education Online*, 6(2), Summer 2011, 17-30.