ChemToy2: A Nanochemical Activity for Undergraduates and the Basis of a Nanochemistry Laboratory Curriculum

Shaun D Black
The University of Texas at Tyler, USA

Statement of the Problem: The Scientific Method requires the human Power of Observation to initiate and operate it. Previous work with ChemToy1 showed that the average undergraduate student had a 36.1 14.3% Power of Observation. That is, under normal conditions, about 64% of all phenomena would be missed during the conduct of an experiment. Recent studies with nanochemical ChemToy2 and greater statistical power showed that undergraduates observed an average of 34.7 10.6%, in harmony with previous results. ChemToy2 also exhibits interesting and useful nanochemical properties that have allowed us to develop an undergraduate nanochemistry laboratory curriculum based on this powerful, new assessment tool.

Methodology & Theoretical Orientation: The nanochemical properties of ChemToy2 are based on Turkevich sol-gel synthesis of gold (AuNP) and silver (AgNP) nanoparticles. We have studied purification, UV-visible spectroscopic properties, dynamic light scattering (DLS) sizes and dynamics, optical light scattering, chromatography, and electron microscopy of these NP.

Findings: Our nanochemical laboratory curriculum is based on a single ChemToy2 per student for the entire semester. The eleven experiments of the curriculum are on Laboratory Introduction and the Power of Observation; Photochemistry; Nanochemistry and nanoparticles; Green Chemistry; States of matter and principles of solubility; Continuity and discontinuity; Beer's Law and dilution; Absorption spectroscopy and localized surface plasmon resonance (LSPR); Light scattering and DLS; Size-exclusion chromatography; and Electron microscopy of AuNP and AgNP.

Conclusion & Significance: Each experiment of the nanochemical laboratory curriculum has been designed, tested, and proven for effective and innovative nanochemistry learning by undergraduates. The Green Chemistry and Continuity and Discontinuity Laboratories are of notable innovation. Pre-lab materials for students and faculty-staff training materials are available as part of the curriculum. This is the first complete nanochemistry laboratory curriculum to be developed.

Biography

Black conducts chemical and biochemical research aimed at discovery. The first concerns the Power of Observation; observation is the origin and heart of the Scientific Method. Our approach to studying this is through chemistry toys which are safe, fun, and interesting to observe; the power of observation can be determined from a toy observed by an individual, and repeated use of ChemToy1 or ChemToy2 can strengthen a person's observational power. The second concerns Chemical Planomics, the macroscopic movement of molecules under their own power. The third is on Physical Oxygen Transport; current theory suggests that oxygen diffuses from the lungs into the blood and from the blood into a target tissue. However, oxygen is non-polar and is not soluble in cells or blood and cannot pass across membranes. The fourth area is the Allosteric Corridor, a group of enzymes that serve as the highly-regulated biochemical engine of all aerobic cells.

sblack@uttyler.edu