



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

~

**RFG** 2018 Session EK10

Francis Jones, UBC, Dep't Earth, Ocean & Atmospheric Sciences



THE UNIVERSITY OF BRITISH COLUMBIA

Faculty of Science



\*This slide-set licensed under  
*Creative Commons, attribution  
non-commercial share-alike.*

\* **Contact:** Francis Jones, Science Education  
Specialist, EOAS, UBC, [fjones@eoas.ubc.ca](mailto:fjones@eoas.ubc.ca)

# 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?

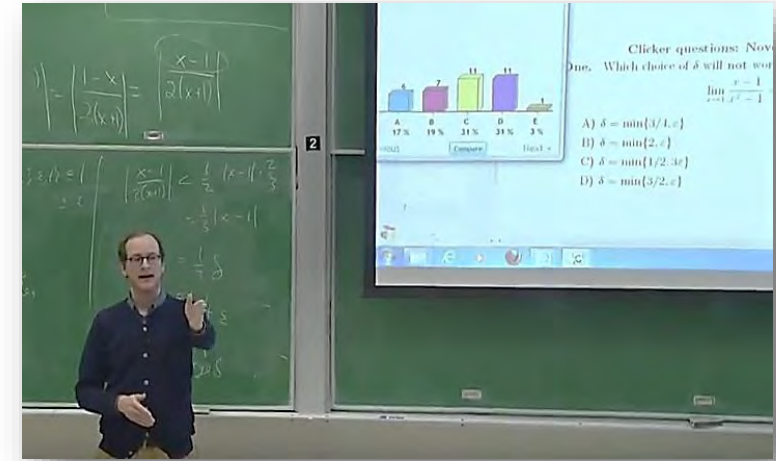
A. Train educators to think like **geoscientists**?

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?
- How to evaluate impact / effectiveness?
- What’s the precedent? What’s the evidence?
- Disseminate results.

# “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 GEs 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 (**1<sup>st</sup> 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 1<sup>st</sup> 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 (**1<sup>st</sup> and 3<sup>rd</sup> 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**.

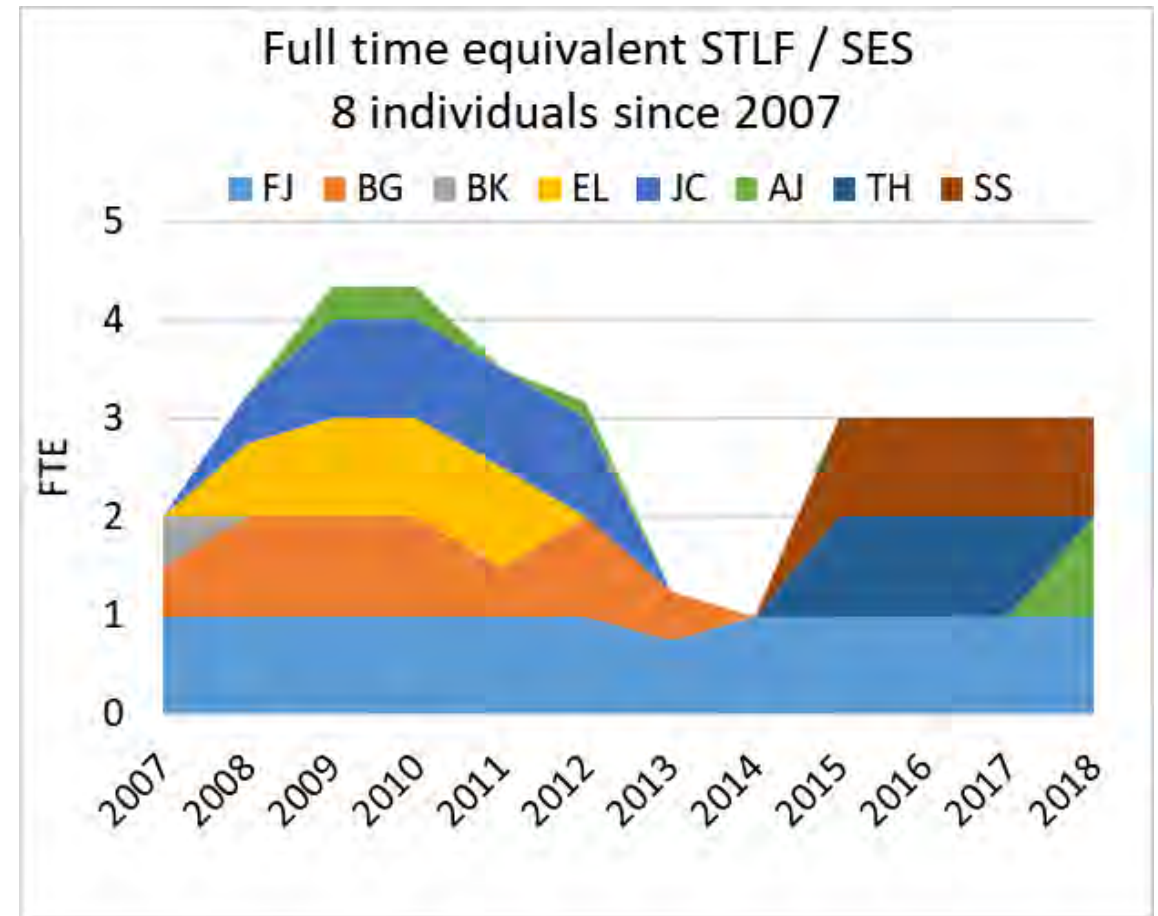


All figures are from videos at <http://blogs.ubc.ca/wpvc/> or the UBC Science youtube channel.

# 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



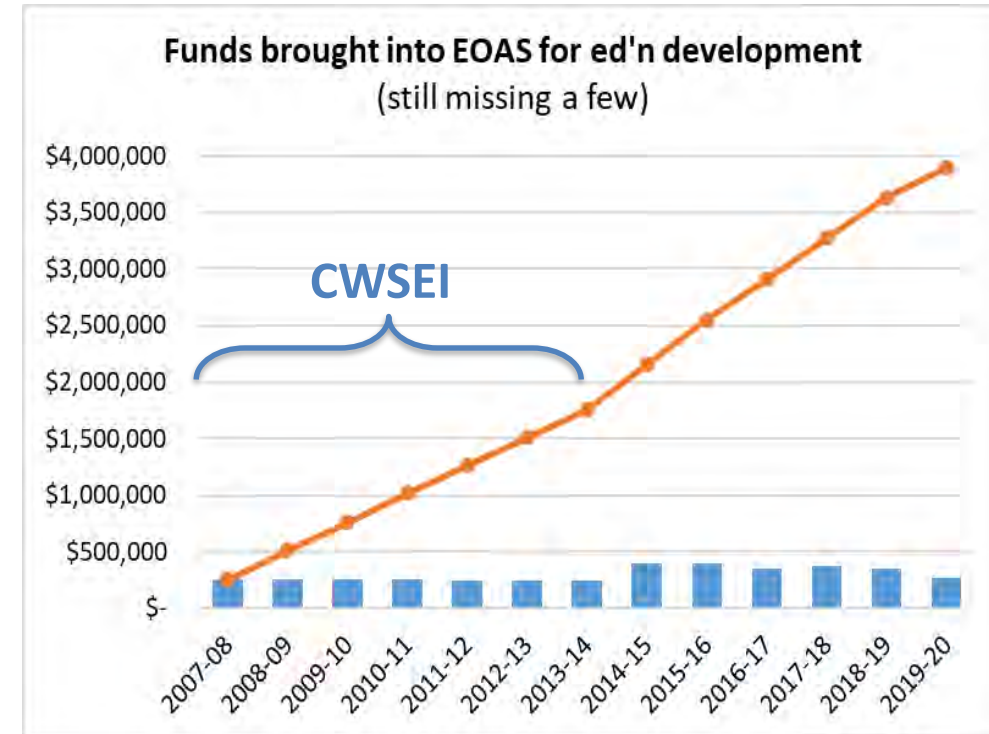
## Since 2018 at UBC ...

- 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.



UNIVERSITY  
OF CENTRAL ASIA

<https://blogs.ubc.ca/eescourses/>



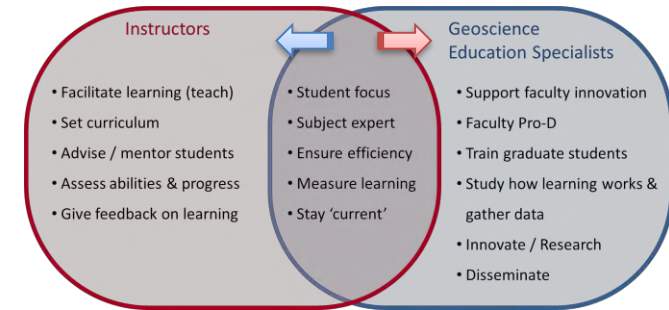
# Visibility of G.E.S. activity at UBC



<b>Descriptions</b>	<b>Further info.</b>
1 <b>Bay View Alliance:</b> EOAS one of 4 dep'ts. in longitudinal case studies of ed'n transformation (NSF-funded TRESTLE project in the USA / Canada).	<a href="http://bayviewalliance.org/projects/course-transformation/trestle/">http://bayviewalliance.org/projects/course-transformation/trestle/</a>
2 <b>Science</b> article: EOAS & Science Education Specialists are featured.	<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>
3 <b>Book:</b> <i>Improving How Universities Teach Science: Lessons from the Science Education Initiative</i> - C. Wieman, 2017, Harvard U. Press.	<a href="http://www.hup.harvard.edu/catalog.php?isbn=9780674972070">http://www.hup.harvard.edu/catalog.php?isbn=9780674972070</a>
4 <b>Book:</b> <i>Transforming Institutions: Undergraduate Stem Education for the 21st Century</i> , 2015, G.Weaver and W.Burgess Eds.	<a href="http://www.thepress.purdue.edu/titles/format/9781557537249">http://www.thepress.purdue.edu/titles/format/9781557537249</a>
5 <b>3M National Teaching and Learning Fellow</b> - S. Harris - 2015.	<a href="https://3mcouncil.stlhe.ca/resources/3m-fellows/award-winners/2015harris/">https://3mcouncil.stlhe.ca/resources/3m-fellows/award-winners/2015harris/</a>
6 <b>Videos:</b> Exemplary teaching practices. Publically accessible collection featuring 5 EOAS, 1 math, 1phys classes.	<a href="http://blogs.ubc.ca/wpvc/">http://blogs.ubc.ca/wpvc/</a>
7 <b>UBC Youtube:</b> Transforming Science Education:	<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>
8 <b>Macleans Magazine:</b> Multiple choice, multiple students: The merits of the two-stage test.	<a href="http://www.macleans.ca/education/multiple-choice-multiple-students/">http://www.macleans.ca/education/multiple-choice-multiple-students/</a>
9 <b>Chronicle article:</b> Dissecting the Classroom.	<a href="https://www.chronicle.com/article/Dissecting-the-Classroom/144647">https://www.chronicle.com/article/Dissecting-the-Classroom/144647</a>
10 <b>Georgia Straight:</b> Clickers give students incentive to go to class.	<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>
11 <b>Open Ed. text book:</b> Practical Meteorology; Prof. Roland Stull.	<a href="https://www.eoas.ubc.ca/books/Practical_Meteorology/">https://www.eoas.ubc.ca/books/Practical_Meteorology/</a>
12 <b>Geoscience tools</b> , simulations, processing kits, case histories, from the UBC-GIF group.	<a href="http://geosci.xyz/">http://geosci.xyz/</a>

# 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
  - Journal of Geoscience Education: <http://nagt-jge.org/?code=gete-site>
- 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:
  - International GeoScience Ed. Organization: <http://www.igeosced.org/>
  - **RFG2018!** <http://rfg2018.com>

# A few references



- Chasteen, S., K. Perkins, W. Code, & C. Wieman. 2016. ***“The Science Education Initiative: An Experiment in Scaling up Education Improvements at a Research University.”*** In *Transforming Institutions: Undergraduate STEM Education for the 21st Century*, edited by Gabriela C Weaver, Wilella D Burgess, Amy L Childress, and Linda Slakey. West Lafayette, Indiana: Purdue University Press.

- Report on outcomes of the UBC initiative.



- Wieman, Carl. 2017. ***“Improving How Universities Teach Science: Lessons from the Science Education Initiative”***. Harvard University Press.

- Book about what worked and what didn’t.



- Ambrose, Susan A., Michael W. Bridges, Michele DiPietro, Marsha C. Lovett, & Marie K. Norman. ***How Learning Works: Seven Research-Based Principles for Smart Teaching***. 1st ed. Jossey-Bass, 2010.

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



- Freeman, Scott, Sarah L. Eddy, Miles McDonough, Michelle K. Smith, Nnadozie Okoroafor, Hannah Jordt, and Mary Pat Wenderoth. 2014. ***“Active Learning Increases Student Performance in Science, Engineering, and Mathematics.”*** *Proceedings of the National Academy of Sciences* 111 (23): 8410–15.

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



- National Research Council. 2015. ***“Reaching Students: What Research Says About Effective Instruction in Undergraduate Science and Engineering”***. Washington, DC: The National Academies Press. <https://doi.org/10.17226/18687> .

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



- From C. King, 2008. ***“Geoscience education: an overview”***, in *Studies in Science Education*, Vol. 44, No. 2, 008, 187–222.  
***“Effective teaching methods for geosciences need extensive research”, particularly:***

- systems approaches to geoscience,
- geological time,
- addressing widespread geoscience misconceptions,
- spatial awareness in geoscience,
- geoscience fieldwork,
- professional development for geoscience education.