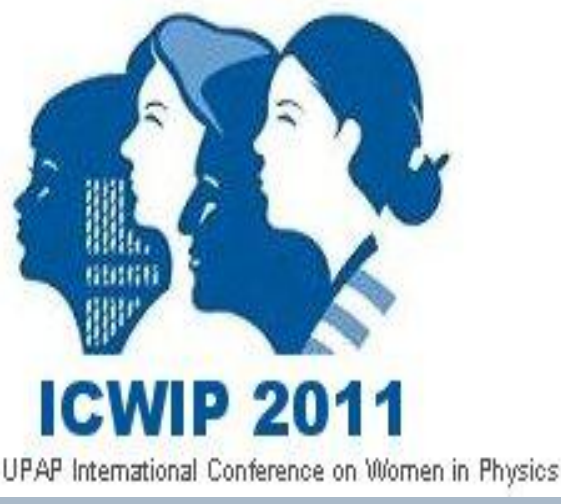


Physics Outreach in Canadian K-12 & Post-Secondary Schools: A University-Industry-Government Collaboration

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Science Education Paths in Canada

In Canada, Education is a provincial responsibility. Most of the provinces have 13 years of mandatory schooling: Kindergarten to grade 12. In Quebec, the system is slightly different: a Junior College (CEGEP: grade 12-13) is required of university bound students. Canadian schools in most provinces are divided into Elementary (grades K-6/7) and Secondary Schools (grades 7/8-12). High schools are often divided into Junior (grades 7/8-9) and Senior High Schools (10-12).

Mandated elementary science curricula include physical science as one of four main areas. Yet, Canadian elementary teachers are generalists. **Most of them have never studied physics beyond grade 11** and have insufficient math preparation. Consequently, physics is taught at a very limited level in K-7/8. In secondary schools, physics as a separate subject is taught for the first time in grade 11. However, many high school physics teachers are trained as mathematics, biology or chemistry specialists. For students, who are interested in physics, an advanced physics course (Advanced Placement or International Baccalaureate) is offered in grade 12, it is often taught by a physics teacher-specialist.

Physical Science Topics of British Columbia Elementary Science Curriculum

In British Columbia, the Ministry of Education mandates elementary teachers to teach physical science content:

- Grade K: Properties of Objects and Materials
- Grade 1: Forces and Motion; Daily and Seasonal Changes
- Grade 2: Properties of Matter; Air, Water and Soil
- Grade 3: Materials and Structures; Stars and Planets
- Grade 4: Light and Sound; Weather
- Grade 5: Forces and Simple Machines; Renewable and Non-Renewable Resources
- Grade 6: Electricity; Extreme Environments
- Grade 7: Chemistry; Earth's Crust

Students' attitudes about science are formed by grades 6-7! While leaving elementary school most students have decided if they like or dislike science.

Elementary students are also expected to be able to make observations, design experiments, control variables, develop models, do measurements, collect and interpret data, infer, hypothesize and communicate their results.

Can elementary teachers with very limited science & math background successfully teach science?

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Canadian Students' Math and Science Performance: PISA 2006

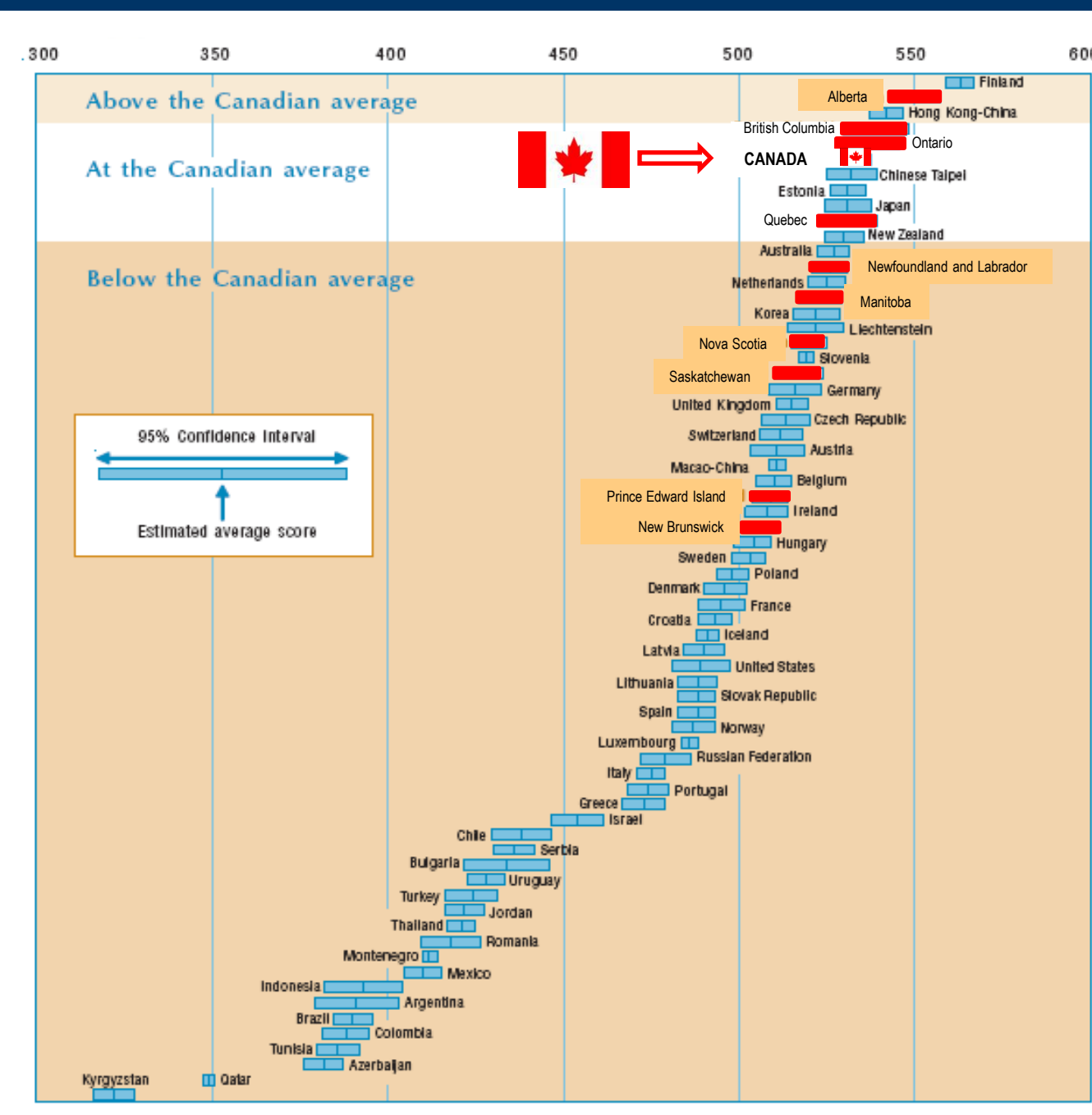


Figure 1: PISA results, OECD, 2006

Fifty Seven countries participated in the Program for International Science Assessment (PISA). Canada was 3rd, following Finland and Hong Kong-China! However, Canadian students' science performance is very uneven. Alberta is ahead, while Quebec, Ontario, and BC showing average results, and the rest of the provinces performing significantly below the Canadian average.

Scientists in Schools: British Columbia, Ontario & Atlantic Canada

Scientists & Innovators in the Schools (SIS) program helps address the need for more scientists, engineers and technicians by promoting student interest in these fields. Its goal is to inspire students with exciting, in-school presentations by real scientists. The program is offered to Grades K-12 everywhere in British Columbia, Ontario and Atlantic Canada: <http://www.scientistsinschool.ca>. The volunteers are matched with teachers who would like to have a guest speaker. The government supports them for travel arrangement and consumables. School-scientists collaborations bring science into schools inspiring thousands of students.



Figure 2: Dr. Milner-Bolotin introduces BC elementary students to air pressure: Otto Von-Guericke would have been proud.

Canadian Research Centers Collaborate with Physics Teachers

Perimeter Institute for Theoretical Physics in Waterloo, ON, The Canadian Light Source in Saskatoon, SK and TRIUMF (an accelerator in Vancouver, BC) are Canadian National Research Centres that collaborate with science teachers via offering workshops, lectures and professional development opportunities for physics teachers, students and the general public: <http://www.einsteinplus.ca/>

Let us Talk Science: All across Canada

A recent survey of Canadian 16-18 year old teens showed that only a third of them intend to take a science course at the post-secondary level, regardless of the science and technology-based career opportunities available to them. Too often Canadian teens do not think of science as an exciting career. The survey, commissioned by "Let's Talk Science" with support from Amgen Canada, underscores the importance of making science fun, relevant and accessible so that teens stay in science in high school and consider pursuing it at the post-secondary level. "Let's Talk Science" is an award-winning, Canadian national, charitable organization that delivers science learning programs and services to children and teenagers. Groups of faculty members, graduate and undergraduate students are taking their passion for science to local and regional classrooms while bringing science and science research to young people in a fun and engaging way.

Science Rendezvous: A Canada Wide Science Festival

In 2008, the National Science and Engineering Research Council of Canada and a group of scientists and science educators in Toronto, Ontario, launched a Science Rendezvous event – a city wide festival of science. This long-day event is result of a partnership between Toronto universities, hospitals, research facilities and is free for general public: <http://www.sciencerendezvous.ca/>. Since 2008, the event has spread all across Canada and keep growing annually.

Operation Minerva in Alberta

Operation Minerva is a one day job shadowing/workshop for girls in grades 8/9 to encourage them to consider science, math, engineering or technology careers. Operation Minerva has been hosted by various organizations throughout the province of Alberta for nearly 20 years. Female faculty members, graduate students, and many female science professionals in participate every year as girls' mentors.

Canada Wide Science Fair and Physics Departments' Outreach Events

Thousands of Canadian elementary and secondary students take part in local, regional, provincial and national Science Fairs. Faculty, graduate and undergraduate students, representative from industry and government help judge the event and encourage young Canadian in pursuing science fields as a future career. Science Fairs are one of the most popular science-oriented events in the country.

Physics Departments all across the country hold Science Open Door events for the general public and create physics teaching resources:

Physics Teaching for 21st Century at the University of BC: <http://c21.phas.ubc.ca>

Atlantic Canada: University-Industry Collaboration

In University of New Brunswick, one of the largest comprehensive universities in Atlantic Canada, efforts have been underway to provide science teachers with various professional development opportunities. The workshop topics are suggested by the teachers and correspond to the current curriculum. Physicists in Nova Scotia & Newfoundland partner with a not-profit company called Techsploration which matches 15-year-old girls with mentors in science, trades and technology. The girls involved in that program (10,000 girls since its inception) will have encountered 150 different science and technology professions. To reach the rest of the public and the world, Saint Mary's University has a physics demonstration website that includes videos and accompanying explanations corresponding to various physics principles from introductory physics curriculum. The site attracted over 100,000 visitors in 2010.

Physics Outreach across Canada

Canadian universities make efforts to generate student interest in science and physics from an early age by offering year-around programs and summer camps, including science & engineering camps for girls. For example, the SPARK summer science camps, offered by Wilfrid Laurier University, offers grade 2-8 students an opportunity to explore science and to work in Laurier's labs guided by senior-level science students. JUMP (Junior University Multidisciplinary Program at Wilfrid Laurier: <http://www.laurierconferences.ca/jump/WhatIs/jumpAbout.htm>) is a 3-day residential program that hosts over 2,000 grade 5-8 students annually. It offers advanced science courses for elementary students and gives teachers and students an opportunity to experience an alternative educational setting. Physics and photonics demos presented by undergraduates are especially popular among visiting high school students who want to major in physics. Female undergraduates involved in the program become true science ambassadors. The Canadian Association of Girls in Science that has chapters all across Canada is another successful example: <http://publish.uwo.ca/~cagis/>

Society for Canadian Women in Science and Technology (SCWIST)

SCWIST (<http://www.scwist.ca/>) is a non-profit association that promotes, encourages and empowers women and girls in science, engineering and technology. Among many successful SCWIST events, **Ms. Infinity programs** offered by SCWIST <http://www.scwist.ca/index.php/main/msinfinity> across the province of BC and the Yukon expose young women to interesting and exciting career options and positive female role models who are pursuing dynamic careers and education in science and technology.