DESIGNING A GEOSCIENCE CURRICULUM TO MEET THE NEEDS OF A CHANGING WORLD

Carolyn H. Eyles and Susan Vajoczki

School of Geography and Geology, McMaster University, Hamilton, Ontario, Canada

McMaster University

Background:

- McMaster University is research-intensive, student-centred
- >18,000 full-time undergraduate students.
- Canadian 'Research University of the Year' 2004 (Research Info Source Inc.)
- School of Geography and Geology (SGG) created in 1997 by amalgamation of departments of Geography and Geology
- Seven Honours B.Sc. geoscience programs replaced with single Honours B.Sc. in Earth & Environmental Sciences in 2000

Creation of SGG initiated an extensive, 3 stage process of curriculum reform and development.

Stage 1: What kind of graduate do we need to produce?

To identify the characteristics of an 'ideal' graduate we conducted a series of surveys of:

- in-program students, alumni (1986-2000), faculty
- potential employers
- co-ordinators of co-op program

Asking questions regarding:

- knowledge requirements
- skill requirements
- other requirements of an undergraduate Honours geoscience degree program

The ideal graduate should have:

- **Strong substantive knowledge**
- **Balance of breadth and depth**
- **Hands on experiences – field and lab**
- **Personal transferable skills**
- **Academic requirements for professional certification as a geoscientist in Ontario**

Other considerations:
Future employment and educational opportunities for graduates

Government: *Environment Canada, Ministry of Natural Resources, Ontario Geological Survey, National Water Research Institute, conservation authorities, land use planning....*

Private Sector: *Environmental consulting, waste management, oil and gas industry, resource exploration, mining, financial services, soft ware design.....*

Education: *Graduate and professional schools (law, medicine, dentistry), teaching...*

Stage 2: Curriculum design: Meeting the needs

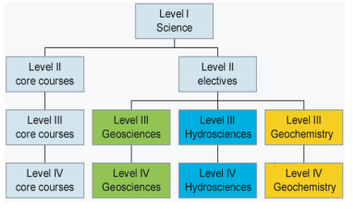
B.Sc. Hons. Earth & Environmental Sciences
The program is designed to provide students with a broad background in geoscience yet allows them to gain 'in depth' knowledge in a specialist field. Knowledge and skills considered as essential for all graduates are included as 'core' courses; experiential learning opportunities and additional skills development are systematically integrated throughout the program. Upon graduation students are well prepared for a broad range of careers or educational opportunities.

Core and specialist stream structure (breadth & depth)

- Common Level I (Science I)
- Core courses (Levels II – IV): essential for all graduates
- Specializations (Levels III - IV) Geosciences, Hydrosciences, Geochemistry
- Co-op option (entry in Level III) inc. 2 x 8 month work terms

Program structure

B.Sc. Hons. Earth & Environmental Sciences



Level				Electives
I	3 of: ▫ Calculus ▫ Statistics ▫ Math ▫ Chemsitry I 3 of: ▫ Chemistry II ▫ Physics I ▫ Physics II ▫ Biology I ▫ Biology II 2 of: ▫ Earth & Envir ▫ Atmos & Hydros ▫ Living Environment			2 courses ▫ _____ ▫ _____
	Core	**Specialization**	**Additional**	
II	5 courses ▫ Soils ▫ Earth History ▫ GIS ▫ Envir Geochemistry ▫ Hydrology		2 courses from course List A ▫ _____ ▫ _____	3 courses; if not completed Earth & Envir, Atmos & Hydros ▫ _____ ▫ _____ ▫ _____
III	3 courses ▫ Field Camp ▫ Research Methods ▫ Remote Sensing	2 courses from specialization List 1 ▫ _____ ▫ _____	3 courses from specialization List 2 ▫ _____ ▫ _____ ▫ _____	2 courses ▫ _____ ▫ _____
IV	2-3 courses ▫ Envir Assessment ▫ Research Paper or ▫ Research Thesis	3 courses from specialization List 1 ▫ _____ ▫ _____ ▫ _____	2 courses from specialization List 2 ▫ _____ ▫ _____	2 courses ▫ _____ ▫ _____

Course List A

- Envir Thought
- Climate
- Geomorphology
- Mineralogy
- Analytical Chemistry
- Organic Chemistry
- Plant Biodiversity
- Ecology

Geosciences

List 1
- Geomorphology
- Mineralogy
- Seds I
- Glaciers
- Geochemistry
- Geophysics
- Structural
- Ecology

List 2
- Geomorphology
- Mineralogy
- Sedimentology
- Glaciers
- Applied GIS
- Petrology
- Paleontology
- Geochemistry
- Envir Systems
- Geophysics
- Structural
- Coastal Envir
- Field Research
- Field Research II
- Mineralogy II
- Envir Geochronology
- Plate Tectonics & Ores
- Applied Geophysics
- Community Ecology

Hydrosciences

List 1
- Climate
- Geomorphology
- Glaciers
- Climate Change
- Physical Hydrogeology
- Structural

List 2
- Climate
- Geomorphology
- Mineralogy
- Climate Change
- Glaciers
- Applied GIS
- Limnology
- Geochemistry
- Envir Systems
- Geophysics
- Physical Hydrogeology
- Structural
- Ecosystem Biogeochemistry
- Advanced Climatology
- Field Research
- Field Research II
- Envir Geochronology
- Hydrologic Modelling

Geochemistry

List 1
- Climate
- Geomorphology
- Glaciers
- Climate Change
- Limnology
- Organic Geochemistry
- Geochemistry

List 2
- Climate
- Geomorphology
- Mineralogy
- Glaciers
- Applied GIS
- Climate Change
- Limnology
- Organic Geochemistry I
- Geochemistry
- Envir Systems
- Ecosystem Biogeochemistry
- Field Research
- Field Research II
- Environment & Health
- Organic Geochemistry II
- Envir Geochronology
- Ecology
- Population Ecology
- Contaminant Hydrogeology
- One of Analytical Chem/ Organic Chem
- One Level III Chem

Experiential learning & skills development are integrated into courses systematically from Level I through Level IV

Experiential Learning

Opportunities for 'hands on' learning are provided through fieldwork, laboratory experimentation, computer applications, use and demonstration of technical equipment (e.g. GPS, seismometers, GPR, total station). Fieldwork experiences are provided in all levels of our program.

Fieldwork

Level I
370+ students
Compulsory half day fieldtrip
Local area - 4 sites
- Niagara Escarpment
- stream modification

2 instructors, 6 TA's
many student 'volunteers'

Level II
120 students
Optional weekend fieldtrip
Earth Surface Processes
3 cave sites - Kentucky
- karst features
- groundwater

1 instructor, 3 TA's
Hotel accommodation

Level III
60+ students
Compulsory 10 day fieldcamp
Local area - techniques
N. Ontario - geologic mapping, environmental geology
2 instructors, 15 TA's
Cottage accommodation

Level IV
10 students
Optional fieldcamp to 'exotic' location
e.g. Costa Rica, Rockies, Arizona
Jointly with Univ. Toronto
2 instructors
Hotel/hostel accommodation

Skills Development:

Opportunities for development of personal transferable skills (such as oral, visual and written communication, numeracy, critical thinking, problem solving and inquiry) are systematically integrated into the Earth & Environmental Sciences program.

Inquiry skills

Level I: 'Question' format in lectures
Design and answer lab questions
Level II: 'Create an Island' lab (Earth History)
Design a field course (Surface Processes)
Level III: Research methods course
Mini-symposia
Level IV: Thesis/Research Paper

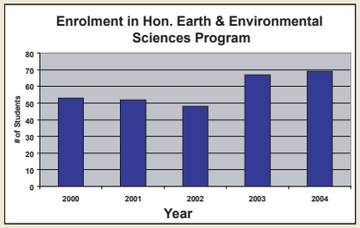
Oral communication skills

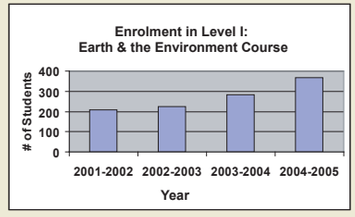
Level I: Short presentations to small group (4-5) in Rock and Mineral lab
Level II: Group presentations (10 mins) to whole lab section (25 students)
Level III: Group presentations to whole class (40+students), field presentations
Level IV: Individual presentations of independent research to whole class and invited guests

Stage 3: Is it working?

Increased student enrolment

- New program has significantly increased enrolment - in program and in courses offered by the School





Graduates of Geoscience Programs 1972-2000			
	1972	**1997**	**2000**
Canada	417	429	583
Ontario	135	143	156
SGG	7	7	22

Increases in numbers of students graduating from the SGG program exceed national and provincial gains over the period 1976 - 2000 (data from Stats Can)

Increased student and instructor satisfaction

- Positive response to new program and course structure on student evaluations
- Happy instructors!

Where do we go from here?

- **Ongoing surveys**
  - of graduating students, faculty, alumni and employers
- **Ongoing enhancement**
  - of instructional methodologies and assessment practices
- **Ongoing communication**
  - with professional certification organization (APGO)
- **Continuous audit of program**
  - to ensure integrity of systematic skills acquisition process
- **Continuous assessment of program design and content**
- **Dissemination and exchange of ideas**
  - at national and international meetings
- **Keeping in touch with the needs of our changing world!**