Large TLEF Project Closure Report

Report Completion Date: 2016/05/27

PROJECT OVERVIEW

1.1. General Information

Project Title:	SCIE_EOAS_Harris: Learning Strategies and resources to enhance learning flexibility in thematically related courses		
Principal Investigator:	Dr. Sara Harris		
Project Initiation:	1 Apr 2013	Project Completion:	31 Mar 2015

1.2. Project Summary

This project aims to enhance the flexibility, quality and efficiency of learning and delivery for related DE, face-to-face and blended courses. The 3-fold approach will be to: 1) apply current DE best practices to F2F courses, 2) adapt F2F best practices for use online, and 3) introduce new resources that work in both settings. Choosing related sets of courses ensures that resources and strategies developed all will be usable in multiples courses and at various levels of our degree programs, thus providing contextual threads and consistency of learning tools throughout the principle EOAS Departmental curricula.

1.3. Team Members - *(Please fill in the following table and include **students**, undergraduate or graduate, who participated in your project).*

Name	Title/Affiliation	Responsibilities/Roles
Francis Jones	Teaching and learning fellow	Employed 70% fte on this project for it's duration. Carried out the bulk of coordination, research, development, construction and reporting of all project components.
Sara Harris	Teaching Professor	Faculty P. I. – consult and advise on all aspects, and coordinate finance.
Louise Longridge	Lecturer	Instructor of all DE sections eosc326 and eosc116. Louise took on the "risks" of trials and new active learning and assessment initiatives.
David Turner	Sessional Lecturer	Instructor of eosc118, which joined the project in year 2. Developed 4 online homework activities using techniques developed for eosc326, and contributed some virtual specimens for those activities.
Stuart Sutherland	Teaching Professor	Taught f2f sections of eosc326 in project year 1. He also developed f2f versions of eosc326 labs & classroom activities which were adapted for use in DE settings. Also permitted use of his exams during development of the BDK[1]. He also recorded gigapan images of key global geologic locations during his sabbatical leave.
Lucy Porritt	Lecturer	Taught eosc110 and supported development of the Visible Geology homework activity.
Martyn Golding	Sessional Lecturer	Co-taught f2f section eosc116 in project year 1, and supported development of online homework plus in-class activities.
Sarah Sherman	Lecturer	Co-taught f2f section eosc116 in project year 1, supported development of online homework plus in-class activities, and advised on other project components.

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[1] Bloom's Dichotomous Key. See ref. Jones, Sept 2014.

James Scoates	Professor	Taught eosc220 and permitted use of his exams during development of the BDK[1].
Kirsten Hodge	Pacific Museum of the Earth (PME) Curator	PME Curator, supported development of the PME Google Streetview virtual tour and photography of exhibits for developing virtual specimens.
Ivana Zelenika	Graduate student assistant	TA in eosc116 helped assess quality of midterm questions
Genna Patton	Graduate student assistant	TA in eosc116 and RA to this project, contributed to development of three interactive online exercises for eosc116
Rhy McMillan	Graduate student assistant	TA in eosc326; contributed to development of BDK and assessment of test questions in eosc326 and eosc220.
Calvin Kemm	Graduate student assistant	TA in eosc326, contributed to development of one interactive online exercises for eosc326.
Gabriel Lascu	CTLT: Multimedia, Graphics	Carried out photography and production of the Pacific Museum of the Earth (PME) virtual tour.

1.4. **Student Impact -** *Please fill in the following table with __past__, __current__ and __future__ courses that have been or will be impacted by your project, including any courses not included in your original proposal. [Note: Adapt this section to the context of your project as necessary].*

Course	Sections	Enrolments	Terms	Comments
Eosc326 f2f	101	~150 per yr in 1 sec'n	1	More of a source of inspiration for others in this list. Also may benefit from virtual resources and activities.
Eosc326 DE	99A, 99C, 98A	~210 per yr in 3 sec'ns	1, 2, S	Most significant and persistent changes for this project occurred in this course
Eosc116 f2f	201	~250 per yr in 1 sec'n	2	Changed with help of sessionals in 2014wc. Carry-over depends on instructors returning from leave.
Eosc116 DE	99A, 99C, 98A	~210 per yr in 3 sec'ns	1, 2, S	Persistent changes were made by adding online interactive homework.
Eosc118 DE	99A, 99C, 98A	~750 per yr in 3 sec'ns	1, 2, S	Persistent changes were made by adding online interactive homework.
Eosc110 f2f	101, 201	~400 per yr in 2 sec'ns	1, 2	Changed with help of sessionals in 2014wc. Carry-over depends on instructors returning from leave.
Eosc310 DE (future impacts)	99A, 99C, 98A	~380 per yr in 3 sec'ns	1, 2, S	Changes in 2015wc and into the future due to transfer of new pedagogies from eosc326DE by instructors Longridge and Hodge.
Eosc114 f2f (future impacts)	101, 102, 201, 202, 99A, 99C, 98C	~2100 per yr in 7 sec'ns	1, 2, S	This completed FL Project (2014-2016) is directly informing development of interactive resources and active learning pedagogies for both f2f and DE in our new 2-yr TLEF (2016-2018).
Other EOSC and ATSC distance ed and face to face service courses will all benefit because our Department has a strong culture of educational collaboration and cooperation. In particular, outcomes of the FL Project summarized in this report should contribute to refinement of learning, assessment and pedagogies to be used in the new course ATSC113.				

1. **PRODUCTS AND ACHIEVEMENTS**

    1.1. **Products and Achievements -** *Please __update__ project products and achievements as necessary. Indicate the current location of such products and provide an URL if applicable.*

Accomplishments by project component

The 10 project components identified in the project proposal are listed below as subheadings with numbers as per the proposal (See Appendix B). Corresponding accomplishments for each participating course are provided with comments and pointers. Most pointers refer to a growing repository of project outcomes, hosted at the UBC blog space starting at http://blogs.ubc.ca/eoassei/ . The reference list also points to project outcomes in the forms of posters and other materials that are accessible online.

General Remarks:

This section contains generic lessons learned related to running and coordinating a complex FL or TLEF project such as this.

- One key to success has been working with instructors who are keen to try new ideas, and who are willing to deal with challenges. Not all contract instructors (sessionals and 12-mth lecturers) can contribute time and energy, but when they do the results can be excellent. Their contributions to education development at UBC deserves more support and recognition.
- Another key is to have a "plan B" for new and innovative learning tasks, either as an alternative activity or paper version of the activity, or to be willing to adjust grading weights to address problems. Openness and good communication with students on these matters is crucial.
- Eosc326 DE (Distance Education sections)
  - Most effort during this project was applied to this course partly because of the direct correlation between recently improved f2f section and partly because the instructor (L. Longridge) designed the original DE version roughly 10 years earlier, has been teaching it ever since, and was enthusiastic about experimenting with improvements.
  - Regarding course content, the breadth vs depth ratio was reduced by removing some content. This is probably easier in service courses than in "core" courses that are required components of degree programs.
- Eosc116 DE
  - As a 1st year course, innovations were less ambitious than for the 3rd year course. Also there were no directly adaptable components of the f2f version until homework was added, one year into this FL project.
  - Content: breadth/depth ratio reduced by removing some content and associated assignments.
- Eosc118 DE
  - No changes were made until the second year of this FL project, when we were able to applied experiences from the first year's work in Eosc326 DE.
  - The instructor is very self-propelled technically and built his own learning activities involving figure annotation, use of virtual museum specimens and embedded Google forms for delivering work results and obtaining feedback from students.
- Eosc116 f2f (face to face sections): Although the instructor was on sabbatical leave, we did work with the two sessionals in this case because one (Sarah Sherman, TLF in EOAS) was helping the other improve interactive pedagogies for the course. Never-the-less, project progress was constrained because temporary instructors are too busy trying to keep up with running a course that is new to them. Accomplishments include:
  - We supported sessionals in their use of Connect.
  - We helped improve assessments using item analysis of previous tests to identify questions that needed adjustment.
  - The new sessional instructor's preparation to teach was supported during Fall of 2014. For example, two supporting documents were prepared: 1) A table linking readings and lectures, including pointers between relationships; and 2) A course schedule and student / instructor workflow table.
  - Learning goals were improved but not finalized.
  - COPUS classroom observations were conducted for each instructor in January.
- Eosc110 f2f: The sessional instructor was effective in this case because she was keen, had time, and this project's input represented one part of a three-week activity sequence.

The remaining portion of this section (2.1, Products and Achievements) is organized under headings that are numbered in accordance with project components articulated in the original project proposal (Appendix B).

1. Readings for f2f based on DE content.
- For f2f versions of eosc326, eosc116 and eosc110, support for using various aspects of CONNECT was provided, based on experiences gained using CONNECT in the DE courses. This represents and "ancillary benefit" rather than specific changes to pedagogy or content.
- Learning goals for DE and f2f were compared for both 326 & 116. However explicit alignment was not achieved because both f2f sections were taught by sessionals.
- Another "ancillary" benefit was general support we provided to temporary instructors of eosc326 and eosc116.

2. Improve online and f2f assessments
- General lessons learned:
  - A workflow was developed for exporting CONNECT Item Analysis and incorporating results into decision making about quality of questions and consistency of tests that use question sets. This is important because if questions in a "set" are not equivalent then different students may experience tests of different difficulties. Developing a workflow was necessitated by the inadequacy of existing Connect item analysis reporting.
  - Bloom's Dichotomous Key (BDK) was developed to help assess the cognitive level (not the "difficulty") of geoscience tasks or test questions. See references with links at F. Jones, Sept 2014 and F. Jones etal, Oct. 2014.
  - One explicit project objective was to adapt activities and tests or quizzes to make use of all 16 types of questions available in Connect, rather than relying entirely upon multiple choice questions. This was accomplished for the most part, although some of Connect's *potentially* promising question types ended up proving less useful than hoped. For example, it is awkward to manage student work supplied by "file submission" questions, and "hot spot" questions are too rudimentary to function successfully except in very constrained circumstances.
- Eosc326 f2f
  - BDK employed to compare tests from 2013wa to those given in 2010wa. See references with links at F. Jones, Sept 2014 and F. Jones etal, Oct. 2014.
- Eosc116 f2f
  - Pre-Post "concept test" was developed from existing (mostly published) geoscience concept questions. Used in 2014wc f2f version of the course but not 2015wc.
  - Midterm and final exams were both run as two-stage exams in 2014wc.
- Eosc326 DE
  - Workflow for using Connect Item Analysis was applied to 2 midterm tests plus the final. Recommendations for improved questions were provided to enhance both the reliability and variety (i.e. include questions other than multiple choice). To date we have no further checks on results.
  - Distribution of course components contributing to each students' final grade was substantially diversified by reducing the weight of midterms and increasing the contributions to final grades from active readings, labs and activities.
- Eosc116 DE
  - Pre-Post "concept test" was used in three terms starting 2015s.
  - Connect Item Analysis was applied to 4 of 5 module quizzes to improve both reliability and variety (i.e. include questions other than multiple choice).
  - The distribution of grades was substantially diversified by incorporating 6 homework exercises.
- Others:
  - BDK was applied in eosc220: tests given in 2013wa and 2011wa were compared. See references with links at F. Jones, Sept 2014 and F. Jones etal, Oct. 2014.

3. Clicker question enhancement
- Eosc326 f2f: Taught during this FLP in two terms, but no changes because:

- o The normal instructor (2014wa) had recently transformed the course and further support was not considered effective use of FL project time.
  - o The sessional instructor (2015wa) filling in while the normal instructor was away on leave was not able to contribute time towards developments.
- Eosc116 f2f: Sessional instructors did introduce new clicker questions in 2014wc with consulting support from this FL Project but the normal instructing team returning in 2015wc did not receive support.
- Eosc110 f2f: Clicker questions were incorporated throughout the course. In particular, the in-class activity sequence discussed later employed clicker questions to help keep students on track and provide feedback during their work. This is not a new idea, but it works very well at helping orchestrate complex group-based in-class activities in very large classes when the instructor and TAs cannot meet one-on-one with every group.

4. New in class activities
- Eosc326 f2f: same comments as item 3 "clicker question enhancement" above.
- Eosc116 f2f: same comments as item 3 "clicker question enhancement" above.

5. Online activities including group work
- General lessons learned:
  - o We developed deployment strategies for online exercises involving solo followed by small group work, including task sequencing, sketching, use of virtual specimens and museum exhibits and grading strategies.
  - o All new lab or homework activities were designed to incorporate a range of "thinking levels", including low level recall or comprehension, moderate level application or analysis, and high level synthesis or judgement tasks. As with all assessment or activity design, we have been more or less successful at this, depending upon the context and time available for iterating to improve.
  - o The Trilobite / Graptolite lab in eosc326 is our "flag-ship" example. It involves a worksheet with data entry handled using Connect "quiz" technology. Sketch annotation is a key innovation, and small group discussions about the sketching task represent a new approach to incorporating peer-instruction into asynchronous distance learning.
  - o Naming of labs, assignments, activities, etc. took 2 years to rationalize. This seems like a minor point, but it is important for efficiency, consistency, and to help students set appropriate expectations.
  - o Two models for making DE learning more active were developed:
    - ▪ Worksheet + data entry &/or "quiz": more sustainable, less engaging.
    - ▪ Activated content + data entry &/or "quiz": more engaging but requires third party production tools.
  - o "Interactive readings" were created using HotPotatoes (https://hotpot.uvic.ca/), which generates self-contained HTML & Javascript pages with mixed content and activities including MC questions, sentence-completion, crosswords, mix/match etc.
  - o Interactive figures (alone or part of interactive readings) were generated using image maps created with the help of http://www.mobilefish.com/services/image_map/image_map.php . These are more interesting intellectually than normal "forced answer" questions (like MC or mix/match), and they are easy to build.
- Eosc326 f2f:
  - o None new during this project but previous CWSEI improvements were the primary inspiration for this Flexible Learning Project and the corresponding changes to the DE version of this course.
- Eosc116 f2f:
  - o Homework was introduced 2014wc. Mostly short readings or video plus questions.

- Eosc326 DE:
  - o The original introductory exercise was converted from discussion board for whole class to small group discussions. This introduces students to their permanent small groups and gets them started using the discussion board prior to the three subsequent exercises that involve small groups.

- o The first active reading developed was a short sequence on stratigraphy. This served as a model for subsequent other active sequences in this course and in eosc116 DE. See item 1 on web-page "Online activities: examples", F. Jones 2016a.
  - o Relative Dating lab: sketching & small group work were added to an existing exercise. See item 2 on web-page "Online activities: examples", F. Jones 2016a.
  - o The original fossil ID question set that uses simple videos of specimens has been split into so-called "Follow-up Questions" for lessons 12-16. Questions are deployed as try-many, submit-once.
  - o Trilobites / Graptolites lab: A new lab exercise, based on an existing and successful hands-on lab in the f2f version of the course. This is the "flag-ship" exercise for the FL project. It involved extensive development of both pedagogy and resources, including construction of all virtual specimens (details below under "3D, video or other digitizing of specimens") and a virtual lab environment within which specimens are delivered. Item 3 on web-page "Online activities: examples", F. Jones 2016a.
  - o Burgess Shale lab. This exercise involves a worksheet followed by data-entry using Connect quiz technology. Resources are all at the Royal Ontario Museum website (http://burgess-shale.rom.on.ca/). Worksheets with tasks and resources can be provided upon request. See item 4 on web-page "Online activities: examples", F. Jones 2016a.
  - o Short essay exercise was adjusted to involve discussions within the permanent small groups of 5-8 students rather than large groups of 50 or more.
  - o Coast Fossils lab: another active reading generated with hotpotatoes, image maps and a follow-up Connect quiz. See item 5 on web-page "Online activities: examples", F. Jones 2016a.
- Eosc116 DE:
  - o Six assignments derived from eosc116.201 (f2f; 2014wc) involving videos plus 3-10 questions in Connect.
  - o Paleoclimate "active reading" (built with Hotpotatoes) plus quiz assignment introduced in term 2014wc. See item 6 on web-page "Online activities: examples", F. Jones 2016a.
  - o Paleogeography assignment involving worksheet plus quiz-like data entry, introduced 2015wc. See item 7 on web-page "Online activities: examples", F. Jones 2016a.
  - o Dinosaur assignment involving a worksheet plus quiz-like data entry, introduced 2015wc. See item 8 on web-page "Online activities: examples", F. Jones 2016a.
  - o One TA contributed towards the design and testing of all three.
  - o Group work NOT introduced. We chose to refine online small-group work techniques in eosc326 and consider group work for 1st year students later.
- Eosc118 DE:
  - o A new mineral ID exercise was developed using virtual mineral and PME museum resources, inspired somewhat by a summer "symmetry" course, introduced for UBC's Vancouver Summer Program in 2015wc. This used both high-resolution zooming images and 3D rotating (annotated) Photosynth (https://photosynth.net/) resources. See item 9 on web-page "Online activities: examples", F. Jones 2016a.
  - o A new beryl crystal interpretation sketch-based activity was introduced 2015wa. See item 10 on web-page "Online activities: examples", F. Jones 2016a.
  - o A new emerald mining sketch-based activity using a mine-site photograph was introduced 2015wa. See item 9 on web-page "Online activities: examples", F. Jones 2016a.
  - o Two ore tonnage sketch-based graphing activities were introduced 2015wa. See item 11 on web-page "Online activities: examples", F. Jones 2016a.
  - o A crustal scale cross section activity was considered but rejected.

6. 3-D, video or other digitizing of specimens
- General results:
  - o Photography equipment and software tools were acquired and will reside with the PME as a permanent resource for building virtual laboratory and/or museum specimens. Facilities include a new Nikon D5200 camera body, a

set of macro lens tubes, an inexpensive lightbox, HeliconFocusPro focus stacking software, zoomify gigapixel delivery software (receipts are available for each). A pair of Nikon zoom lenses (one old with manual focus only) was donated by an EOAS colleague to complete the virtual specimen building equipment kit. Software and other resources are referenced in more detail on the web-page "Resources and Tools" via the F. Jones 2016a reference.

- o Virtual resource design/build workflows were developed for building high resolution (stitch & zoom), rotations (3 methods), and focus stacked images and then for deploying them in practical, sustainable ways for educational purposes within the Department.
- o We learned a great deal about how & where to efficiently store and deploy resources when learning and assessment tasks are delivered using the Connect LMS.
- o Workflows were developed for generating virtual specimens using camera, lenses, lightbox, and software for gigapixel image stitching, focus stacking, zooming image deployment and video. Workflow was not documented, although this is probably something that should be done.

- Eosc326 f2f:
  - o Resources built for DE courses could be incorporated into f2f homework but this awaits the return of the principle instructor from sabbatical leave.
- Eosc326 DE:
  - o Virtual specimens were built (zooming high-resolution images and videos of "handling" the specimens) for the trilobite / graptolite lab described above. See item 3 on web-page "Online activities: examples", F. Jones 2016a.
  - o A virtual lab space was developed to emulate the space used in the f2f section of this course, using a zooming image with overlaid hotspots. See the "virtual lab space" link in item 3 of the web-page "Online activities: examples", F. Jones 2016a.
- Eosc116 DE:
  - o Resource packages were built for 3 active assignments consisting primarily of simple images with links to external readings.
- Eosc118 DE:
  - o Mineral specimens and exhibit cases in the Pacific Museum of the Earth were photographed for delivery to students using zoomify high resolution images and Photosynth rotations. See item 9 on web-page "Online activities: examples", F. Jones 2016a.

7, 8, 9; Google Earth, Gigapan, Visible Geology
- General results
  - o With support from CTLT's G. Lascu, a Google interior street view virtual tour of the Pacific Museum of the Earth was completed in Jan. 2016; see http://pme.ubc.ca/hours/virtual-tour/. Most exhibits referenced at http://pme.ubc.ca/exhibits/ include an embedded view of the virtual-tour that starts by facing the corresponding exhibit.
  - o Support was provided for S. Sutherland's GigaPan photography project which was subsequently carried out during his sabbatical leave in 2015. We have yet to process and deploy results but he has imagery of key geological outcrops in the UK, Australia, Canada and elsewhere.
  - o Background research into development of educational activities using Google Earth was carried out as part of this FL Project. This effort will be applied in our current (2016-2018) TLEF project.
- Eosc116 f2f
  - o Visible Geology was experimented with by S. Sutherland in 2013wc but it was not used by sessionals who taught the course later.
- Eosc110
  - o A new exercise for eosc110 students involving the online interactive geology structure facility called "Visible Geology" was developed as the second part of a 3-part (one part per week) activity sequence being designed by L. Porritt and B. Gilley. It was implemented as homework for eosc110 in the winter term of 2015. For a description and exercise & quiz files, see item 12 on web-page "Online activities: examples", F. Jones 2016a.

- Eosc326 DE
  - Visible Geology is used as part of the "Stratigraphy" active reading, item 1 on web-page "Online activities: examples", F. Jones 2016a.

1.2. Item(s) not Met - *Project products and achievements that were not attained and the reason(s) for this.*

Items not (or only partially) met:	Reasons:
Readings for f2f versions were not derived from DE content. Also, aligning the content and learning goals for f2f and DE versions of eosc326 & eosc116 was not achieved. Three reasons are indicated to the right.	1) The f2f instructor went on leave for 3 of 6 terms spanned by this project. 2) The focus became development of resources and pedagogic techniques enabling active learning in the asynchronous DE environment. This precluded most efforts to simply adjust aspects of course content. One exception is that some content was removed to make time for more active learning. 3) Also, the project proposal explicitly stated (under "What's Out of Scope?") that major changes to course purposes and content were not planned, and aligning content and goals between the f2f and DE versions of courses would have required such major changes.
Little progress was made improving the f2f version of eosc326.	1) The course was dramatically improved between 2010 and 2012 as part of the CWSEI, therefore it seemed unreasonable to apply much effort in this course during the Flexible Learning project. 2) Also the instructor was on leave and sessionals cannot be expected to participate in education improvement projects.
A key shortcoming: Project evaluation based on analytics from Connect was less than optimal.	The capacity for Connect to provide useful and usable analytics, BOTH on student online behavior AND their achievements, is appallingly inadequate. Many hours during this Flexible Learning project were spent trying, and there were many exchanges of communication with Connect and IT support, both of whom were most helpful.
Clicker question enhancement was only partially accomplished in one course (eosc116) for the same reasons as previous items in this list.	See the first two items in this table.
The quantity of new in class activities was also not as great as anticipated, again for reasons identified above.	See the first two items in this table.
Incorporation of GigaPan imagery was not completed although GigaPan photography was carried out.	It turns out that "GigaPan" is now somewhat outdated since photographs of any resolution are now easily stitched, and they can be deployed on the web using any of several facilities, both free and commercial. Gigapan was "state of the art" when the proposal was written, but use of high resolution and/or panoramic photography is already now fairly common practice.
The Omniglobe spherical projection system was not incorporated into learning activities.	Effort ended up being focused on developing resources and strategies involving virtual specimens. Also the museum curator (a key partner if the Omniglobe is to be used) was absent on maternity leave for some of the project.
Google Earth was not directly incorporated into learning activities, although the Google "street-view" virtual tour of the PME was completed and is coupled to Google Maps.	Interactive resources and corresponding learning strategies occupied the bulk of our time. Our subsequent (2016-2018) TLEF project will pick up where this FL project left off; i.e. to incorporate Google Earth directly into learning and assessment activities.
We had hoped to engage the Pacific Museum of the Earth (PME) as a repository for the virtual specimens and exhibits used by students to carry out learning or assessment tasks. This has begun, but is a	1) The PME curator has been away so partnering with them is on hold. But our hardware, software and web-resources are intended to be housed as virtual museum exhibits so that any courses (not just the ones involved in our project) can incorporate them into engaging learning tasks. This FLP has built exemplars of resources and learning activities

work in progress. Two points are worth mentioning:	which others will hopefully be able to emulate. 2) There are others on campus with similar interests related to virtual specimens and there are ongoing discussions about partnering across campus in virtual or augmented reality projects. This is ongoing and time consuming.
Assessment of student capabilities was to be done both before and after introducing new learning opportunities. This proved less successful than anticipated.	The reason is that material upon which students were tested changed as a result of introducing active learning strategies. However, measuring student performance along with the use of the BDK to evaluate the sophistication of tasks is anticipated to demonstrate that students are demonstrating equal success while carrying out higher level cognitive tasks than before the project.

2. PROJECT EVALUATION

2.1. Project Outcomes - *Intended outcomes or <u>benefits of the project</u> for students, TAs and/or instructors.*

Students: Based on the five project objectives in the proposal, the principle intended benefits were that students would encounter more active, experiential and/or collaborative learning in DE or blended courses; their online assessments would be more frequent and more diverse (i.e. incorporate automatic and peer-assisted grading and feedback OTHER than multiple choice quizzes); and that both expert-to-novice and group interactions would be increased.

TAs and instructors: New resources and teaching strategies will enable instructors to deliver student-centric, evidence-based instructional practices to large numbers of students using existing online technology. TAs and instructors were provided with better opportunities for engaging as experts with their students, and the feedback and assessments they provided are more high-level, diverse, effective and yet scalable to large numbers of students. Documentation for these innovations will be included.

2.2. Findings – *Please describe the findings of your project evaluation effort: to what extent were intended project outcomes achieved or not achieved? Include graphical, scenario-based or other representations.*

NOTE: Many findings noted here are illustrated on the poster presentation of Jones, Longridge and Turner, 2016 (see references for a URL).

2.2.1. Most importantly, many interactive learning tasks and corresponding virtual resources were developed, ALONG WITH corresponding strategies for orchestrating these tasks with hundreds of students. Findings related to this development work include the following, many of which are illustrated on Jones, Longridge and Turner, 2016.

2.2.1.1. Compared to f2f settings, similar tasks for distance education students need more scaffolding and more carefully managed sequences of steps.

2.2.1.2. Sketching and image annotation can be conducted online for hundreds of students and results are more efficient for grading and peer instruction than "essays". There are many reasons, not the least of which is that generative (as opposed to forced-answer) thinking can be made visible without the limitations of English language writing as a medium of communication.

2.2.1.3. Multiple choice questions can be improved based on data from analytics, but it can be very time consuming and takes significant practice.

2.2.1.4. Alternatives to multiple choice questions are practical within Connect. Again, it takes time and practice to generate meaningful tasks based on these automatically graded question types.

2.2.1.5. The balance between "breadth and depth" of content covered will shift (topics will be dropped) when more engaging pedagogies are employed. This is probably a good thing, especially for more senior courses.

2.2.1.6. The use of rubrics for all graded work was found to be appreciated by both students and TAs or instructors. They are not always easy to produce successfully the first time, but iteration is worthwhile.

2.2.2. Students spent more time on meaningful tasks other than readings (i.e. labs, assignments and group discussions), without adversely affecting self-assessed relative workloads and enthusiasm. Data from Connect reports providing analytics about user time online, page hit-rates, discussion board activity etc. can and should be effective for assessing student behavior, but they are very hard (and unreliable) to obtain from the Connect system.

2.2.3. Interestingly, workloads and enthusiasm depend significantly upon season - fall, winter, or summer terms - presumably because different groups of students take these courses in different terms. However, this has not be studied in detail. This too is illustrated on Jones, Longridge and Turner, 2016.

2.2.4. SLES (Student Learning Experiences Survey; Jones, 2016b) data showed that both a) "*answers to questions obtained via discussion board*" and b) "*discussion board interactions with other students"* were considered significantly more helpful (P<0.01 and P<0.05 respectively) after introducing small group work, compared to before when discussions were all open to everyone in the class.

2.2.5. Both task scores and feedback saying "*more help is needed*" improved during the project, suggesting we did manage to figure out how to support students in the use of new tools, resources and tasks. ALSO the activities using new facilities (especially whether the online image annotation/sketching and other activities were "liked") remained consistent and positive. Negative remarks such as "confusing" or "redundant" etc. were used to adjust subsequent versions of exercises, and negative remarks declined with time.

2.2.6. Interaction between students in required, asynchronous group discussions did increase.

2.2.7. Student products generated by groups were more consistently appropriate than products generated alone in solo portions of the exercises that are required prior to group discussions. This is one demonstration that the benefits of peer-assisted learning are evident in distance learning courses.

2.2.8. Both instructors who contributed significant time (in eosc326/116 and eosc118) were enthusiastic about incorporating more active components into their DE courses. Further comments on this aspect are below in the "Teaching Practices" section.

2.3. **Data Collection and Evaluation Method*s* -** *Please describe the data collection strategies used, how the data was analyzed, and perceived limitations.* ***Note: Please attach copies of data collection tools (e.g., surveys and interview protocols), any additional data or other relevant items.***

NOTE: Many findings noted here are illustrated on the poster presentation of Jones, Longridge and Turner, 2016 (see references for a URL).

1. Re. finding 1: these findings are based on experiences of TAs, instructors and the TLF. They are general, anecdotal, based on continuous communication among parties, and do not have specific measures to back them up. However, email threads could be perused to obtain example statements.
2. Re. finding 2: The Connect System user activity reports demonstrates increased average activity per student after introducing new virtual labs and assignments that include small group discussions.
3. Re. finding 3: Workloads and enthusiasm were measured as part of the Student Learning Experiences Survey (Jones, 2016a) in every term of the project. Data from before and early in the project represent "baseline data" against which later results were compared. For learning about students' perceptions of workloads and enthusiasm, students were asked to identify another course they are taking and indicate whether "this" course was more or less work than that other course, and whether they were more or less enthusiastic about the course.

4. Re. finding 4: These results arise from two questions in the Distance Learning version of the Student Learning Experiences Survey instrument.

5. Re. finding 5: Feedback about the activities was included in all online quiz portions of each activity in all three DE courses (eosc116, 118, 326). Usually 4-5 simple questions are posed including "how long did it take you from start-to-finish to complete this exercise?" Results of survey questions and analytics from technical questions from the first deployment of each exercise were used to update subsequent versions.

6. Re. finding 6: Connect reports were used to generate this finding, and results are illustrated in the poster (Jones, Longridge and Turner, 2016).

7. Re. finding 7: comparing solo and corresponding group work demonstrates improved outcomes. Actual discussions within small groups demonstrate that interactions are productive and that most (although not always all) students do engage in these opportunities and "learning". Examples of online conversations could be provided if desired since all group discussions are saved within the Connect system.

8. Assessment of student capabilities was to be measured by considering test scores along with results of evaluating test question sophistication using the BDK, both early and late in the project. This has yet to be completed. However, topic coverage has been reduced in favor of having students spend more time engaging in more detail with certain aspects of the subjects (in eosc326, 116, 118 and 110). Comparison of topic and learning goals lists demonstrates this shift from "breadth" towards "depth" of coverage.

9. A pre-post concept test was deployed in eosc116 for DE and for one term in f2f. This showed similar gains across 3 terms. Results to not contribute much to evaluating this Flexible Learning Project except to show capabilities and learning on those specific concepts remained consistent in the presence of changes towards more active learning tasks.

10. The effectiveness of improved in-class activities in eosc110 was further assessed by obtaining feedback from two volunteer geology faculty who were not involved in teaching the course but who kindly observed the activity sequence in classes to provide feedback. A report from these observations is available.

2.4. Dissemination – *__past__ and __future__ scholarly activities (e.g., publications, presentations, invited talks, etc.) in which you or anyone from your team have or intend to disseminate the outcomes of this project.*

- **Past:** To date we have delivered **seven** poster, presentation or workshop contributions listed in the references section below (both peer-reviewed and not). Items in the reference list include URL pointers and links to corresponding materials.
- **Future:**
  o A paper is planned for Journal of Geoscience Education titled something like "*Adapting Geoscience Resources and Active Classroom Pedagogies for Distance Education*". We have a backlog of publications being written, so it may be a year before this gets finished.
  o Several workshops and presentations directly related to this work are anticipated during the upcoming year(s) within the Faculty of Science (eg. a supper series workshop) and for broader audiences within UBC (eg possibly a "celebrate learning" workshop), especially within the interest groups identified below under "Anticipated expansions or extensions".
  o We also hope to contribute a poster or presentation at a conference on distance education or learning analytics within the upcoming year.

3. **TEACHING PRACTICES** – *Please indicate if __your__ teaching practices or those of __others__ have changed as a result of your project. If so, in what ways? Do you see these changes as sustainable over time? Why or why not?*

   3.1. Instructors of eosc326/116 and eosc118 (DE sections) have both begun incorporating lessons learned during this project into their own online teaching practices. Instructors continuing to carry out modifications and improvements

on their own after participating in a project is perhaps one of the strongest indicators that their practices have changed permanently.

For example, the eosc326 and 116 instructor declared she was "unable" to teach a DE course she took on after this project without making significant adjustments by adding assignments, rubrics and discussions. She said "*This is the first time any sort of exercise like this has been offered in eosc310 … I am just using what I know from 116/326*". Also, "*I'm trying to get some more scaffolded assignments together … so that the students have a more uniform experience in the course - I feel it is way too self-guided right now … without direction, etc.*" These quotes indicate a desire to apply well-supported, student-centric active learning in ways that we developed together during this FL Project.

3.2. Personally my experience with face to face teaching has been augmented by this project so that I have a stronger appreciation of the similarities and differences between online and f2f teaching settings. The project has caused me to recognize that fundamentals about how people learn do apply regardless of the teaching "medium". I have also become convinced that active learning can be fostered online, BUT that it does require adaptations, especially when the online setting is entirely asynchronous. Most particularly, care is required to scaffold and sequence the learning tasks so that students have a chance to commit to a learning outcome before engaging in peer (i.e. group) interactions. It also takes greater time and energy to design, test and deploy learning activities or sequences than it does for, say, an in-class worksheet activity. Finally, the resource construction, delivery and maintenance issues are more "technical" than in f2f courses, and require different infrastructure at the course, Department, Faculty and Institution levels. UBC is making great progress but these matters are definitely still a work in progress.

3.3. There is no proof of this, but I expect the four graduate students who assisted with design, development, testing and assessment will bring lessons we have all learned into their future teaching practices, whatever form those may take. This presumption is based on experiences with other graduate students who have supported educational development projects in f2f courses.

4. **PROJECT SUSTAINMENT** - *Please describe the sustainment strategy for the project components. How will this be sustained and potentially expanded (e.g., over the next five years). What challenges do you foresee for achieving the expected long-term impacts listed above?*

- Instructors of the DE sections of eosc326 and eosc118 have both begun incorporating lessons learned during this project into their own teaching. This demonstrates sustainable improvements in the teaching expertise of these instructors.

- Enabling teaching assistants to effectively teach and assess in these courses requires facilities to help them set expectations for student capabilities and to gain familiarity with the tools and techniques, especially regarding online learning and teaching strategies. Instructors new to the course also need supporting resources. To meet these needs, each DE course participating in this project has a space within the LMS (i.e. in Connect) that is hidden to students but visible to TAs and instructors in which are stored guidelines, rubrics, videos of task steps (like building small groups within Connect) and assessment solutions. Resources produced for outcomes of this project are listed in a spreadsheet with over 100 line-items describing the items, their type and technology, necessary resources, where seen in Connect, where stored in Connect, any associated data, and recommended changes. This table can be provided upon request. (As of May 20 2016 roughly 10 items in this list have yet to be completed.)

- Challenges for sustaining long term impacts:

  o It takes "pedagogic expertise" to facilitate learning using evidence-based practices. New instructors need time and training to become expert teachers. They, as well as instructors taking on a course with which they are unfamiliar, need support to gain confidence with the techniques used and to help align their own perceptions of learning and the "story to tell" with the practices, strategies, exercises and assessments that were developed.

- o For both f2f and DE courses but especially DE, managing online resources and learning facilities is highly non-trivial and UBC's LMS (Connect) does little to help. Some resources need storing (and therefore managing) outside the Connect system so IT support and a well-articulated "chain of responsibility" is needed.

- o We found it important to clearly separate "resources" from "learning tasks". Facilities like virtual specimens or scenarios must be completely decoupled from the instructions or assessments. As an analogy, no one would attach assignment or assessment instructions to a museum specimen that lies inside a display case – the instructions would be separate and the instructor would refer to the specimen. The same must be done for virtual resources, otherwise updating or customizing the students' task involves working with the actual resources themselves. However, this creates a curating challenge. Where should we house resources so they can be accessed by more than one course? Our solution (still yet to be successfully achieved) is to partner with the Pacific Museum of the Earth. If our funded projects can generate virtual resources, then the Museum can curate them as part of their online presence. This is a work in progress.

- Anticipated expansions or extensions:

  - o The Department's current 2-year TLEF is taking direct advantage of lessons learned to leverage ideas, resources, learning tasks and teaching strategies that evolved during this recently completed Flexible Learning Project.

  - o Cross-fertilization from DE into corresponding f2f courses is also expected to occur as the principle instructor of f2f courses will be returning to those courses after over a year spent devoting time to projects outside UBC.

  - o We are also participating and contributing in three more-or-less ad-hoc UBC communities of practice, enabling transfer of lessons we learned to other units, groups and individuals. These groups are the Learning Analytics and Visual Analytics (LAVA) group, the virtual and augmented reality interest group, and the group developing Adaptive Comparative Judgement as a means of peer-assisted learning.