

# Tools for Discovery and Learning

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# Role of the Academies

- Traditional role:

Meeting place for distinguished scientists and for the scientific debate (but remember Monteiro Lobato...)

- Currently:

- ...

- Science & Technology policy making

- Debate and validation of scientific results

- Science teaching, diffusion and popularization

# Universal science education is a must for every country

- Scientific research requires more and more talented and educated persons.
- Scientific activity is now intimately mixed with the economy and with the strategies of corporations, regions and nations.
- In developed countries, scientific activity faces increasing hostility from many groups within the public:
  - Victims from nuclear and chemical wastes
  - Opponents to genetically modified organisms
  - Defendants of animal rights
  - Opponents to innovation strategies from large corporations

# Consequences of the hostility of the public

- Denial of the “right to operate”
  - Obstruction to industrial activities
  - Aggression to animal houses
  - Destruction of experimental plant fields
- Reduced entrance of new students in the science and engineering careers

# In Brazil

- Cities and states fight for industry, including refineries
- Student demand for engineering courses is high
- Research increasingly associated to wealth and jobs
  - Only country in the world producing fuel from a renewable source at a lower price than oil
  - Competitive agribusiness (soybeans, chicken, sugar, wood), petrochemicals, steel-making, paper and pulp, cement
  - An effective program for public AIDS (SIDA) treatment supported by local production of anti-viral agents
  - *Much research has to be done here. Nobody else will do it for us.*

# Current features of the scientific and education activity

- Improved access to scientific information
  - Data bases
  - New investigation patterns
  - New frontiers of science
- Changing patterns in science making
- Science is a mass activity
- Early introduction of children to science

# Improved Access to Scientific Information

- The amount of printed papers is too large for straightforward reading.
- But new, powerful tools of information recovery are now available:
  - Internet search engines (Google...)
  - Journal databases and search engines (Chem Abstracts, Web of Science)
  - Patent databases and search engines (USPTO, Espacenet, Derwent)
  - E-publishing and access to reports

# Dissemination of the new tools

- Requires extensive use of the Internet
  - Google and other search engines, USPTO, Espacenet, e-libraries
  - Need for Internet access points in schools, community centers, churches and homes
    - Increased expenditures of Brazilian families on cable TV and Internet, down to “C” class and entering “D” class
- Requires subscription to searchable databases
  - Capes “Portal”
  - Need for teacher support centers giving access to subscribed databases
- Training teachers and students on the use of Internet facilities



# Changing patterns in the making of science

- Formerly: experimental and theoretical
- Currently, beyond theory and experiments: simulation, computation experiments
- “A New Kind of Science” (Wolfram): cellular automata
- New powerful and inexpensive tools:
  - Image acquisition and processing
  - Pattern recognition analysis
  - Inexpensive, high performance instruments and tools

# Data mining

- A new tool for discovery
  - Requires previous database construction
  - Database cross-examination
  - Tool for discovery of facts and patterns
  - Hypothesis formulation
- A local (global) example
  - Drought in the Brazilian Northeast and floods in the South.
  - EL NIÑO phenomenon in Peru (fish moving away, displacement of water currents).
  - Heating of waters in the Pacific ocean.

# Data mining requires abundant data

- On the weather, soils, waters, biota, effluents, traffic, population.
- Data acquisition requires educated human power.
- In Brazil, we do not have well-established “survey” services operating regularly and continuously for long times.
- Even in the US, “amateur” contribution to the collection of sparse data is important.
- *We could motivate hundreds of thousands of teachers and millions of students to engage in data acquisition tasks.*

# A most important actor: the science teacher

- The science taught in schools vs. the technology that surrounds the students.
  - How is steel made? (The class vs. the TV)
- The formation of new teachers
  - A second-class carrier (but with an outstanding well-to-do minority)
  - Too much debate, too little strong practice
- In-service teacher training
  - A must for Brazil
  - Many activities going on

# A recent personal experience

- “Teia do Saber”
  - Secretary of Education of São Paulo State and universities
  - Training modules with defined emphasis in methodology, specific contents, interdisciplinary topics...
  - 10-week duration (activities on Saturdays, teachers go to the campuses)
  - 30-50 trainees, 1-6 trainers per group

# Activities

## Bio, Chem, Phys for high school teachers

- **Learning science in the environment**
  - *e.g.* surface tension, surfactants, adhesion and intermolecular forces
  - Leaf surface structure and morphology: stomata...
- **Laboratory activities**
  - Inexpensive (but powerful) equipment
  - Visits to research laboratories
  - Planning experiments
  - Discussion of the observations
  - Planning of school activities
- **Use of the computer**
  - Distance education tools
  - The Internet
- **Immediate impact on teachers' practice**
- **Positive evaluation by teachers**

# Distance education tools developed at Unicamp (open software)

- Rau-Tu (<http://www.rau-tu.unicamp.br/>)
  - Questions are posed by users (open or closed group)
  - Answers are provided by a well-prepared group of university and school personnel
  - The users make continuous evaluation of the quality of the answers
  - A supervisor examines the user evaluations and verifies the answers given to users
  - FAQ section
- Nou-Rau (<http://www.rau-tu.unicamp.br/nou-rau/>)
  - File indexation and searching
  - Platform for e-library (at Unicamp, currently based on theses)
- TelEduc: a learning environment
  - Open teaching (every course within Unicamp), increasingly used for teacher training.

[http://teleduc.nied.unicamp.br/~teleduc/pagina\\_inicial/index.php](http://teleduc.nied.unicamp.br/~teleduc/pagina_inicial/index.php)



# What could be achieved

- 4K university faculty and experienced school teachers, each contributing to the improvement of 20 teachers/year:
  - 80K teachers benefiting from the contact with faculty and experienced teachers
  - 5M students benefiting from better teachers (8.5M students in high schools in Brazil)
- (Teia do Saber at Unicamp: 60 trainers, 1600 trainees)
- *Chinese programs for 25M teachers!*



# Proposals

- Concrete, feasible programs for LARGE numbers of students
- Scientific journalism committed to science and to the public
  - and free from less-respectable interests
- Open and honest attitude of scientists in face of the critical issues
- Readiness of the scientists to work with teachers, students (adult and children) and the public

