Geoscience Education Specialists; Merging Geoscience and Educational Expertise to Enhance Future Learning About Earth and Its Resources

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Introduction / Outline

• Why “Geoscience Education Specialists”?

• Distinction between Geoscience Educators and Geoscience Education Specialists.

• Results of having Geoscience Education Specialists embedded within UBC’s Department of Earth, Ocean and Atmospheric Sciences for 11 years.
Unique aspects of learning about the earth

Geoscience - one of the most multi-disciplinary of all STEM subjects.

- Quantitative
- Qualitative
- Chemical / Physical / Biological
- Social
- 3D & 4D thinking, at scales ranging many orders of magnitude
- “Seeing” and “observing” - and implications of what’s noticed
- Modelling; a synthesis of “what’s known ...” and “what if ...”.
- Phenomena are not “naturally” experienced in ‘normal’ life
- Decisions often use incomplete information.
- Etc ...

Therefore ... “expertise” regarding how people learn geoscience is important.
Geoscience Education Specialists: Bridging Geoscience Learning Research and Teaching Practice

Which will be most effective?
A. Train educators to think like geoscientists? 
   OR
B. Train geoscientists to employ educational proven practices?

G.E.S. Professional abilities:
• Experts in their field of geoscience.
• Well-grounded in How Learning Works, focusing on geoscience and STEM.
  – think about learning from the novice or student’s perspective;
  – understand instructors’ contexts, priorities and educational expertise;
  – distinguish between novices & experts, and understand the path from one to the other.
  – aware of both student AND instructors’ misconceptions (e.g. “expert blindness”)
• Researchers, studying strategies for effective & efficient learning about geoscience.
How to become a geoscience education specialist

• **Qualifications & Experience**
  – M.Sc. or PhD. Work experience is an asset.
  – History of supporting learning of undergraduates.
  – History of pursuing deeper understanding of “how people learn”.
  – Demonstrate a scholarly and “inquiring” attitude.

• **Training** (ideal):
  – *Graduate courses and workshops* on STEM learning and teaching within the department.
  – *Active community-of-practice*: regular facilitated meetings, reading group, workshops etc.
  – *Support and mentoring*; eg. A Department or Faculty “center of learning and teaching”.
  – *TEACH!* ... all or part of a course, at least once a year.

• **Research orientation**:
  – What does excellent learning look like?  – What’s the precedent? What’s the evidence?
“Instructor” or “Geoscience education specialist”?

**Instructors**
- Facilitate learning (teach)
- Set curriculum
- Advise / mentor students
- Assess abilities & progress
- Give feedback on learning

**Student focus**
- Subject expert
- Ensure efficiency
- Measure learning
- Stay ‘current’

**Geoscience Education Specialists**
- Support faculty innovation
- Deliver faculty prof. dev’t.
- Train graduate students
- Study how learning works & gather various types of data.
- Innovate / Research
- Disseminate
Examples of GES’s enhancing learning & teaching

• **Learning**: improve *students’* abilities to …
  – *apply* existing knowledge in novel settings;
  – *engage* productively with both content and peers;
  – develop self-directed and self-disciplined practices and **habits**;
  – receive, apply and give feedback about learning or other efforts of **peers**.

• **Teaching**: improve *instructors’* abilities to …
  – support the **organization** and **structuring** of knowledge/skills/attitudes;
  – balance solo, peer-assisted, and instructor-supported *learning*;
  – *assess* and give **feedback** using authentic, diverse, evidence-based strategies;
  – enhance **motivation** to ensure students apply necessary work and time-on-task;
  – identify and address **misconceptions** (students’ and instructors’);
  – foster a productive “**learning climate**” in classroom, lab, field and community settings.
Some specific changes GESs at UBC have supported:

- Reduce content delivery (lecturing) in favor of expert-assisted active learning tasks;
  > regular use of peer-instruction, worksheets and “clickers” (most EOAS courses now).

- Enhance student motivation;
  > introduce choice & creativity: projects with student-selected topics (1st yr course for 500+ students).

- Add “capstone” activities that emphasize integration of knowledge;
  > whole-class synthesis exercise practicing skills & framework concepts, in a final 50-minute mineralogy lesson.

- Measure – and increase – the sophistication of learning task;
  > evaluate the “cognitive level” of assignment & assessment tasks, and target a balance of levels (several courses);
  > improve questioning of all types by measuring analytics on student work (several 1st yr and Distance Ed. Courses).

All figures are from videos at http://blogs.ubc.ca/wpvc/ or the UBC Science youtube channel.
Some specific changes G.E.S’s at UBC have supported:

- Learning tasks emphasizing application in novel settings (transfer skills);
  > scaffolding of field-school requirements based on expert task deconstruction.

- Promote benefits of “learning together” (students now prefer, and ask for, group work);
  > group work in class (nearly all EOAS classes now);
  > exams with both solo AND group work = “two-stage exams” (most EOAS classes now).

- Enable hands-on laboratory experiences for large numbers of students;
  > labs, with group-based follow-up, for a class of 150 non-specialist students (1st and 3rd yr paleontology courses).
  > adapt hands-on laboratory exercises for online, distance education (several distance ed. courses).

- Teaching assistants learn about, and contribute towards, geoscience education;
  > TAs apply knowledge of “how people learn” when assisting students in most classes, labs, online or individually.

All figures are from videos at http://blogs.ubc.ca/wpvc/ or the UBC Science youtube channel.
Geoscience education R & D at UBC

- G.E.S. fte’s in UBC’s Dep’t Earth Ocean and Atmospheric Sciences
- All were focused on education enhancement.
- C. Wieman initiative: 2007 - 2013
- Other funding sources 2014 – 2018

Since 2018 at UBC ...
- Embedded Science Education Specialists in the Faculty of Science.
- So far: 5+ full time, SES “staff” positions, 1 each in most Science dep’ts.
**Geoscience education R & D at UBC**

- Funding success represents perceived “importance”.
  - CWSEI, TLEF, Science Faculty, equipment, TA grants, etc.
  - Activity has increased since CWSEI.
  - Both internal UBC funds and external donors.

- Scholarly dissemination since 2007 (minimums):
  - 21 peer reviewed publications
  - 104 presentations
  - 61 workshops given multiple times

- HQP (highly qualified personnel)
  - (8, 15) Hired academic assistants: (Grad, Ugrad)
  - (1, 4) Geoscience ed. theses: (PhD, Honors)
  - ~111 Grad students took EOAS graduate sci. ed. course
  - ~56 EOAS faculty received professional development
Geoscience Education Specialists and international curriculum development

• Partnership between UBC and University of Central Asia.
• 13 Science Education Specialists (~6.5 fte over 3yrs).
• Build a 22-course curriculum for UCA’s new B.Sc. in **Earth & Environmental Science**.
• To be taught starting Sept 2018, in English, at the new UCA campus in **Khorog, Tajikistan**.
• G.E.S’s - enhancing **future generations of Earth and Resources Scientists**, in Central Asia’s mountain regions.

https://blogs.ubc.ca/eescourses/
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<th>Description</th>
<th>Further info.</th>
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<td>1</td>
<td><strong>Bay View Alliance</strong>: EOAS one of 4 dep'ts. in longitudinal case studies of ed’n transformation (NSF-funded TRESTLE project in the USA / Canada).</td>
<td><a href="http://bayviewalliance.org/projects/course-transformation/trestle/">http://bayviewalliance.org/projects/course-transformation/trestle/</a></td>
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<td>2</td>
<td><strong>Science</strong> article: EOAS &amp; Science Education Specialists are featured.</td>
<td><a href="http://www.sciencemag.org/features/2015/09/effective-teaching-be-effective-educator-get-active">http://www.sciencemag.org/features/2015/09/effective-teaching-be-effective-educator-get-active</a></td>
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<td><strong>3M National Teaching and Learning Fellow</strong> - S. Harris - 2015.</td>
<td><a href="https://3mcouncil.stlhe.ca/resources/3m-fellows/award-winners/2015harris/">https://3mcouncil.stlhe.ca/resources/3m-fellows/award-winners/2015harris/</a></td>
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<td><strong>Videos</strong>: Exemplary teaching practices. Publically accessible collection featuring 5 EOAS, 1 math, 1phys classes.</td>
<td><a href="http://blogs.ubc.ca/wpvc/">http://blogs.ubc.ca/wpvc/</a></td>
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<td><strong>UBC Youtube</strong>: Transforming Science Education:</td>
<td><a href="https://www.youtube.com/watch?time_continue=243&amp;v=wSTIXWPu30o">https://www.youtube.com/watch?time_continue=243&amp;v=wSTIXWPu30o</a></td>
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<td><strong>Macleans Magazine</strong>: Multiple choice, multiple students: The merits of the two-stage test.</td>
<td><a href="http://www.macleans.ca/education/multiple-choice-multiple-students/">http://www.macleans.ca/education/multiple-choice-multiple-students/</a></td>
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<td><strong>Chronicle article</strong>: Dissecting the Classroom.</td>
<td><a href="https://www.chronicle.com/article/Dissecting-the-Classroom/144647">https://www.chronicle.com/article/Dissecting-the-Classroom/144647</a></td>
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<td><strong>Georgia Straight</strong>: Clickers give students incentive to go to class.</td>
<td><a href="https://www.straight.com/article-269649/clickers-give-students-incentive-go-class">https://www.straight.com/article-269649/clickers-give-students-incentive-go-class</a></td>
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<td><strong>Open Ed. text book</strong>: Practical Meteorology; Prof. Roland Stull.</td>
<td><a href="https://www.3m.eoas.ubc.ca/books/Practical_Meteorology/">https://www.3m.eoas.ubc.ca/books/Practical_Meteorology/</a></td>
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<td>12</td>
<td><strong>Geoscience tools</strong>, simulations, processing kits, case histories, from the UBC-GIF group.</td>
<td><a href="http://geosci.xyz/">http://geosci.xyz/</a></td>
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Conclusions

• Roles for **Geoscience Education Specialists** and **Instructors** do overlap, but the focus for **G.E.S’s** includes:
  – Experts on unique aspects of learning about Earth.
  – Geoscience faculty development.
  – Instructional innovation.
  – Support for instructors keen to innovate.
  – Investigating, acting upon and disseminating “evidence of effective learning”.

• Geoscience learning and education is now a legitimate, new domain of expertise.

• The G.E.S. profession is a vibrant and growing option for geoscientists.

• G.E.S’s are helping enhance education about **Earth & Resources for Future Generations.**
Examples of organizations focused upon geoscience ed.

- NAGT: National Associate of Geoscience Teachers
- NSF funded initiatives (US)
  - https://serc.carleton.edu/integrate/index.html
  - https://serc.carleton.edu/index.html
- GSA and AGU education division and annual sessions
- Europe:
  - https://www.egu.eu/education/
  - Earth science Teacher’s assoc. http://www.esta-uk.net/
- Other:
  - RFG2018! http://rgf2018.com
A few references

  - Report on outcomes of the UBC initiative.

  - Book about what worked and what didn’t.

  - In my opinion, the most succinct and complete set of guidelines for teaching and learning, every page applicable to post secondary STEM instruction.

  - Extensive metastudy of the question “does active learning work better than traditional methods?”.

  - A “white paper” about how students learn in the math, science and engineering disciplines.

  - “Effective teaching methods for geosciences need extensive research”, particularly:
    - systems approaches to geoscience,
    - spatial awareness in geoscience,
    - geological time,
    - geoscience fieldwork,
    - addressing widespread geoscience misconceptions,
    - professional development for geoscience education.