Pilot program to integrate nanotechnology in Utah’s high schools

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ABSTRACT

The application of nanotechnology has enormous potential to greatly influence the world in which we live. The major challenge is to incorporate nanotechnology into our understanding of what it means to be scientifically literate. This is even more vital for that segment of our population that will move into the scientific and technical workforce in 5 to 10 years. This pilot program is developing course materials to be incorporated into existing high school science subjects as part of K12 Nanoeducation.

Keywords: Nanoeducation, teacher preparation

The little word, \textit{nano}, has been rapidly insinuating itself into our consciousness because of its big potential. Nanotechnology has enormous potential to influence the world in which we live. The major challenge is to incorporate nanotechnology into our understanding of what it means to be scientifically literate. This is even more vital for that segment of our population that will move into the scientific and technical workforce in 5 to 10 years.

Present school students are the 21\textsuperscript{st} century workforce in this field for the nation. Education at this level is extremely important and necessary for any development for the country. Nanoscience and technology education at high school is needed not only to grow interest among students but also to build the foundation of their knowledge about future technology. Educating students at different grades 7-16 is one of the objectives of National Nanotechnology Initiative (NNI). This project intends to take nano-education to their regular classrooms for grades 9-12.

At the “Nano Utah 2003” conference, organized by Salt Lake City Community College, high school students raised questions such as:

- Do we need to learn chemistry, physics, biology, math, computer science and engineering to be a Nanotechnologist or Nanoscientist? – That’s tough!
- If someone likes physics but not biology or other subjects, how will he/she consider higher education in this exciting area?

Given the highly interdisciplinary nature of this exciting future technology, it looks like some students were more scared and lost interest on this subject.

Similarly, school teachers have questions like: Who will teach nanotechnology course, Physics teacher or Chemistry teacher or Biology teacher or a new faculty with
The country will not have enough teachers with Nanotechnology BS/MS degrees to cover all schools of the nation for another 10-15 years. Should we wait for those expert teachers or think of alternative ways to introduce NanoEducation at schools within a shorter time frame?

The challenge is to introduce nano-education in a systematic and thoughtful way at each school level. Since at present teachers of nanotech education at school level are not available, this pilot project is an attempt to utilize current resources by splitting the course into different modules such as Chemistry, Physics and Biology, and organize syllabus and detailed lecture notes for each module, but these modules will be part of a coherent whole. Thus, teachers of each subject can include the respective module in their regular course as expansion and extension of those general courses of school science subjects. After an initial training they will be able to teach the newly added sections of their course with references in further reading section as these modules will be part of a coherent whole. Basically the idea for nano-education at schools is to introduce different terminology and brief description of methods, characterization tools and usefulness of nanoscience and nanotechnology.

The goal of the high school nanoeducation program is to develop course materials such that the newly added section(s) are able to help students become and stay interested on nanoscience and nanotechnology. For this purpose, West High School of Salt Lake School District is considered as a testbed, and the project is funded by Utah State Office of Education, Salt Lake City. Authors are in the process of developing lecture materials on nanotechnology for honors and general Chemistry and Physics courses. School teachers already taught part of these new lecture materials in their regular classes and will continue in coming fall semester. Depending on student’s level of interactions, comprehension and acceptance, lecture materials will be revised. In future, a teachers training program will be organized for schools of the entire State of Utah to prepare them to teach nanoscience, so that all high school students get the flavor of nanotechnology.

The newly added sections on nanotechnology considered in this pilot project are:

1. Introduction to micro and nano scale.
2. History of Nanotechnology
4. Limitation of the human eye and optical microscope.
5. Introduction to electron microscope.
6. Bottom-up and Top-down technology
7. Introduction to Fullerenes and Carbon nanotubes
8. Structure-property relation
9. Synthetic methods, such as CVD, MBE etc
10. Size-dependence of properties.
11. Applications of Nanotechnology

Due to limitation of hands-on experiments, multi-media presentations on Nanotechnology developed by Nanopolis (www.nanopolis.net) will be used for intuitive explanations of nanotechnology concepts, technological processes and applications. A
story telling section on applications of future technology is also planned in this pilot project.

Consideration of the isolated and stand-alone sections on nanotech seems hard for student’s understanding and teachers had to provide backgrounds to correlate with new section and that kills class-hours. Also a completely separate section in Chemistry and Physics seemed have less impact on student’s interest and understanding of cutting-edge technology related education as those that will be taught most-likely at the end of the regular course in one or two lectures. However, if these newly added sections are considered as an integrated part of regular curriculum in appropriate places, the lesson was very well received, and easily understood by all the students. Advantages of integrated lessons on nanotech over one or two isolated sections are two-fold: first students will get lessons regularly over the year which is related to their regular class work, thus the word nano and its importance will insinuate more thoroughly into their awareness. Secondly, teachers will avoid extra class-load for the additional isolated parts.