Pacific CRYSTAL - Centre for Research in Youth, Science Teaching and Learning

Science literacy for our Youth

E. Van der Flier-Keller Co-Director

In 2004 NSERC Funded 5 Pilot Centres (5 years, $5 million)

New Initiative - Partner scientists and science education researchers together with the community, to

- enrich the preparation of young Canadians in math and science
- understand the skills and resources needed to improve the quality of science and math education K-12

Pacific CRYSTAL
A Team Built around Partnerships

The Community

- Teachers (118), Schools (47), School boards (8), Ministry of Education
- Outreach Groups e.g. SeaChange, SeaQuaria, World Fisheries Trust, EdGEO, CBC, BC Innovation Council, NSERC Pacific, CRD Parks (Bamfield)

Universities

- Scientists (Earth Science, Biology, Computer Science), Science Education Researchers (Curriculum and Instruction, Educational Psychology and Leadership) and CETUS (Centre of Excellence in Teaching and Understanding Science).

In Year 3, 19 Ph.D. and Masters students, and 14 P.I.'s

- University of Victoria, Simon Fraser University, Vancouver Island University

Our Goals - to address the needs expressed by the community, for engaging student science experiences and teacher professional development in science

- Research focus 1 → BUILDING

authentic, engaging, science experiences for students

- Research focus 2 → EXPANDING

these approaches into the classroom

- Research focus 3 → TEACHER LEADERSHIP

Lighthouse Schools, Teacher Professional Development and Teacher Training

1 Building Engaging Science and Technology Experiences

In Year 3 - 159 events for 4662 students

Informed by constructivist pedagogies

- Student internships in university science labs (Biology)
- First Nations science leadership development (Snitcel)
- Field based ecology programs (EcoRowing)
- Intertidal systems and aquaria in schools (Seaquaria)
- Hands-on Earth science activities (EdGEO)
- Computer science concepts through robotics (SPARCS)
- Environmental learning in the field and classroom (SFU)

Career awareness and influences on student career choices regarding science (Marshall, Earle and Cooper)

2 Expanding Science Literacy in the Classroom

Enriched math activities (High school)

Science literacy through reading, writing and oral discourse (Middle schools)

Weather unit and on-line assessment tool

Understanding the relationships between student performance in science and technology, and student, school, home and community characteristics (PISA data)

Integrating authentic science experiences

3 Knowledge Translation and Empowering Teachers in Science

- Lighthouse Schools – Strawberry Vale Elem., Glanford Middle, plans for Bowen Island Elem., a First Nations Lighthouse and a Technology Focused School
- Pre-Service Teacher Training e.g. Education Lab in First Year Earth Science, CETUS workshops
- Teacher Pro D e.g. Year 3 - 20 workshops 368 teachers, Year 4 - BC Science Teachers' Assoc Conference April 08 - 6 CRYSTAL workshops ~200 teachers,

Earth science is a very important part of Pacific CRYSTAL

- Developing Earth science activities
- Pre-service teacher training (Education Lab in first year Earth Science)
- EdGEO teacher workshops

E.G. The Education Lab, 05-07

- Hosted in EOS 120, Introduction to the Earth System II
- A dedicated lab section for students intending to become teachers (20 students per year)
- Same content as regular labs (students attended the same lectures)
- Education Lab had one additional introductory education tutorial
- Activities and teaching methods transferable to the K-10 teaching environment
- A new lab manual was developed specifically for this lab
- Labs are built on a constructivist model for science education
- Goals; - Increase student teacher confidence in, and enthusiasm for, earth science
  - Increase earth science knowledge and address misconceptions
  - Provide earth science resources for use in their first classrooms and beyond

Lab Topics

- Lab 0 – Teaching methods, Education and BC Science Curriculum
- Lab 1 – Plate tectonics
- Lab 2 – Identification of common minerals
- Lab 3 – Igneous rocks
- Lab 4 – Weathering and sedimentary rocks
- Lab 5 – Metamorphic rocks
- Lab 6 – Stratigraphy and fossils I
- Lab 7 – Stratigraphy and fossils II
- Lab 8 – Glacial and fluvial processes and landforms
- Lab 9 – Field trips and methods I
- Lab 10 – Field trips and methods II

How is the Education Lab different?

- Teaching based on Constructivist Methods

  EDU Model - Explore, Discuss, Understand
  Demonstrations
  Hands-on activities and experiments
  Think Pair Share
  Group work
  Student generated charts and diagrams
  Role Playing (e.g. seismic waves, fossil footprints)
  Rock Obituaries
  Fortunately/unfortunately stories
  Peer Teaching (and lesson planning)
  Fieldtrips

What is Constructivist Learning?

- An active process – hands-on, emphasising purposeful interaction and use of knowledge in real situations
- Challenging students to think critically
- Relating new experiences to their own previous understanding
- Involves cognitive restructuring on behalf of the student (not memorising facts), so the students must be involved in the learning process (the teacher is a stage setter and facilitator)
- Not just knowledge but also the ways of thinking in the discipline

e.g. Discovering plate tectonics

- Students figuring out how plates diverge and converge using models.
- The students had to construct the model themselves using materials available, *then* the lab instructor checked the model.

Concept development

- After hands-on activities, the students then applied their knowledge to map work, building from *concrete* experiences to *abstract* ideas—as they should as teachers.

The next generation of Teachers!

Hands (Feet) -On Activity

Trace Fossil Footprints
Peer Teaching

Evaluating the impact of the Education Lab

Human Subjects, so Step 1- Ethics Approval
Step 2 - Participant Consent

Our Evaluation Approaches

- Pre and Post lab surveys
- Student group interviews (wrap up at end of course) and comparison to a Regular Lab section 05 (same TA)
- Lab evaluations (standard procedure for all labs)
- EdGEO evaluations – requirement of EdGEO (partly funded the teacher resources)
- Student marks – course work and lab work (e.g. Lab grade, final exam and midterm exam)
- Researcher observations (incl. video of teaching lab)
- Student reflections
- Longitudinal survey to examine longer term impact

1. The Pre and Post Lab Surveys

Designed to test changes in attitude to Earth science, were misconceptions addressed, and high school Earth science experience

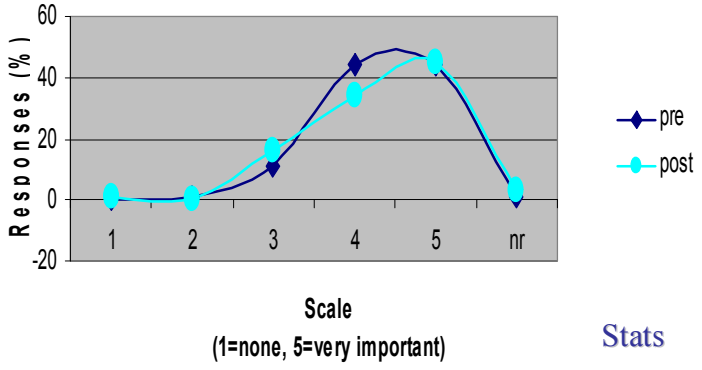
Surveys given without prior warning – results therefore represent long-term 'deep' knowledge not last minute cramming

- DATA COLLECTED
  - Prelab - demographic info, high school earth science background, enjoyment and interest in earth science, relevance to society, and knowledge questions
  - Postlab - motivation for taking the course, relevance to society, how much they thought they had learned, interest in earth science and the same set of knowledge questions as the Prelab survey

What changed?

- Attitudes to Earth science
- Interest in Earth science
- Knowledge of Earth science
- Student comments

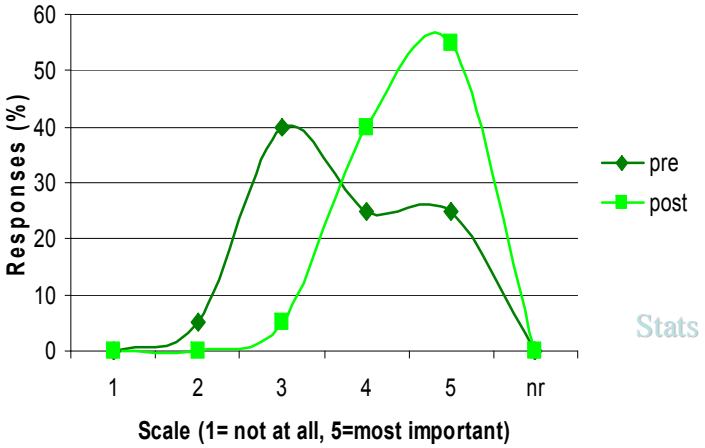
Changes in Attitude "Is Earth Science Relevant to Society" for Regular Students



Stats

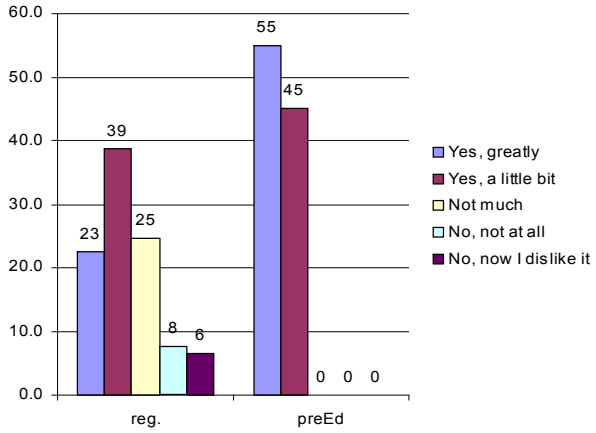
N=90, two tailed, alpha @ 0.05, tobs, 0.773< tcrit 1.97 , therefore no statistically significant difference between pre and post test views on social relevance.

Changes in Attitude “Is Earth Science Relevant to Society” for Pre-Ed Students.



N=20, p = 0.001, two tailed, alpha @ 0.05, tobs, 3.907< tcrit, 2.093 , there is a statistically significant difference between pre and post test views on social relevance in the Pre-Ed group.

“Did This Course Increase Your Interest in EOS/GEOG?”



Did the Education Lab students learn as much as their peers?

The students expressed concern ….

- Several students commented in interviews during the class and afterwards (but before the final exam) that they were concerned that they were having “too much fun to be learning earth science” as well as their peers in the regular lab sections.

FINAL COURSE RESULTS

Group	Pretest (%)	Post test (%)	Lab % (out of 50)		**Final % on the course**
Regular N=84	62.75	69.60	40.31		69.70
Pre-Ed Hopefuls N=9	51.65	66.10	41.48		70.50
Pre-Ed N=20	66.25	78.25	43.38		75.80

Examples of student comments - Earth Science Education Lab

- “A fabulous way to present science to people who are interested in teaching”
- “It provided me with many good ideas and resources that will benefit me in my career”
- “I’ve never had more fun in a lab science class before”
- “Having an Education Lab option is a great idea. It would be great to have it in more science courses”
- “Let’s make good teachers now as opposed to fixing them later”
- “Very practical resources and ideas, I can’t wait to try in a classroom”

What does this tell us?

- Students learn better using the EDU model – interactive, exploration based activities
- The other students planning to become teachers performed the same as the rest of the regular students even though they had the same motivation as the Education Lab students

Other benefits of this approach

- Peer group with the same goals could share experiences, ideas, and provide support
- Student-centred learning environment generated a positive attitude to science "no longer afraid"
- Worked with the resources they will eventually use to teach
- They were fully engaged and enjoyed Earth science → enthusiasm