Eosc114 Final Project Report

Project Scope

People ("workgroup")

- Lead instructor – Roland Stull
- Lead STLF – Francis Jones
- Principle ongoing instructors – Erik Eberhardt, Stuart Sutherland, May Ver
- Recent temporary instructors/administrators – Graham Andrews, Ben Kennedy, Joel Finnis, Melissa Grey.
- Others involved (& former instructors): Sara Harris (STLF and former administrator & instructor), Brett Gilley (STLF & former instructor), Erin Lane (STLF), Mary Lou Bevier (former instructor)

Pre- and post-requisites, student background.

- Minimum entry into UBC (BC Science10, Principles of Math 11, any one grade 11 science course)
- This course is NOT required by any subsequent course at UBC

Department context (aims)

- Showcase department strengths in earth, ocean and atmospheric sciences.
- Attract students into EOS programs
- Increase student / instructor ratio in service courses

Relevant curriculum (matrix of course goals versus EOS service courses curriculum goals):

- See *Dept-Course-goalsmatrix-114.xlsx*
- See also recommendations below.

Course-level learning goals

A. For earthquakes, volcanoes, landslides, storms, waves, and meteor impacts, you will:

1. Learn how they work.
2. Locate the dangerous places where they've often occurred.
3. Learn ways to observe and monitor them.
4. Find out why it's hard to forecast them.
5. Learn what you and your community can do to prepare for them.

B. We will strive to:

1. Empower you to be a survivor.
2. Enable you to approach new challenges insightfully.
3. Sharpen your observations of nature.
4. Stimulate your excitement in our planet.

These course-goals will be modified slightly to mesh with the Faculty of Science Learning Goals, and the EOSC Dept learning goals, after they have been decided.

See also the matrix of course goals with service courses curriculum goals (*Dept-Course-goalsmatrix-114.xlsx*).

Module- or lecture-level learning goals

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Module: Fragile System - Part 1

Day 1

* List the main topic modules we will cover.
* Recognize (most of) the instructors.
* Use the i>Clicker system.
* Access content information from the online course notes and from the textbook.
* Use the course web page to anticipate learning goals, reading assignments, warm-up assessments, exams, and other scheduled events.
* Know where to go for help (web FAQs, Vista Discussion Board, ECAC).
* Actively participate with your classmates to enhance your learning

Day 2

* Explain what density is, & how it relates to stratification.
* Explain why disaster scales are based on the Order-of-Magnitude concept.
* Interpret graphs with logarithmic scales.
* Relate natural-disaster intensity to frequency & return period.
* Describe how concentration or dilution of energy relates to disasters
* Get the disaster info you need from reliable sources.

Day 3

* List the 1st and 2nd most common elements in the earth, ocean, and atmosphere.
* Describe how viscosity and compressibility relate to the phase of matter.
* Be able to diagnose the type of strain by the way a material deforms.
* Explain why gravity is a force.
* List the 5 types of energy, and describe what causes them to vary.

Day 4

* Explain (with examples) how energy conservation applies to natural disasters.
* Describe relationships between force, pressure, stress, strain, energy, and power.
* Describe population growth and explain why it is important for natural disasters.
* Explain how Earth's carrying capacity and overpopulation are related to the fate of the human race, and anticipate your role in it.

Day 5 - Explore Your Background.

* Know more about aspects of the Carl Wieman Science Education Initiative (CWSEI) and active learning.
* Use feedback about warm-up exercises to focus YOUR learning.
* Re•do the background exercise perfectly.
* Become more interested in current, global natural hazards.

Module: Earthquakes

Day 1

* Use concepts of (1) stress causing strain and (2) plastic versus brittle deformation to explain how energy is released causing earthquakes
* Recognize visual evidence of tectonic forces in rocks and landscapes (e.g. fault types)

Day 2

* Explain the global distribution of earthquakes (i.e. rare, large and frequent small quakes) in terms of tectonic plate interactions and the forces that drive them
* Describe how the Earth builds, stores, and releases energy in earthquakes
* Describe how an earthquake moves through the Earth

Day 3
* Describe how an earthquake is recorded and how to locate the epicentre
* Compare and contrast the meanings and uses of earthquake magnitude and intensity scales
* Given any structure, ground type and earthquake location, predict the types and extent of damage likely to be caused by all four seismic waves

Day 4
* Understand that earthquake prediction is difficult and why
* Difference between prediction and forecasting
* Be aware of earthquake hazards and notice how they can be the cause of other natural disasters

Day 5
* Be aware of large and local earthquakes (when are we expecting an earthquake in BC?)
* Know what to do in the event of an earthquakes (survival techniques)

Module: Volcanoes

Day 1
* What is magma?
* Why does magma erupt?
* Why is magma important?
* Why are gases are critical?

Day 2
* Why do volcanoes occur where they do?
* What are the different types of volcano?
* Why are there different types of volcano?

Day 3
* Estimate the SIZE of eruptions.
* Compare different types of eruption:
  – LAVAS
  – PYROCLASTIC FALL
  – PYROCLASTIC FLOWS
  – LAHARS (next class)
* Use them to rank the danger of probable hazards.

Day 4
* have examined the major volcanic hazards:
  – LAVAS (Wednesday)
  – PYROCLASTIC FALL (Wednesday)
  – PYROCLASTIC FLOWS
  – LAHARS
  – SECTOR COLLAPSE
  – POISONOUS GASES

* and used this knowledge to MAP major hazards around different volcanoes.

Day 5
* describe and assess different volcano monitoring techniques
* discuss the way BC's volcanoes are monitored
* evaluate hazards and risks associated with an eruption from Mount Baker

Module: Landslides
Day 1
* Explain how the socio-economic impact of landslides depends on the type and characteristics of the landslide hazard.
* Define the chief components of landslide risk.
* Distinguish the different modes of failure (falls, flows, slides, topples, and spreads) and how they are influenced by geology.
* Compare and contrast landslide causes and how they differ from landslide triggers.

Day 2
* Compare and contrast the role of causes and triggers in the occurrence of landslides.
* Assess the balance between the strength of the slope and the destabilizing forces acting on it (Factor of Safety)
* List and describe how groundwater affects shear stress and shear strength, and how it contributes towards the increased likelihood of a landslide.
* Outline the different factors, both natural and human, that contributed to the Vaiont landslide disaster.

Day 3
* Compare and contrast several of the key triggers of landslides and how they affect the force balance equation (i.e. Factor of Safety)
* Differentiate the mechanism by which liquefaction landslides develop in loose sands and sensitive clays.
* Explain why British Columbia has the highest frequency of landslides in Canada and what the future holds as the population expands into mountainous regions.
* List the different human activities that contribute to increased landslide hazards.

Day 4
* Relate the type of landslide damage expected as a function of its velocity.
* Identify tell-tale signs of an unstable slope.
* Compare and contrast avoidance, prevention, and protection strategies for dealing with landslide hazards.
* List the mitigation techniques commonly used for avoidance, prevention and protection strategies.

Module: Storms
Day 1
* Be wary of the main storm hazards.
* Describe the different types of lightning, how they form, and what happens when they strike something.
* Recognize thunderstorms, be able to identify Tstorm components, and and explain how they evolve.
* Explain how storms get their energy from the sun.

Day 2
* Explain the main characteristics that make a supercell so much nastier than a normal Tstorm.
* Be able to recognize thunderstorms in radar and satellite images.
* Explain the behavior of downbursts and gust fronts, and identify their associated cloud & dust features.

* Describe why the fact that cold air holds less water vapour is critical in explaining how Tstorms can extract energy from humid air.

Day 3
* Be able to recognize tornadoes and wall clouds.
* Explain why supercell thunderstorms spawn the most dangerous tornadoes.
* Relate the Enhanced Fujita scale to different amounts of damage.
* Describe safety procedures near tornadoes.
* Identify the times and places for high tornado risk.

Day 4
* Recognize mammatus clouds and the flanking line, and describe their relationship to Tstorms.
* Explain how vertical and horizontal winds are created by heat released in storms.
* Explain what the continuity effect is, and how it ties vertical and horizontal motions into circulations.
* Describe rain and hail hazards of Tstorms, and state actions you can take to be safe near Tstorms.

Day 5
* Identify the components of a hurricane.
* Explain how hurricanes get and utilize heat energy, and why hurricanes can exist for weeks.
* List the requirements for hurricane existence, describe how hurricanes evolve, and what causes them to die.
* Describe the risks associated with hurricanes, and appropriate safety procedures.

Module: Waves

Day 1
* Identify key properties of waves
* Use these properties to determine wave speed and behavior in either shallow or deep water
* Explain how waves move matter and energy
* Describe the forces that generate waves, eliminate waves, and return the ocean to a flat surface
* Explain the factors that determine the roughness of the sea

Day 2
* Define wave breaking, and determine when a wave will break.
* Explain differences between plunging and spilling breakers.
* Predict the type of breaker that will be found on a given beach.
* Describe how coastlines affect waves, and how waves affect coastlines.
* Compare the effects of breakers, groins, seawalls, and other structures on coastal erosion.

Day 3
* Determine how two waves will interact, and explain constructive and destructive interference.
* Discuss wave reflections, standing waves, and resonance.
* Relate wave interference and resonance to marine hazards.
* Explain how a tsunami differs from more common ocean waves.

Day 4
* Discuss why tsunami come ashore so violently.
* Describe how tsunami form.
* Identify tsunami warning signs, and know how to respond.
* Describe the processes responsible for a storm surge, and identify where in a hurricane the maximum surge will occur.

Day 5
* List 2 causes of eustatic changes in sea level.
* List 2 causes of regional changes in sea level.
* Relate these changes to risks for coastal communities.
* Describe the impact of sea ice and permafrost melt on erosion in the Arctic.
* Describe the impact of Mississippi erosion efforts on New Orleans.

Module: Impacts

TOPIC1: Extinctions

1. Concept of a biosphere `
   a. Understand the concept of a biosphere and Earth System Science and that the biosphere has evolved over time

2. Principles of Stratigraphy
   a. Distinguish between the oldest and youngest portion of a geological section using principles of superposition, original horizontality and cross cutting relationships

3. Biostratigraphy
   a. Describe the concept of faunal succession and the use of fossils in correlation and in the subdivision of Earth history
   b. Recognize the qualities that make fossils useful in biostratigraphy

4. Historical Figures
   a. Identify important historical figures in the development of stratigraphy and biostratigraphy

5. The concept of deep time
   a. Appreciate the scale of changes that can occur over geological time scales
   b. List some of the major subdivisions /ages of the geological time scale and appreciate the relative scale between the Phanerozoic and the Precambrian
   c. Understand how extinction events are linked to the structure of the geological time scale

6. Mass extinction events
   a. Define the characteristics of a mass extinction
   b. List the ‘big 5’ mass extinction events and their order through time
   c. Distinguish between broad extinction producing phenomena.
   d. Describe the late Ordovician and Permo-Triassic extinction

TOPIC 2: Case study, the K/T extinction

1. K/T Extinction
   a. Describe the character of extinctions at the K/T boundary
   b. Discuss the evidence used to support the K/T impact
   c. Describe the location and probable nature of the K/T impactor
   d. Describe the initial and long-term effects of the impact and their environmental consequences
   e. Consider other potential causes of the K/T environmental collapse

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TOPIC 3: Impacts

1. Our place in the solar system / galaxy
   a. Describe the type and location of potential impactors and rate of meteoroid influx

2. History of impacts
   a. List some of the major impact features preserved on the Earth's surface and explain why impact craters appear to be rare on Earth

3. Periodicity of mass extinctions and possible ET driving mechanisms
   a. Describe the hypothesis proposed by Raup and Sepkoski

4. Recent history of impacts and risk assessment
   a. List and describe some recent impacts and "near misses"

5. Impact risk and mitigation
   a. Understand the risk associated with an impact hazard
   b. List possible mitigation strategies and appraise their relative effectiveness

From the textbook Readings:
   a. List some of the major developments in the history of life on Earth
   b. Describe some of the features and processes of crater formation
   c. Provide examples of Canadian Impact Craters

Module: Fragile System — Part 2
DAy 1
- Synthesize your knowledge of individual disasters into a coherent understanding.
- Analyze your neighborhood's risk to various natural hazards, and recommend activities to mitigate some of the future risk.
- Critique your own and your family's preparedness. Design plans to be better prepared, and implement them.
- Evaluate the actual situation when faced with a natural disaster, make decisions based on available (often incomplete) info, and take well-reasoned action to enhance your survival.
- Make well-informed life decisions, such as where to live and work, who to vote for, how best to utilize your tax dollars. These will require you to synthesize your knowledge of disasters with broader societal issues.

(These goals will be tested in the crucible of your own life.)

- Evaluate the satisfaction of our overall course goals.
- Compare the info you gained by the end of this course to the info you wanted at the beginning of term. Decide how you can get the remaining info.
- Determine if any additional EOSC & ATSC courses can serve your needs.
- Know how to prepare for the final exam, utilizing various course resources including the Learning Goals in this table.

See *goals-Feb2009.xlsx* for correlated module and course level goals, with Bloom's level and comments.

Assessment and Feedback

Opportunities for providing students with feedback about their learning are (in order of increasing response time):
- Clicker questions
- PeerWise (peer to peer feedback; to be implemented in Fall 2009 on a trial basis)
- Homework (online)
- Midterms (all MCQ)

Feedback to instructors about students learning and their satisfaction with the course comes from:

- All student assessments above
- Final (all MCQ)
- Midterm and end of term surveys have been used, and may continue to be used as needed.

NOTE: Data (*ie* feedback about student learning) need to be USED by instructors. This is standard practice for "scientific teaching" – ie teaching practice is continuously improved by measuring and reacting to results. Therefore each instructor needs to receive the analysis and recommendations generated by an STLF, lead instructor or administrator. Beyond the transformation project, instructors would be expected to carry out some form of analysis in order to ensure their teaching is informed about it's outcomes.

Data are delivered as follows.

Clickers: Annotated "Reports" files generated by the *i>grader* program, and annotated using Word or an HTML editor to comment on the questions, their context, the response pattern, and recommendations for keeping, modifying, removing or adding.

Homework: Annotated "warmup questions" files, including

- The online quiz itself (generated by printing the Vista assessment to PDF)
- Response analysis based on (1) Vista "reports", and (2) counting all instances of all distracters.
- Annotations and recommendations for improvements.

PeerWise: Data available to the students include:

- Online access to all multiple-choice questions invented by all students that term.
- Online ratings and evaluations about the student's own question from fellow students
- Online debate/blog about questions and answers

Exams: Data include

- Copies of midterms and exams with questions numbered according to the "A" version of the test.
- Classical Item Analysis of responses, including coloured and graphed response and discrimination statistics.
- Annotations and recommendations for improvements.

Midterm and end of term surveying: Results are compiled and graphed for interpretation and comparison to previous years. Ideally comments from students should also be analyzed to discover both trends and the inevitable few but important well thought out reflection or suggestion.

- Surveys have been done using EOS in-house system since 2007, and results are accessible to instructors.
- Survey method may will change in the near future since UBC is trial-running a third party facility.

Pedagogy

- Sources of basic knowledge
  - Lecture (including online copy of lecture notes/PowerPoints)
  - Textbook (2nd edition Custom Text designed specifically for this course)
- Opportunities for active learning via PeerWise online system.
- Opportunities for solo, peer, group and whole class interactions via clicker exercises.
- Aspects of pedagogy that target consistency of learning for students, especially given multiple instructors.

Short summary of structure & rationale

This is a large lecture-based course targeting as many students with as wide range of backgrounds as possible. Distinctive characteristics of this course are

- Natural disasters are conceived as a hook for learning about Earth Science processes, and how humans and the Earth interact.
- In course learning goals, roughly equal weight is attributed to learning about processes, and learning about human effects & mitigation practices. In practice, somewhat more time is usually spent on "how things work" rather than on "what we can do about it".
- Efficient delivery from the Department's perspective is a strong determinant for decisions about how the course is run.
- The lead instructor (R. Stull) sets the tone and standards. Each module is taught by a different instructor (most of whom are not involved for more than 2 or 3 contiguous terms). They generally try to emulate the teaching style using content that is passed down from previous instructors of each module.
  But with Stull often sitting in many lectures by the other instructors and his careful review of the lecture notes, these handed-down PowerPoints are steadily getting better from term to term, in the sense that they better address the CWSEI objectives.
- The Department attempts to find instructors with expertise related to the module they teach, however the success of this varies, and many instructors are sessionals (post doctoral research fellows, PhD students, etc.). In fact, the summer version is usually taught by a single sessional instructor who definitely does not have expertise in all six modules. This should not be a problem since the level of sophistication is generally low.
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Teaching, learning and administrative structure can be summarized as follows:

- Overarching teaching goals are overseen by the lead instructor (Stull). He is a very vigorous proponent in running this course smoothly. He works with the administrator during the exam and overall course grading to ensure fairness from section to section and year to year. He also ensures that the face-to-face and distance-ed versions are synchronized in content, textbook, learning goals, and grading practices.
- Administration is handled by a sessional hired as a course administrator. This includes coordinating the test creating, scheduling of teaching, scheduling of events (review sessions, field trips, etc), supervising the TAs, coordinating ECAC, handling student administrative issues and make-up exams, updating the web page, compiling all grades including clicker participation, running the Vista warm-up homework pages, etc.
- Teaching of each module is done by each professor/instructor/sessional expert in that area. These instructors set the learning goals for their area of expertise -- but in actuality the goals created by the original experts are changed only little by subsequent experts.
- TAs provide most of the office hours (in ECAC) used by students in this course.

Materials archived

Materials, assessment results and analysis (discussed under Assessments) should be collected and packaged for easy transfer to new instructors and administrators. Two formats are recommended:

1) a well organized DVD that does NOT contain extraneous material. It needs to be organized because sorting out what's really needed can be challenging and error-prone for new instructing team members.
2) the CWSEI archive system should be used at least to begin with. This is one of the expected outcomes for receiving CWSEI support, and it results in "publically" visible resources and recommendations. Note some materials can be archived "privately" – eg exams, etc.

Normal f2f version: Packaged both as a DVD and delivered to CWSEI archive

- Module 1: Fragile System
  - PDFs of lectures + Media used (video, Flash, etc)
  - Zipped "KeyNote" collection for lectures.
  - PDFs released to students
- Module 2: Earthquakes
  - PPTs of lectures + Media used (video, Flash, etc)
  - PPTs released to students
- Module 3: Volcanoes
  - PPTs of lectures + Media used (video, Flash, etc)
  - PPTs released to students
- Module 4: Landslides
  - PPTs of lectures + Media used (video, Flash, etc)
  - PPTs released to students
- Module 5: Storms
  - PDFs of lectures + Media used (video, Flash, etc)
  - Zipped "KeyNote" collection for lectures.
  - PDFs released to students
- Module 6: Waves
  - PPTs of lectures + Media used (video, Flash, etc)
  - PPTs released to students
- Module 7: Impacts & extinctions
  - PPTs of lectures + Media used (video, Flash, etc)
  - PPTs released to students
- Module 8: last week
  - PDFs of lectures + Media used (video, Flash, etc)
  - Zipped "KeyNote" collection for lectures.
  - PDFs released to students

- PeerWise: pool of student-designed questions, to be saved by the lead instructor, and copied to the Dist Ed instructor, copied to module instructors in subsequent terms, and archived as html and other electonic files for CWSEI.
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Summer version

- PPTs of fifteen 3-hr lessons + Media used (video, Flash, etc)

Plan for sustainability

1. See also Archiving above.
2. Guidelines documents have been constructed. Whether these continue to be useful depends on if they are updated annually by the lead instructor and administrator.
   a. One such document is Guidelines for Administrators
   b. Another document is Guidelines for Team Instructors.
3. Regular pre-class briefing for all instructors in early Sept. and Jan. Agenda:
   a. De-brief previous term's clicker questions using i>grader HTML reports to view each session
   b.
4. Workshop for all instructors at start of fall term.

Share progress/problems

Dep't Mini retreat.

Recommendations

Some recommendations can be implemented immediately, but for each initiative, be sure to consider the administrator's work load, the balance of students' task load, and how feedback will be implemented for students (can they tell if it is helping their learning) and instructors (is it working as intended).

1. We have long desired to implement a required Instructor Pre-term Workshop for new instructors. However, this is difficult to enforce. Meanwhile, Stull conducts (Just-in-Time Training to the new instructors during the few days just before they start teaching, because this is the only time that the new instructors are motivated to listen. Unfortunate, but that's the reality.) See instr-workshop.doc.
2. Web content is from multiple servers :
    a. Vista for the warm-up exercises, and for displaying exam results, and
    b. the departmental web page for the course http://www.eos.ubc.ca/courses/eosc114/index.html
    c. SSC/FSC for registering, receiving final course grade, and for receiving broadcast emails.
    d. Remote content, such as from YouTube, etc.
    e. Starting in Fall 2009, an additional source of online connectivity and content will be PeerWise, maintained by Paul Denny out of New Zealand.

    Students have been handling these multiple online sources with ease. The main issues are when the internet or a web server goes down just prior to the due date of an online assignment.
3. Consider Perry Samson's LectureTools: CWSEI has video of his May 26, 2009 presentation, and see the website for further details. (But EOS-SEI fellows discouraged Stull from employing Samson's Lecture Tools. As a result, these Lecture Tools will never be used in EOSC 114.) https://www.lecturetools.org/
4. Use of TAs – currently ECAC and test checking, but other options can be considered. 27hrs/wk were allocated for ECAC in spring'09. See *D:\eossei-resources\projects\courses\eosc114\Admin-Spring09\TA Info\ECAC Spring 2009\ECACSPR2009.xls* and *D:\currentprojects\eossei\projects\TAs\08W_TA List-JAN09_FINALvrs2.xls*
5. Although the Learning Goals have been improved and refined under the EOS-SEI effort to about 80% of a max idealized quality and consistency, small refinements can still be made, as listed below. Also, as new sessionals are hired most terms to teach some of the modules, it means that their new learning goals are often not quite as refined as the goals produce by returning instructors. Thus, from term to term there are simultaneous forces to both decrease and increase the quality of the Learning Goals. Thus, it is unlikely that the Learning Goals will ever achieve 100% quality. Some desirable traits to aim for are:
    a. all learning goals are consistent with best practices for writing goals and aligning assessments;
    b. duplication and coupling among and within modules is intentional.
6. Pick most applicable (for 114) of the 50 CATs (Classroom Assessment Techniques) – see http://www.uoregon.edu/~tep/resources/newteach/fifty_cats.pdf (This won't happen unless performed by an EOS-SEI. But since EOS-SEI support for this course has ended, it means that this will never happen.)
7. Re. Clickers: need for "correct answer" is debatable. But either way (graded or participation only), the method of accumulating clicker marks is currently unwieldy. Change to the 355 approach.
8. Many of Fragile and Storms lecture slide sets include "additional material" after the "last slide". Doing this has questionable value. Stull will eliminate this extra material, starting in Fall 2009.
9. Could do with some pros and cons of making new questions every year? Or some guidelines for how to make exam building more efficient?

    This might be alleviated in future terms by using some of the best-quality questions created by students via PeerWise.
10. All the module goals need fine tuning, preferably using a consistent pattern so that there is better consistency of expectations in all modules. This is already happening under Stull's supervision.

11. Even after the formal EOS-SEI involvement in the E114 course has ended, it would be good if EOS-SEI could continue to provide occasional support as needed to experiment and test new teaching methods in this course.
12. Even after the whole CWSEI program has ended (or its funding to EOSC has ended), it would be good if the dept could establish a permanent Teaching Council of department experts to continue to maintain and promote the improvement of science teaching in all our courses.

Final Thoughts by Lead Instructor: Stull

The Wiemanization of EOSC 114 was more than a burdensome administrative exercise. All of the instructors learned many new and positive aspects of teaching and learning, which we will carry with us for the remainder of our careers. It has permanently changed our approach to teaching — for which we are thankful.

Although the EOSC 114 course has always been successful in attracting students, in the past it was somewhat superficial — an exercise in teaching and entertainment with little regard to the final knowledge gained by the students. But after Wiemanization, I feel that we are now aiming toward higher ideals of successful learning by the students — learning that the students can apply to help them live long and prosper as productive world citizens.

References & other documents

1. EOS Course Optimization Guidelines, http://www.eos.ubc.ca/research/cwsei/resources/OptimizationGuidelinesVer9.pdf and
2. Characteristics of an Optimal Course: http://www.eos.ubc.ca/research/cwsei/resources/optimal-course.pdf
3. "General Model for STLF-Faculty interactions": http://www.cwsei.ubc.ca/resources/files/STLF-faculty_interaction_description.pdf