Big Ideas in Nano Higher Ed (Discipline-based)

NCLT 2nd Annual Faculty Workshop
(DAY 1)

GROUP 1 (Chemistry)

1. Energy and forces that are critical in NSE
2. Size and properties that change with size
3. Instrumentation and characterization
4. Self-assembly
5. Quantum vs classical ideas
6. Bonding and reactions
7. Chemical and molecular networks
8. Biopolymers
9. Surface properties vs bulk properties
10. Materials and basic properties
11. Acid/base chemistry

GROUP 2 (Physics)

1. $\Delta E \neq E$: important to make things go
   As r decreases, the surface area and quantum mechanics become important
2. Intermolecular forces
3. Scale: instrumentation
4. Ratio
5. Life as natural nanotech (we use it as a template)
6. Faith in "Nano" science and empirical evidence
7. What makes a Nanoscale system unique
8. Given many forces
   identify (dominant ↔ regime correlation)
9. Necessity for tunable depth
10. Realm of validity of each model

GROUP 3 (Engineering)

1. Impact of scaling on properties
   (How do things change on "Nano" level?)
2. Definition of nanotechnology?
   (Students have heard of the term but what is it? And why different definitions by different people?)
3. Surface area/volume vs size
4. Surface forces (not gravity, but adhesion, melting, and solubility)
5. Inter-relating disciplines framework to give an overall picture (big picture for "Nano") and show where your are
6. Electronic properties differ at "Nano"
   electron interactions including magnetic and optical properties
7. Teach on a continuum level (not necessarily "new")
8. Properties relative to size
9. Relative size to determine properties "critical length" associated with a phenomenon.
10. Not necessarily new "Nano" course, but incorporate into existing course
    (through not new, but new techniques and manufacturing)
11. Do all students need quantum mechanics?
    Yes to do "Nano"! (for college)
    Then, how to teach quantum mechanics? (need to introduce quantum mechanics concepts and need to teach adequate match for "Nano")
12. Can measure or see consequences of "Nano"?

GROUP 3 (Engineering)

13. High school quantum mechanics – develop conceptual levels and appreciation
14. Optical nano properties
15. Interdisciplinary issues : biology, chemistry, surface reaction, and societal issues (risks and ethics)
16. Need to understand biology
17. Fears : is "Nano" the next "nuclear power"?
How do we educate the general public?
18. Technological tools and instrumentation
How does everyone have access to the tools?
19. Computer simulations and visualizations
20. Demonstrations needed
21. "Nano" structures and tools to "see"
22. Processing: moving atoms, self-assembly, bottom-up, synthesis, top-down
23. "Nano"-engineering : "microelectronics" really at "Nano" level (large impact)
24. Design on "Nano"-level (new ideas)
25. What new things should students know?
26. Where does all these "Nano"-phenomenon lead to?
27. Impact? (e.g. powder metallurgy)
28, Need motivation
29. Quantum mechanics-a gateway to understand "Nano"-difference between high schools and colleges

GROUP 4 (Science Education)

1. Tool (e.g. content map, taxonomy, hierarchy) for key concepts by discipline/field or grade/age levels
2. "Active" tools, how to explicitly relate content, pedagogy, and assessment.
3. Need to develop (or begin to) "standard" terminology for interdisciplinary/public education and literacy
4. Threshold concepts-concepts that span contexts and currently existing disciplines
5. Do we need a "central dogma" for k-16 NSEE?
6. Curricular sequencing- the key problem!!
7. Meta-learning and flexibility/ability to change