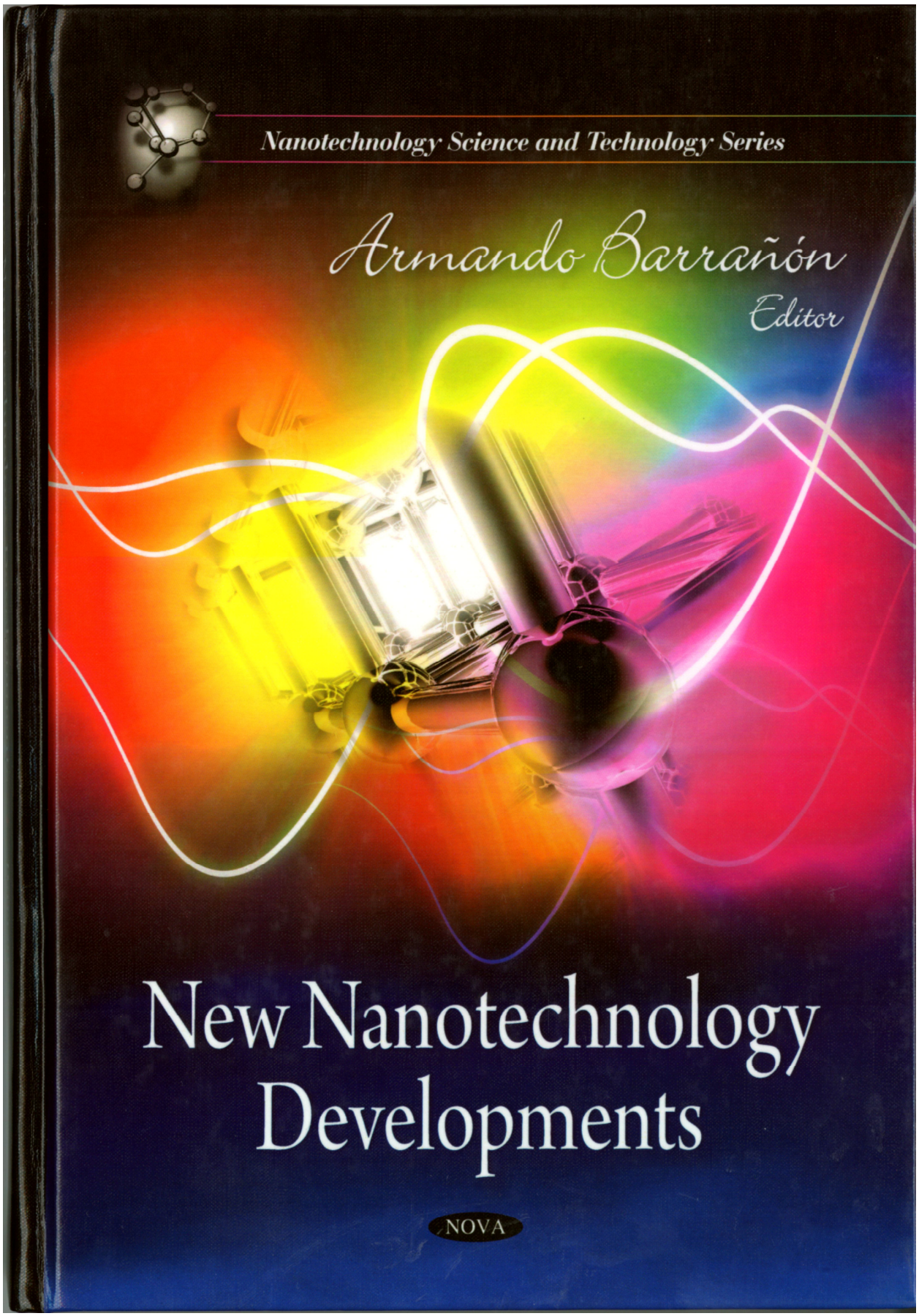
Nanotechnology Science and Technology Series
Armando Barrañón
Editor
New Nanotechnology Developments
NOVA

In: Research in Nanotechnology Developments
Editor: Armando Barrañón
ISBN: 978-1-60741-028-7

Chapter 2

CHILDREN AND TEENAGERS: SEEDS FOR A NEXT GENERATION OF NANOSCIENTISTS

LOS NIÑOS Y LOS JÓVENES: SEMILLAS DE LA PRÓXIMA GENERACIÓN DE NANOCIENTÍFICOS

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A primary factor in nanoscience strengthening is to train scientific researchers capable to understand nanometric phenomena, which requires join efforts from society and scientific community in order to attract younger students during their early academic education. The present work proposes the incorporation of seminars and workshops about nanotechnology as a part of elementary school teaching programs, this strategy will allow kids to be acquainted with areas related to nanotechnology such as mathematics, physics, biology, medicine among others . All this with the final end to increase their curiosity in nantechnology.

1. INTRODUCTION

Nowadays nanotechnology, nanoengineering and nanoscience, are areas of research with increasing relevance at the international level, this is because they are strongly linked with areas of study such as biology, chemistry, physics and mathematics, which embrace all the scientific knowledge gained so far by the Humankind (Deal, 2002).

To develop these nanoareas, research has made impressive efforts in improving and developing technologies that allow us to study and analyze the phenomena to study at

nanometric scales. Some of these improvements ranging from enhanced resolution and modes of operation in the electron microscopy, until the creation of new visualization tools as those of sonda microscopy, atomic force microscopy and tunnel effect, among others. These new microscopes allow for visualization and analysis of physical properties of materials at the nano and atomic level and they have been instrumental in generating new materials. All these developments have been used in the manufacture of what is currently called "smart materials" (Deal ,2002) .

However, this technological development, is not enough, because to exploit the potential use of nanoscience is not only necessary to invest in equipment and laboratories, but investing also in primary education and generating a genuine enthusiasm for nanoresearch in younger generations.

Based on studies in the field of learning, we know that children and young people between 7 and 16 years old, are in a stage characterized by the search for explanations of the world around them. Particularly, for ages going from 4 to 12 years, there is a critical and crucial stage for the development of their intellect and their socialization (Rico, 2004), since in this age children have the highest rate of curiosity and interpretative ability about the causes of phenomena surrounding them.

Since antiquity it is well know the lust for knowledge in children, however, nowadays children and young people are much more aware of the advantages offered by new technologies because they live immersed in them. This awareness and curiosity about the world around them, as well as children desire to transform what they already know, are useful to promote a rapprochement between children and nanoscience. The main objective of this paper is to propose some initiatives or strategies, which favor closer ties, teaching and dissemination of various areas of nanotechnology among children and young people who are in Secondary and High school.

1.2. The Problematics of Nanoeducation

The obstacles for a rapprochement between nanoscience and children, lie in two main points. First, there is a poor dissemination to the general public of knowledge and developments in the field of nanoscience, without conveying relevant applications and benefits of nanotechnology to society. And also there is a lack of recognition of children and youth as a group of high impact on scientific and technological development.

Nanotechnology is not explained in K12 instruction, since it is not included in curricula. We believe that there are three factors that govern this issue: the economic factor, the social perception about science and researchers and finally, the role of educators and nanoscientists.

1.2.1. Economic Aspect

On the economic side we know that scarce funding is directed to education and national technological development, which results in low wages to teachers, lack of resources in schools to comply with the contents of curricula, poor infrastructure for the development of scientific research, lack of support for children with fewer resources to access education. This turns into low satisfaction for faculty, students and society at large (Vazquez-Queen, 2007).

During the presentation of the report "The State of World Children 2007", Oliver Degreef, representative of UNICEF in Mexico, said that the reduction in education spending

is a danger to our country. This comment stems from the premise that "the development of a nation is directly dependent on its level of education", nevertheless the Education Federal Budget has been recently reduced (Degreef, 2006); (Amir, 2006) .

Another consequence of the low educational budget is the difficulty of updating curricula, limiting access of teachers and students to new research being conducted not only in our country nut also globally. This way that infants have a limited picture and therefore will be apathetic to research and science. However, given the importance of scientific and technological activities in its three components: i) Research and Experimental Development (IDE), ii) education and scientific and technical education (postgraduate education) and iii) science and technology and in spite of current economic perspectives, efforts are under way to invest in science and technology among which are the areas of nanotechnology, nanoengineering and nanoscience (CONACYT, 2006).

1.2.2. Social Perceptions About Science and Researchers

Some Mexicans consider that education is not a key factor for having success either as individuals or as a country. This creates a greater distance between the society and scientific activities, which explains ignorance on the part of society about the existence of nanoscience and the impact on quality of life that can be derived from studying nanosciences. An important segment of population, namely the labor sector and students' parents, do not see education as a source of support to improve their living conditions. According to recent surveys about the personal opinions of Mexicans with ages between 18 and 50 years(*¿Cómo se siente el Mexicano?*), 9.1% of this sector is interested in education. Education is almost the last in a list of six priorities for Mexicans, being Employment (84.1%) and Economics (56.9%) their top priorities (Fields and Penna, 2006). This perception is strongly influenced by the fact that many students graduate with the feeling that they lost time while studying, because they do not find work areas to apply their knowledge and end up working in another field unrelated to their major. This is results in social frustration on the part of the student, and is perceived as a waste of economic resources in the family (SEP, 2006).

Another point which feeds the estrangement between science and society is that "scientists" or "researchers" belong to a selected group, in terms of wealth and intellectual capacities, demoralizing youngsters who feel attracted to science. Besides, researchers contribute to this mythification by using an obscure language when addressing audiences which restricts social understanding of science.

1.2.3. The Role of Educators and Nanoscientists

Regardless of the education given by parents to children, in most cases the first rapprochement of children and youth with science is through their teachers who usually explain them why happen the phenomena that surround them. The role of teachers in K12 education is of great importance, not only at the level of assimilation of knowledge by students, because it is supposed to develop a positive perception on study and learning.

The problem here is that in Mexico, teachers do not receive an adequate level of job satisfaction. This feeling is mainly attributable to factors such as lack of involvement in given targets, lack of autonomy in the development of activities, not being able to be regularly updated, lack of advice and expert help, lack of recognition of their work by parents and pupils, also lack of promotion based on performance, and of course and unpleasant economic situation (Vazquez-Queen, 2007). This dissatisfaction and the fact students do not always

want to learn, discourages teachers whose frustrations and stress affect negatively students and the quality of education (Garcia-Garrido, 2004).

Scientific community shares the same factors of disappointment mainly due to the lack of recognition of their research and in most cases because of the impossibility to apply such knowledge to practice. In the specific case of nanoscientists, the challenge of overcoming the uncertainties associated with a cutting-edge science developed at an atomic scale. But nanotechnology, nanoengineering and nanoscience deal with research activities the with applications to technology, industry, biology, physics, chemistry, medicine, computer science, among many others (SEP-IPN, 2007).

Unlike educators, researchers, including nanocientists, will have no direct impact on children's perception of science although researchers are responsible for social perception of science and can be promoters of youngsters' involvement with science which might lead to the development of human resources capable to understand and create better benefitial technologies to our country.

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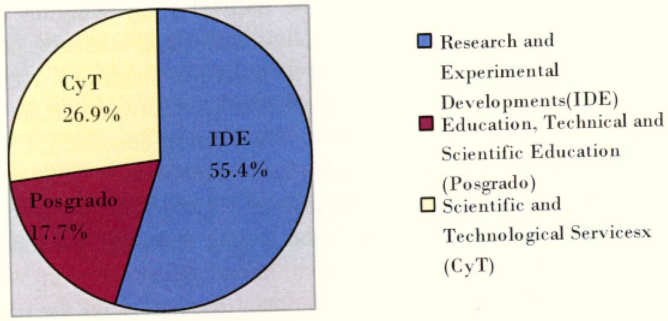

2. PROPOSAL

Our goal is to propose some strategies which favor teaching and dissemination of various areas of nanotechnology among children and young people attending K12 instruction Considering dissemination of nanoscience to K12 students, we propose:

I. I Direct collaboration between nanoscientists and educators.

This is the cornerstone of any initiative on "nanoeducation" because it is necessary to unite the skills and experience of both researchers and specialists of nanoscience with educators and K12 teachers.

Seminars aimed at K12 teachers about global research efforts on Nanoscience and Nanotechnology.

Seminars on teaching methods and groups management by K9 teachers addressed to nanoscience researchers.

Detection of K9 students' areas of interests in order to show how these areas are benefited everyday by nanotechnology. To attain this end, toys and video games can be useful as well as examples based on body performance during sickness and sport activities.

II. Links between scientists and young people

These links will enable youngsters to interact with researchers, opening the possibility for students to become acquainted with nanoresearch, sharing research experiences that will help students to develop their own research in the future. Coexistence among students and researchers can occur in schools under topics such as science week, also allowing parents to be present in these talks, so that the community begins to participate in scientific efforts.

These collaborations can lead to the development of forums aimed particularly at children and young people, where researchers are supported by teachers to convey their work to public audiences in a didactic fashion.

III. Group visits to research centers and Labs.

It is convenient for a child or young person to become acquainted with the places where nanosearch is conducted, the equipment employed, so that students have a better idea about this type of research activities, the social use of nanotechnology as well as the future impact of nanoresearch.

Development of educational materials.

Collaboration and ideas exchange between educators and researchers will help to design teaching materials useful for students, scientific and technological update of educators and enhancement of teaching strategies.

Creation of a multidisciplinary committee on "Dissemination of Nanoscience and Nanotechnology". This will be a committee composed of K12 instructors, nanoeducators and nanoresearchers from various fields of nanoscience, promoting collaboration between educators and researchers that would allow a better organization of teaching programs, designing programs, update for educators and researchers, development of educational materials and a better attitude of students and teachers with respect to nanoscience.

3. CONCLUSIONS

Nowadays, due to social and cultural factors, children are not considered as a high impact group in regards to scientific and technological development. However, men where children deelop their character and interests at this stage. It is necessary to introduce youngsters and infants to the basics of Nanotechnology, Nanoengineering and Nanosciences, so that children may understand the importance of this research, and the role they can play in future efforts to develop such benefitial areas as environmental protection, medicine, development drugs, development of smart materials and technological developments. It is also important to note that nanoscience should be incorporated to national education programs (SEP, 2001). Another important point to stress is that the engine for bringing youth with nanoscience is the close

cooperation between educators and nanoresearchers as an optimal strategy of giving publicity to nanoscience.

ACKNOWLEDGEMENT

We are grateful to Physics Education Group of UAM-Azcapotzalco, Nanotechnology and Molecular Engineering Lab at UAM-Iztapalapa, financial support from CONACyT/104746 Fund and help from Eng. Andrés de Luna Bugallo and Eng. Israel Morales Reyes.

This work is supported by Nanotechnology and Molecular Engineering Laboratory, UAM-Izatapalapa, Mexico.

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- Fisico-chemical characterization of nanoparticular material and development of new methodologies in the field of nanotechnology with especial emphasis for industrial applications.