

Need of Introduction of Nanoscience and Nanotechnology in the High School Curriculum in Indian School System

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Abstract: Over the last few years, prefix 'NANO' has invaded every scientific and technological literature. This field is considered as the anchor of the next industrial revolution. The application of nanoscience to 'practical' devices is called nanotechnologies. Nanotechnologies are used to form materials, structures, components, devices and systems at the nanoscale by manipulation and integration of atoms and molecules. Nanotechnologies are the application of nanoscience especially to industrial and commercial objectives. The rapidly advancing fields find new approaches to research, development and manufacturing that aim to understand phenomena and to manipulate matter at the level of atoms, molecules and clusters of molecules. As a consequence of this development, it has been frequently recommended that education in nanoscience and nanotechnology (NST) be provided at different levels. Many governments as well as private industrial houses are currently making huge efforts to be at the forefront of nanoscale science and engineering research. Unfortunately, it has not been included in the school curriculum, This paper explains how some topics on nanoscience and nanotechnologies can be incorporated in high school education and how it will affect the general awareness of these students towards the recent developments in science and technologies. The demand to teach nanosciences and nanotechnologies at Indian high school level requires the exploration of how they can be meaningfully introduced in secondary schools. Few suggestions for nanosciences and nanotechnologies curriculum development are also discussed.

Index Terms : Nanoscience, Nanotechnology, High school, Curriculum

I. Introduction:

The progress in teaching should be in accord with the progress of science, that's why the subject of teaching must be supplemented by the elements of modern knowledge which permit pupils to understand better what happens around us. Inclusion of nanotechnology in the science curriculum will foster interdisciplinary explorations of science in high school (8th to 12th) curriculum. Nanotechnology is based on the science at nanoscale, which is again based at the scale of atoms and molecules. Because nanotechnology is an emerging interdisciplinary field, it can be included in physics, chemistry, biology, environmental sciences, and engineering. Nanotechnology provides connections between the sciences that which will understand the relationships between various disciplines.

II. What is nanoscience and nanotechnology?

Nanoscience : Nanoscience is the study involving how different materials properties change at a very small scale. A nanometer is one millionth of a millimeter. One millimeter is the smallest measurement visible on a 30 cm ruler. Nanoscience deals with the objects which are 1000 times smaller than anything that can be seen with an optical microscope. Nanoscience is a platform that includes biology, chemistry, physics, medicine, materials science and engineering.

Nanotechnology : Nanotechnology is the manufacture and development of materials, devices and structures by knowing the behavior of materials at the Nanoscale. Nanotechnology is now applied widely in the ICT (Information and Communications Technology) industry in the manufacture of smaller integrated circuits (computer 'chips') and more efficient data storage mechanisms. It is also used in the medical field to make

smaller and smarter products. Several commercial examples of nanotechnology are on the market, and many more promising applications of nanotechnology are being investigated. Nanotechnology will impact virtually every industry in the future.

However, the words 'nanoscience' and 'nanotechnology' are used interchangeably.

Where is nanotechnology already being used?

- Carbon nanotubes are being used in the sports industry to make lighter and more robust equipment such as tennis rackets and lightweight bikes for scratch resistance, or are self-cleaning e.g. in waterproof and stain-resistant clothing, paint, self-cleaning windows.
- Face-creams and cosmetics also contain nanomaterials (also called liposomes/ nanosomes), which help retain moisture and deliver active ingredients to cells.
- Nanotechnology can miniaturize computers and other electronics. Also, the data storage capacity can be increased tremendously using nanotechnology.
- Nanoscience is applied in the development of faster and more sensitive medical testing devices and treatments.
- Sun creams use nanoparticles of zinc oxide or titanium dioxide to absorb the harmful UV rays from the sun, while making the sunscreens appear 'invisible'. Macro-sized particles are not transparent.
- Nanotechnology can help the environment by development of low energy consuming devices and by producing more efficient solar cells. The water purification process can be improved using nanoscience.

Therefore, where this field fits into science curriculum and how something that occurs at the atomic and molecular level can actually be addressed in the high school science curriculum? The fast progress of nanotechnology, which belongs to the most dynamically developing branches of science and technology and brings together various sciences such as solid state physics, chemistry, material science and molecular biology has been already observed for the past several years. The three steps, which are related to nanotechnology and could be introduced into curriculum at the high school level, are discussed below.

Middle School: At this level, the concepts of atoms and molecules are difficult to understand, but the students are developing the foundation for more advanced understanding of science. Important foundations to be addressed at this level include addressing the things like- understand scientific inquiry, properties of objects and materials, position and motion of objects and light, heat and electricity, organisms and environments, distinguishing between natural and man-made object, ability of technological design, and understanding about science and technology, changes in environments and science and technology in local challenges, science as a human endeavor etc.

High School (5th to 8th) : At this level, students start understanding science concepts at a higher level and they can perform experiments/seek information to understand these concepts. While middle-level students are still not ready to understand the world of atoms and molecules, they do develop a knowledge about the characteristics of materials which is an important component in understanding nanoscale science. Curriculum can include information on nanotechnology like properties and changes in properties of matter in nanoscale, structure and function in living systems, regulation and behavior, and ecosystems, technological design and understanding about science and technology, resources, and environments, risks and benefits, and science and technology in society.

High School (9th to 12th) : At this level, students have a rich knowledge base about the sciences. They expand the knowledge learned in earlier classes to understand the microscopic structures of materials and substances. Chemical interactions, the chemical basis of life, and cell structure and function all become part of the curriculum. Because of its interdisciplinary nature and its relationship with the basic science concepts, nanotechnology can be included in a variety of high school curricula taught in classes. The structure of atoms, structures and properties of matter, chemical reactions, properties of light, conservation of energy and increase

in disorder, and interactions of energy and matter, cell, matter, energy, and organization of living systems, behavior of organisms, and molecular basis of heredity, technological design and understanding about science and technology, natural resources, environmental quality, natural and human-induced hazards and science and technology in local, national, and global challenges etc. are the few topics that can be related to nanoscience.

III. Experimental Modules :

Various experimental modules can be introduced at different levels like :

1. Prepare and test gelatin: In this part of the experiment, students will prepare gelatin and test it with a laser pen to confirm its colloidal nature.
2. Colloid and its properties : Milk is a natural colloid and students will confirm this.
3. Synthesis procedure for different nano particles like silver, gold etc.
4. Synthesis procedure for different thin films using simple routes etc.
5. Demonstration of differences of physical, chemical properties of nano materials versus their bulk counterparts.

IV. Conclusion :

Nanoscience and nanotechnology are the current areas of our science and technology and should be included from the high school level. In this paper we discussed how, when and at what level these areas should be included in the high school curriculum.

REFERENCES :

1. Ban K. and Kocijancic S., **2011**, *2nd World Conference on Technology and Engineering Education*, 79-84, WIETE Ljubljana, Slovenia.
2. Budzik S., Ph.D. Thesis, 2011.
3. SCIENTIX NEWSLETTER, 2014.

