

**Nano Science Education
Challenges and Opportunities
North-South Dialogues**

Trieste, Italy

It is an honor to participate

NANO



The NanoTechnology Group Inc.

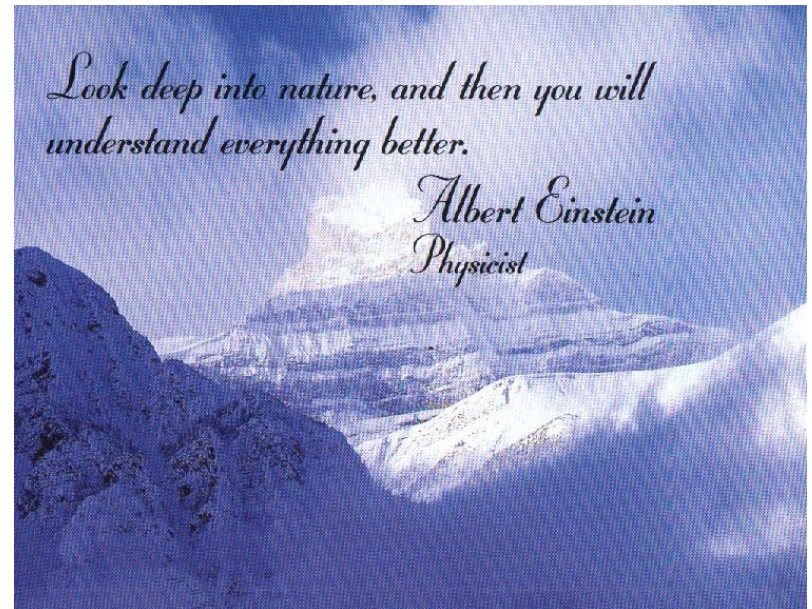
The NanoTechnology Group Inc.

A Global Education Consortium

Dedicated to advancing
Nanoscale Science Education & Awareness
To Students around the world.

Nature is our Teacher

- Science is the study of how the world works
- It is the natural foundation of a knowledge base that interweaves the patterns, rhythms and connectedness of every thing in our reality.



Conclusions of Human Resources Conference in Thailand 2003

- Find the needs of the industry in each developing country to establish plans for future nano products. Search for the supply and demand side of prospective niche products.
- Translate English teaching materials into regional languages and/or build up the students' English proficiency to follow courses in nanotechnology
- Develop informational workshops to introduce and address virtues of nanotechnology to industry.

Conclusions re: Universities

- Re-train faculties in Universities to enable them to teach nanotechnology through short term and specialized courses.
- Identify overlaps amongst faculties, learn more about each other's subjects and develop inter-and intra-departmental collaborations in Universities.
- Utilize a lecture/research combination for nanotechnology training.

Conclusions re:collaborations

- Create a network for the exchange of students amongst Universities in Asia-Pacific as well as more developed nations in Asia, Europe and America, so that final year of masters students can make use of the vast available infrastructure of the advanced countries to achieve hands-on learning experiences.
- Collaboration on textbook development preferably made available over the internet for easier dissemination of information irrespective of the buying power of students.
- Expanded modules of current syllabus to add topics specific to nano science information in biology, chemistry and mathematics.

Conclusions re: training

- Include subjects based on engineering disciplines necessary to develop the Human resources in these areas.
- Schedule interactive lectures given via electronic media from various universities and interrelated disciplines.
- The Asian Institute of Technology has followed through and put their new courses online free for global access by students.
- <http://www.nano.ait.ac.th/>

Present knowledge of semiconductor Engineers

These include a good understanding of:

- device physics,
- chemistry,
- material science,
- general manufacturing knowledge,
- and metrology,
- often with hands-on, in-line SEM (scanning electron microscopes)
and TEM (transmission electron microscope)
experience.

Refresher Math courses needed

- algebra,
- trigonometry,
- calculus (through three dimensional calculus)
- matrices,
- vector analysis,
- and fractal geometry for measurement of wavy surfaces at the nano scale.

Review seminars or courses:

- general chemistry,
- solid-state physics,
- optics,
- electricity
- and magnetism.
- These should be followed by an in-depth course on:
 - quantum mechanics
 - and quantum field theory.

Nano Specific Courses

- nanoparticles,
- MEMs,
- fullerenes,
- nanotubes (not just carbon nanotubes),
- quantum dots / wells / wires,
- and self-assembly.
- Second, the engineers will need to take a nanometrology and nanomanipulation course that is followed by a two to three month tour of duty in a nanometrology laboratory to gain the hands-on experience.

Issues at Global Universities

- Low enrollment exists for the courses that have unified the sciences and developed undergraduate and graduate nano courses. Ex: Uppsala University, Sweden with only 5 students enrolled in 2004.
- Students can compensate on their own initiative by taking a **double major in mathematics and physics** coupled with a **double minor in chemistry and biology** (or an equivalent combination of the engineering counterparts).

High School course issues

- High school students, who wish to major in nanotechnology at a University, must take advanced placement (AP), equivalent to first year college general survey class) biology, AP chemistry, and AP physics while still in high school.
- Math foundation needs to include:
- Algebra, geometry, fractal geometry, trigonometry, calculus (through 3 dimensional), matrices, vector analysis, plus some computer programming courses.

Current Education Issues

- Students graduating from high school and registering for post secondary courses have not been exposed to the paths of study necessary for nanotechnology and are not aware of the many possible paths that nano sciences and the resulting technology will involve in their future.
- Public awareness is lacking concerning nanotechnology and nano science.
- Research at <http://www.esrc.ac.uk/esrccontent/DownloadDocs/Mapdocfinal.pdf>

Alternate Solutions

- The majority of Community Colleges and Technical Colleges are in early stages of course development for the integration of nano science and technology.
<http://www.league.org/2003cit/>
- Texas State Technical College is developing nano specific courses to train technicians for the workforce with a Texas Workforce grant.
- www.TSTC.edu

1999 TIMMS RESULTS

Participating Nations by Average Score

1.China -569	11.Slovak R.-535	21.Italy-493	31.Iran -448
2.Singapore-568	12.Belgium FI-535	22.Malaysia-492	32.Indonesia-435
3.Hungary-552	13.Slovenia-533	23.Lithuania-488	33.Turkey -433
4.Japan-550	14.Canada-533	24.Thailand-482	34.Tunisia -430
5.Korea Rep.-549	15.HongKong-530	25.Romania-472	35.Chile -420
6.Netherlands-545	16.Russian F.-529	26.Isreal -468	36.Philippines 345
7.Australia-540	17.Bulgaria-518	27.Cyprus -460	37.Morocco -323
8.Czech R.-539	18.United St.-515	28.Moldova-459	38.S.Africa -243
9.England-538	19.N.Zealand-510	29.Macedonia-458	
10.Finland-535	20.Latvia-LSS-503	30.Jordan-450	

The Problems to Consider

- Experts have estimated that future demands will require 15 trained technicians for each scientist in a nanotechnology manufacturing business.
- While we are distracted with the university level courses, China, who consistently leads the world in Science and Math has started teaching nano science in primary grades 1-6 this year.

Nano Play Room in China School

- There are eight electron microscopes - which have a X1600 resolution.
- This means the students can see objects the size of a micron - which is about the size of a dust particle. Each microscope costs about \$3,000.
- Lab is for grades 1- 6.



How do they teach children so young?

- All the children go to the lab two or three times a week. Lessons are made fun and simple, especially for the younger ones.
- Grade 1 & 2 are allowed to fiddle around with the microscopes under supervision.
- They are then encouraged to talk or write stories about their experience. So as they familiarize themselves with a science lab and the objects found there, they are also improving their speaking, reading and composition skills.
- Grade 3 & 4 learn how to construct models of atomic structures, using golf balls and Lego sets.

Things get a little more in-depth in Grades 5 & 6.

- Grade 5 pupils are able to peer down microscopes to examine a strand of hair. They are then required to record their findings on worksheets which instills good research skills at an early age..
- The Grade 6 pupils also have to do a project on nanotechnology.
- Skin on hand at 1 nano meter under microscope.

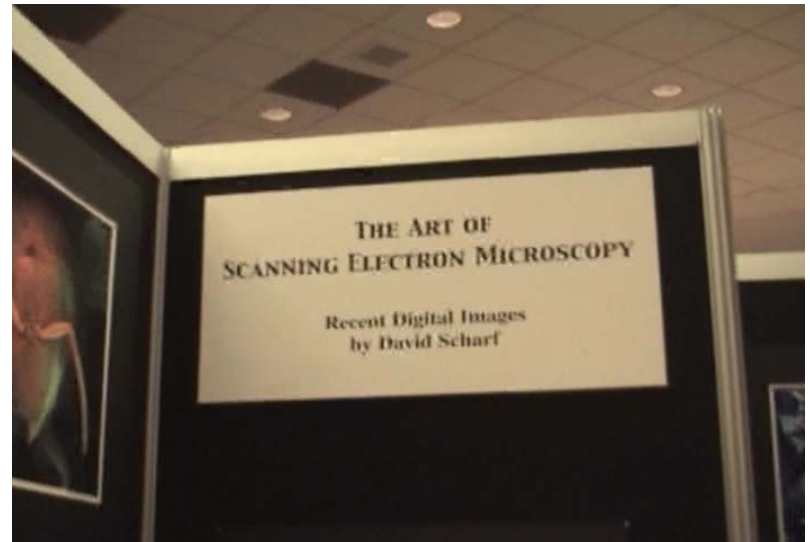


No exams or tests.

- Instead, it becomes a part of their syllabus by being integrated with other subjects. This is a key factor in the success of integration of subjects.

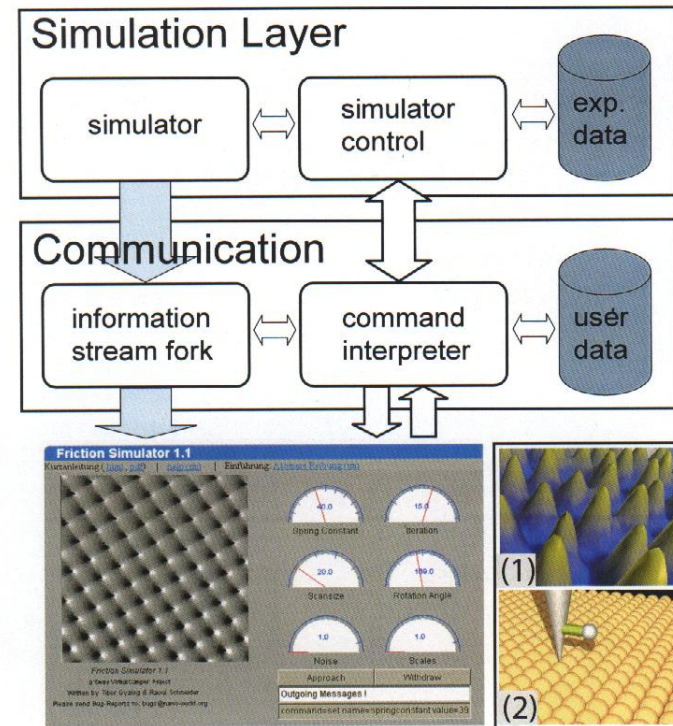
How do they integrate nano with other subjects at this young age?

- Young children are very active in a creative mode, so an art teacher can book the lab and ask her pupils to draw what they saw under the microscope.
- The natural beauty of the shapes and the colors at the nano scale stimulate a natural creativity.



Can we offer a solution to provide nano science education globally?

- Simulated virtual play rooms for grades 1-6 will be the classrooms of the future that can teach the same lessons that these young children are learning in China .
- Virtual Nano Labs can be developed for online use and digitally produced on DVD for grades 7-12.



Thank you for your attention

NANO



The NanoTechnology Group Inc.

The NanoTechnology Group Inc.
A Global Education Consortium

www.TNTG.org Judith.LightFeather@TNTG.org

A Special Thank You to our Education Resource Director
Ashley C. Cockerill, B.A. Physics, B.A. Mathematics, M.B.A.
Co-Author of Abstract

PO Box 456, Wells, TX. 75976 Ph.: 830-660-0054

TNTG Inc. 2005