

# Nanotechnology Higher Education is a Unique Education

**Dr. Ali Ahmad Ansari**

*Assistant Professor of Physics Deptt. of Physics , Kishanganj College of Engineering and Technology,  
Veriadangi Kishanganj Bihar India-855107  
E-mail: aliahmadansari456@gmail.com*

---

**Abstract**—*Nanotechnology is a recent branch of technology that provides high potential educational efforts in workers, engineers and other working agents. It has many potential benefits including energy savings, alternative energy suppliers , efficient use of raw materials, biological applications, cancer treatment, environmental protection, agriculture applications medical breakthrough etc[1]. All these applications managements are related to engineering and technology education. Thus nanotechnology education to be given during undergraduate candidates mostly for engineering students is to prepare them in career related to nanotechnology education. In this paper, a comparative study of nanotechnology education course contents from several world universities are summarised in one place that provides a base for nanotechnology higher education is a unique educational system itself. The course of nanotechnology in engineering technology, secondary , senior secondary and PG level demands the entire students for the understanding of the fundamental and introduction of nanotechnology where the pre-requires courses may be pre-university Physics, Chemistry and Biology etc[2]. When comparison is done between many world universities students the result is found that some universities students lags behind the other developed universities students. The suggested guidelines can modified to address the evolving needs of nanotechnological higher education without loss of focus on mostly engineering technology higher education[3].*

**Keywords:** *Nanotechnology, unique, education, efforts.*

## **Introduction**

Nanotechnology-Nanotechnology is a field of applied science concerned with the control of matter at the dimension of approximately 1 to 100 nm. The development of micro-scale engineering in the area of electronics and computer engineering has demonstrated low cost, and high efficiency technology advancements in miniaturization. These efforts have led to the emergence of nanotechnology dealing with a wide range of engineering applications at the nano scale. During the last two decades, there have been many advances in research, development, and commercialization of nanotechnology[4]. Nanotechnology is concerned with the design, characterization, and fabrication of new materials, devices, and systems on the nanometre scale, with their

properties dramatically improved from their bulk counterpart. Nanotechnology converge several disciplines including physics, chemistry, biology, and engineering, and covers the use of quantum effects, synthesis and processing of nanoparticles, self-assembly of nanostructure, fabrication of nanostructure and devices including chemical and biological sensors. Nanoscale science and technology impact application markets such as medicine, healthcare, biotechnology, communications, electronics, etc. Realizing the potential impact of nanotechnology on science and technology and economy, all industrialized nations and some developing countries have developed a national strategy for developing nanotechnology ranging from a general science research strategy to applications-motivated strategy.

Therefore, education and training of a new generation of technicians and engineers in nanotechnology is extremely important. However, due to the interdisciplinary nature of nanotechnology, there is a major challenge for engineering and technology educators to modify the existing curricula that primarily focus on one single discipline[5].

The following sections describe research and education efforts in nanotechnology. Also are discussed the challenges that the engineering technology educators face in teaching nanotechnology as it relates to undergraduate education. The guidance for curriculum design for a baccalaureate-level nanotechnology program in the realm of engineering technology is provided[6].

Carbon nanotubes(CNT)-Carbon nanotube is a nanomaterial that can be used by nanotechnology for the fabrication of different nanodevices those are used in the field of education. After that educational process becomes easy. There are two kinds of nanotubes single walled and multiwall nanotubes. Carbon nanotubes have extra ordinary electrical and mechanical properties which in many cases exceed those of any other materials.

### Requirement of Nanotechnology Higher Education-

As we know that this education is the multidisciplinary technical education. It provides a huge impact of work force in working agents. With the increase of impact of nanotechnology education on all aspects of our daily life and the increased demand for workforce trained in nano science and technology fields, the educational institutions around the world face a big challenge that is how to integrate the nano science and technology education contents into the existing curriculums or to develop a new curriculum to meet the need of the fast growing field[7]. Some universities in developed countries that is Europe and North America have developed a variety of nano science and technology programs. These programs are mostly based on physics, chemistry, or biology, and are separated from mathematics and engineering. The developing countries, such as China and India, are also building up their research and education efforts related to nano science and technology although specific programs in nanotechnology are lacking. China started research in nanotechnology in the mid 1980s. With strong support from the central and local governments and recently from the private sector, several nation-wide nano research centers have been developed[8]. To date, more than 50 universities are engaged in research and development of nanoscience and nanotechnology in China. Several centres for research and development of nanoscience and technology have been established which include centres at Peking University, Tsinghua University, Nanjing University, Jiaotong University, East China University of Science and Technology, Fudan University, Zhejiang University, and others. The education for nanotechnology in China focuses on graduate education based on research activities in their universities and research centers. Currently, there are no nanotechnology programs in China at the undergraduate level except for programs in materials science, microelectronics, etc[9].

A variety of nanotechnology related courses or programs have been developed at the undergraduate and graduate levels. The National Nanotechnology Infrastructure Network (NNIN), an integrated networking partnership of thirteen universities supported by the NSF, provides user facilities serving the resource needs of nanoscale science, engineering and technology, and supports a wide range of educational programs. The National Nanofabrication User Network (NNUN), with Cornell University as the lead institution, offers undergraduate and graduate courses and laboratory services for nanotechnology community[10].

### Nanotechnology Higher Education in Engineering Technology

With huge investments from the government and private sector, nanotechnology has developed at a great pace during the last two decades, and so has the commercialization of nanotechnology. A key challenge to sustain this development trend is to provide needed researchers and skilled workers

with interdisciplinary backgrounds. Although many courses and programs have been developed for universities and research centers in this field to train future engineers and scientists, limited efforts have been made to train technologist and technicians. It is this great challenge that the engineering technology educators face to develop a new curriculum for nanotechnology education[10].

As the size goes down to nano scale, we need to deal with atoms interacting with each other; this is why many programs are based on chemistry and physics. On the other hand, design of devices and application of technology requires understanding of the principles of engineering; this leads to involvement of engineering in development of nanotechnology. The interdisciplinary nature of the nanotechnology field encompasses biology, chemistry, physics, materials science, engineering, computer sciences, and mathematics[11]. A program in nanotechnology in the realm of engineering technology should provide its graduates with the ability for critical understanding, characterization, and measurements of nanostructure properties; it should provide its graduates with the ability for synthesis, processing, and manufacturing of nanodevices and nanosystems. These educational objectives require students and faculty to have a thorough understanding of the basic theory and experience with hands-on activities in the nano field. The traditional curriculum has defined boundaries between these disciplines. It is a key challenge to develop nanotechnology experts with interdisciplinary skills. Engineering technology programs traditionally are less theoretical and more hands-on. A thorough grounding in physics, chemistry, biology, and mathematics is a basic requirement for nanotechnology programs, and is a great challenge for both students and educators. A variety of equipment and techniques from different disciplines is used in the development of materials and devices at the nanoscale. Many of the advanced facilities are too expensive for one individual investigator or program to own when it is not being used frequently. Therefore, collaborations between labs from different disciplines are strongly encouraged[12].

Although nanotechnology higher education is interdisciplinary in nature, one however, needs to be trained in a home discipline. One cannot be an interdisciplinary without a home discipline. Therefore, a baccalaureate degree (B.S.) in engineering technology for nanotechnology should have a different concentration depending on the home discipline. The curriculum for nanotechnology program are categorised in four parts[13].

- [A]. General Studies
- [B]Interdisciplinary Fundamental Courses
- [C] Core Courses .
- [D]. Hands-on capstone courses .

These four parts are summarised in table-1 with their different activities as demonstrated below

**Table I: The Curriculum and Resources for a Nanotechnology Higher Education Program**

Category	Resource	Collaboration
[i]General Studies	Lectures for general studies	Within the university
[ii]Interdisciplinary Fundamentals	Lectures /labs	Partnership between departments within the University
[iii]Core Courses	Lectures/labs	Collaborate inside and/or outside university
[iv]Hands-on Capstone Courses	Labs	Collaborate between Universities

In order to accomplish the curriculum requirements for nanotechnology higher education in engineering technology, a much broader collaboration is often required, as shown in Table I. Due to resource limitations of the engineering technology programs, especially the lack of advanced equipment and facilities, and sometimes faculty in the nano field, collaborations from outside of the program is advisable. The interdisciplinary fundamentals, including the basic principles of chemistry, biology, physics, mathematics, and computer science, can be accomplished with partnerships between individual departments within the university[14]. The faculty from the various diverse fields should, in general, teach the core courses relative to different concentrations.

Designing an innovative curriculum for nanotechnology in engineering technology is a complex task and requires a high level of integration. The students, the faculty, collaborating labs and participating institutions, must all work collaboratively. The graduates from this kind of a program will provide the needed workforce in nanotechnology field for the 21<sup>st</sup> century. The best advantage is that the graduates could enter the job market in a variety of areas, such as nanobio, nanoelectronics, medicine, materials, environment[15], etc.

## Conclusions

Nanotechnology education is the most recent technological education. Due to rapid development of nanotechnology higher education in engineering and sciences, education and training of a new generation of workforce skilled in nanotechnology education will play an important role in the development and applications of nanotechnology higher education in the future. It is the interdisciplinary nature to devise a mechanism to integrate nanotechnology into one's home discipline in engineering technology education is a challenge for the workers agents and engineering technology educators. It remains a great challenge for engineering technology educators to develop innovative content and novel teaching and learning tools in all fields from nanotechnology higher education.

## ACKNOWLEDGEMENT

I am indebted and grateful to my supervisor Dr. Amita Sherma Assistant Professor of Physics Deptt. of Physics, RABUB Muzafferpur Bihar for her constant guidance and encouragement for research work. My thanks to Dr. B Roy, Dr. VK Thakur and Dr.Madan Jee for their valuable suggestion for research work.

## REFERENCES

- [1]www.nsf.gov/crssprgm/nano/reports/BroaderSocIssue.pdf
- [2]AC 2007-1087:Road to nanotechnology education in engineering technology: an area of interdisciplinary studies.
- [3] Zhu, Jinwen and Varma, Virendra. "Charting a Pathway for Nanotechnology in Engineering Technology Education." Proc. of the 2006 IJME – INTERTECH Conference, Kent University, New Jersey, Oct. 2006.
- [4] Modern Engineering Physics,2008(S Chand)
- [5]Doodhew, Peter. "Education Moves to a New Scale." Nano Today, Vol. 1, No. 2, 2006, pp. 40
- [6]http://www.aznano.com.
- [7]Bai, Chunli. "Ascent of Nanoscience in China." Science, Vol. 309, No. 5731, 2005, pp. 61–63
- [8]Bacon R.J. App.phys. 31,283-290(1960).
- [9]World-Wide Web URL http://www.nanoctr.cn
- [10]Endo. Chemtech 28,568-576(1998)
- [11]World-Wide Web URL http://www.nnin.org
- [12]MRS(Material Research Society),website: http://www.mrs.org/
- [13]Elements of Nanotechnology.Education in Engineerinf curriculum Worldwide Research paper-2009
- [14] Chang, R.P.H. "A Call for Nanoscience Education." Nano Today, Vol. 1, No. 2, 2006, pp. 6.
- [15]World-Wide Web URL http://www.nclt.us.