Nanotechnology 6-E Lesson Plan Template

Author: Courtney Vance	**Date: June, 5, 2009**
Topic: Nanotechnology	
Title: Tiny Teacup	**Grade Level: 3 - 10**
Lesson Summary: Students will observe a tiny teacup from which water will not pour out. They will then choose three slightly larger different sized teacups and predict whether they will pour water. After testing, they will devise ways of making water (or other liquids) pour from the tiny teacups.	

Arkansas Math and Science Frameworks SLEs:

DAP14.8.1 Design and conduct investigations which include (1) adequate number of trials (2) unbiased sampling (3) accurate measurement (4) record-keeping
DAP 14.8.3 Interpret or solve real world problems using data from charts

NS 1.8.6 Formulate inferences based on scientific data.
NS 1.8.7 Communicate results and conclusions from scientific inquiry following peer review
NS1.8.9 Generate questions that can and cannot be answered by science

Main SLE covered in this activity:

DAP14.8.1 Design and conduct investigations which include (1) adequate number of trials (2) unbiased sampling (3) accurate measurement (4) record-keeping

Objectives: The learner will:
1) design and carry out an original investigation of how to make tiny teacups pour water or other liquids
2) use the scientific method to test hypotheses

Essential Question:
How can a tiny teacup be made to pour water or other liquids from it?

BACKGROUND INFORMATION

Timeline:

One - two 45 - 55 minute class periods

Materials: the AR Museum of Discovery Nanotechnology Trunk; Tiny Teacup Activity which includes the following materials: Tiny plastic teacups which will not pour water, and other assorted small teacups, mugs, goblets, bowls, etc. which will and will not pour water.

You can either provide the following experimental materials to choose from, or ask students to bring them from home after they design their investigations:

- **Experimental liquids such as distilled water, carbonated water, alcohol, vinegar, cooking oil, syrup, carbonated soda, milk, honey, molasses, etc. Note: use a fume hood if bleach, ammonia, etc. are tested**
- **Experimental solutes to add to water such as table salt, Epsom salt, sugar, baking soda, etc.**
- **3 oz. bathroom cups to hold/dissolve liquids**
- **Hot and cold water in thermoses**
- **Other experimental aids such as Pam cooking spray, liquid dishwashing detergent, bar soap, WD-40, ski or table wax, powder, mineral oil, etc. (these items can be used to coat the tiny teacup before adding the water)**
- **Safety goggles, gloves, and lab aprons**

Teacher Preparation:

1) **collect materials**
2) **assign groups of 2 – 4 students**
3) **copy Student Lab Sheets**
4) **research Brownian motion of particles and surface tension**

PROCEDURE

Engage:

- **Have another teacher help you present the Nanotechnology Puppet Show from the other AR Museum of Discovery Network Nanotechnology Trunk.**
- **Demonstrate dipping both a regular sized teacup and a tiny teacup into water to fill them, show the students that they both contain water; then try to pour out the water from both cups. Ask students to guess why it won't pour from the tiny teacup, and how this is related to the puppet show. [Answer: when objects get small, their behavior can change drastically! Don't answer the reason why the water won't pour from the tiny teacup.]**

Explore:

- **Instruct the students that in their assigned groups they will select 3 small cups/bowls and predict whether they will pour water.**
- **They will then test their prediction.**
- **Each group will design 6 different investigations based on their group's ideas of how to make the water pour from the tiny teacup. They will develop their own data tables for their investigations. If desired you can provide the various liquids, solutes, and other aides for them, or have students decide on their experimental materials and bring them in the next day.**

Explain:

- **Each group will report on what they did to make the water pour out. These may include coating the cup with oil, wax, soap, etc.; adding a solute to the water such as salt or sugar; using hot or cold water; and mechanically making the water come out such as shaking or thrusting the cup.**
- **Each group will report on which liquids would pour from the tiny teacup when plain water would not. This may include more slippery liquids such as liquid dish detergent, bleach, ammonia, etc.**

Elaborate:

- **The teacher will lead a discussion of why the plain water did not pour from the tiny teacup. [The main factor is Van der Waals forces that make the water molecules stick together; the Van der Waals forces are greater than the force of gravity for the small volume of water in the tiny teacup.]**
- **Then discuss why the coating of the teacup worked. Discuss why adding solutes did or did not work.**
- **Discuss why other liquids did or did not pour.**

Extend:

- **If desired, allow students to take home a tiny teacup for further investigations at home.**
- **Assign internet research on Van der Waals force and/or the Dutch scientist Johannes Diderik Van der Waals.**

Evaluate:

- **The students' lab sheets can be scored.**
- **While students work in groups the teacher can use a rubric to score each group member's participation.**
- **Students can evaluate their group member's work and contribution using a rubric.**

CROSS CURRICULAR CONNECTIONS

Math: measurement, data collection, data analysis

Language Arts: oral and written communication

Social Studies: history of nanotechnology and Dutch scientist Johannes Diderik Van der Waals

Parental Involvement: Ask a parent to assist with this somewhat messy lab.

Technology Connections:

Internet research

Resources:

Van der Waal force:

www.chemguide.co.uk/atoms/bonding/vdw.html
www.physlink.com/Education/AskExperts/ae206.cfm

Nanotechnology:

www.nanowerk.com

Doll house tiny teacups, mugs, goblets, bowls, canisters:

www.dollhousecollectables.com
www.CraftsEtc.com
www.AmericanDollhouseCompany
www.miniatures.com
www.customdollhouse.com
www.nanasminiatures.com

Notes: Proper safety equipment must be used by all students and the teacher such as lab aprons, gloves, safety goggles, and in the case of bleach and ammonia, a fume hood. Students should be instructed the day before to wear old clothes in case they spill staining materials on them such as molasses or oil.

Credits:

This lesson: __is original _X_was adapted from _Cynthia Miller's original lesson.