Chemistry Department

The Chemistry CWSEI program started in 2008 and has concentrated on evaluation and redesign of the CHEM 123 lab – Physical and Organic Chemistry. The First Year Assessment sub-committee of the Chemistry Lab Committee is overseeing this project. The sub-committee members are: Brian Cliff (chair), Guillaume Bussiere, Ed Grant, Laurel Schafer, Vishaka Monga, Sophia Nussbaum, John Sherman, Robin Stoodley, Nancy Vered, Peter Wassell and Dana Zendrowski. In conjunction with these efforts, undergraduate laboratory revitalization for years 2 - 4 is ongoing in the department.

Jackie Stewart, former Skylight Affiliate and now the Departmental Director has been involved with the CWSEI since the start of the overall initiative in 2007 and has been doing substantial redesign of CHEM 233 Organic Chemistry for the Biological Sciences and working with the teaching teams in CHEM 121 and 202 to improve learning in those courses (independently funded by the department and TLEF).

In addition to CWSEI teaching initiatives, the department has undergone an independently funded external review of our 1st year chemistry program. Also, Mike Wolf, Derek Gates and Jackie Stewart have developed improved course support materials for CHEM 121 (tailored in-house textbook, homework sets, power point notes for instructors, etc.) independently supported by TLEF and Skylight. Funding for a similar in-house text for CHEM 123 has been secured. Additionally, seven interactive online tutorials have been developed and implemented over the past eight years to complement existing Chem 121 lab experiments as part of an ongoing co-operative between Sophia Nussbaum and the ChemCollective of Carnegie Mellon University. Funding from Skylight was used to develop yet another interactive tutorial and refine two existing tutorials with Carnegie Mellon.

SEI Director: Jackie Stewart

STLF Emeritus: Jennifer Duis (emeritus)

Faculty: G. Bussiere, B. Cliff, G. Dake, N. Dryden, E, Grant, V. Monga, S. Nussbaum, L. Schafer, J. Sherman, R. Stoodley, M. Thachuck, N. Vered, P. Wassell, and D. Zendrowski

Former Consultant: Dave Pushkin

Students: Nicholas Mah, Samantha D'Souza (2010-2011)
Ainge (Y. C.) Chang, Aalia Sachedina, James Zhou (2009-2010)
Michael Carlson and Yuri Samozvanov (2008-2009)

Course Transformation

Course	Learning Goals	Assessments	Improved methods
CHEM 121: Structural Chemistry, with Application to Chemistry of the Elements (Lab component) (Oct '08 start) Faculty: S. Nussbaum STLF: Jennifer Duis	Course-level goals: Outline from CHEM 123, focus on transferable skill acquisition Experiment-level goals: process for development established Course-level outline and experiment-level development process appropriate for the entire lab program	Attitudes survey (C-LASS CHEM) given 3 Terms Development and implementation of end-of-term technique assessments o Year 1: TA visual assessment of technique with provided guide o Year 2: Visual assessment guide refined and technique questions added to the end-of-term quiz	Alterations made to increase alignment with 1st-year lab goals o Marks re-allocated to increase emphasis on maintaining a lab notebook o Directions on maintaining a lab notebook expanded in lab manual o Brief "taking observations" module developed and added during check-in o Peer marking of observations using supplied templates added to each experiment o Technique modules will be expanded to include choosing glassware for analytical vs. non-analytical purposes o A new experiment was piloted o "Pair-technique-ing" (ala comp. sci. pair-programming) was piloted with a small subset of students
CHEM 123: Physical and Organic Chemistry (Lab component) (July '08 start) Faculty: S. Nussbaum, L. Schafer, J. Stewart STLF: Jennifer Duis	Course-level goals: working version, inspired by Rice University's interdisciplinary science lab learning objectives, approved by Chemistry Lab Committee Experiment-level goals: (developed from existing course materials) 4 of 4 experiments complete and approved by Chemistry Lab Committee o Further refinement of LGs underway	Chemistry background and demographics survey developed and given 2 Terms Attitudes survey (C-LASS CHEM) given 2 Terms Pre-/Post-Lab skills survey (written) developed & given 4 Terms o "LG use" questions added Refined hands-on lab skills assessment implemented 2 terms Assessments of experiment specific learning goal achievement (surveys, observations, interviews) o 3rd round of refinement based on expert & student	Learning Goals incorporated into lab manual (under refinement) Alterations made to increase alignment with learning goals o Marks re-allocated to increase emphasis on maintaining a lab notebook o Directions on maintaining a lab notebook expanded in lab manual o Expanded quizzes will be introduced to test technical skills o Addition of manual dilutions to electrochemistry experiment to increase technical experience and conceptual understanding of the effect of dilution on voltage o Lab final modified to test students' "solo" completion of an experimental design, recording of observations and data, and evaluation of skills using a pipet and weighing by differences

		validation nearing completion	

- **CHEM 113, 121, 415, 425, 449:** Attitudes survey (C-LASS CHEM) administered Spring '09 (CHEM 113 & 121 also participated in the written Lab Skills Survey)
- **CHEM 425/448:** Engaging students in cutting edge chemical education research, report writing, and presentations.

Curriculum

- As CHEM 121/123 is in many ways a service course, identify interdisciplinary science lab skills that other science streams consider to be important and/or are expecting students to get from 1st year chemistry to improve "service".
- Survey Co-op employers to aid in focusing efforts of optimization and determining impact on upper level laboratory revitalization.
- Modification of course curriculum for CHEM 415/425 approved by Chemistry Department to expand research opportunities to chemistry majors.

TA Development

The third round of modified TA training was implemented by Anka Lekhi and Sophia Nussbaum, with support from the TA Training Program through the Provost and Vice-President Academic Office and the Chemistry Department.

Research

Attitudinal Survey: C-LASS CHEM given in multiple courses, statistical comparisons between UBC and CU-Boulder.
CHEM 123 Lab Learning Goals: Assess students' achievement of lab learning goals.
1st Year Practical Lab Skills: Compare students' achievement of practical lab skills as determined by written vs. hands-on assessment
CHEM 233 Learning Objectives Alignment Study: Investigating students' perceptions of the alignment between learning objectives and assessment, probing their ability to judge cognitive complexity of learning objectives, assessment items, and study tactics.
Chemistry Concept Diagnostic Tests: Propose administration and validation of an existing chemistry concept test to first year chemistry students.

Other

Presentations at national/international meetings: 237th& 240th American Chemical Society National Meeting, 21st Biennial Conference on Chemical Education, 92nd & 93rd Canadian Chemistry Conference, Improving University Teaching 34th International Meeting.

Computer Science Department

Computer Science received seed funding from CWSEI in 2007 and began the efforts listed below in the Fall. The department moved to full funding starting in mid-2008. We currently have one full-time STLF.

SEI Director: Paul Carter

STLFs: Allison Elliott Tew
Ryan Golbeck (emeritus) – involved in CPSC 110 and 210
Ben Yu (emeritus) – involved in CPSC 101, 111, 121, 211, 213, 221, 304, 310, 322, 404, and APSC 160
Ray Lister (emeritus) – involved in CPSC 111, CPSC 260, and APSC 160
Beth Simon (emeritus) – involved in the early work of CPSC 101, 111, 121, 211, 213, and 221

Faculty: D. Acton, M. Allen, P. Belleville, G. Carenini, P. Carter, C. Conati, A. Condon, M. Dulat, K. Eiselt, M. Feeley, W. Heidrich, H. Hoos, N. Hutchinson, G. Kiczales, E. Knorr, K. Leyton-Brown, J. Luk, J. McGrenere, G. Murphy, R. Ng, R. Pottinger, D. Poole, G. Tsiknis, K. Voll, S. Wolfman

Post-doc: Frank Hutter, Gabriel Murray

Course Transformation

Course	Learning Goals	Assessments	Improved methods
CPSC 101: Connecting with Computer Science (Sept '07 start) Faculty: M. Allen, A. Condon, S. Wolfman, H. Hoos STLF: Ben Yu	Course-level goals: complete Topic-level goals: complete	Performed study of instructor & student perception and use of learning goals. Developing assessment to probe student understanding of JavaScript code. Piloted a new Computing Attitude Survey (CAS) in the Fall of 2011 as part of the survey validation process.	Used clicker questions in class. Developed broad set of clicker questions. In the process of adjusting delivery of course to use Just-in-Time teaching methods with pre-class readings and in-class learning activities.
CPSC 110: Computation, Programs and Programming (Sept '09 start) Faculty: G. Kiczales, P. Carter, K. Eiselt STLF: Allison Elliott Tew, Ryan Golbeck	Course-level and topic-level goals: solid draft in place	Have per-question analysis of midterm and final exam data. Developed weekly problem sets that provide students with timely feedback on their learning. Piloted a new Computing Attitudes Survey (CAS) in the Fall of 2011 as part of the survey validation process.	Developed a series of relevant and engaging labs. A plug-in was developed for Dr. Racket IDE so that students can submit assignments electronically from the development environment. This reduces the number of tools that students have to master and allows the course to focus on concepts.
CPSC 111: Introduction to Computation (Sept '07 start) Faculty: K. Eiselt, C. Conati, W. Heidrich, J. Luk STLF: Ben Yu, Ray Lister This course is no longer offered. It has been replaced by CPSC 110.	Course-level goals: complete Topic-level goals: complete	Attitudinal survey revised and administered at start and end of term in all sections of summer and fall terms. Cognitive pre-test developed and administered at start of course. The same test was administered to students in APSC 160. Questions targeting specific learning goals have been included on exams. A lab checklist has been developed to track the kinds of problems that students run in to during labs.	
CPSC 121: Models of Computation (Sept '07 start) Faculty: S. Wolfman, P. Belleville, K. Voll, M. Allen STLF: Ben Yu	Learning goals have been further categorized to identify pre-class learning goals. Students are expected to achieve pre-class learning goals on their own in advance of the corresponding class.	Attitudinal surveys developed and administered in summer and fall terms. Student interviews conducted in summer and fall terms. Pre and post-tests developed and administered. MCQs developed for final exam that target specific learning goals.	Two-stage exam conducted in summer term. Results published in ICERI 2009 and further analysis appeared at SIGCSE 2010. Refined online quizzes used to assess pre-class learning goals on the basis of previous term's quiz results. Re-structured in-class problem solving activities to be based on progressive clicker questions with solo- and group-response format. Approximately 160 clicker questions developed

		A scenario based think-aloud survey tool has been developed to study how students approach solving mathematical induction problems. The tool is being used to examine the effectiveness of a decomposition technique that teaches students to approach such problems by breaking them down into more manageable pieces.	and used in class. Continued work on labs to make them "open-ended" and driven by student exploration rather than closed-ended. Continued to re-design labs so that they are more closely aligned with core learning goals, avoiding extraneous detail. Established a protocol for preparing TAs to a consistent level and for developing a community of support among the teaching staff.
CPSC 210: Software Construction (Jan '10 start) Faculty: G. Murphy, M. Allen STLF: Allison Elliott Tew, Ryan Golbeck	Topic-level goals: solid draft in place	Parallel assessment in progress with CPSC 211 (the course that CPSC 210 will eventually replace).	Examining the use of cell phones in some labs to increase relevance and student engagement.
CPSC 211: Introduction to Software Development (Sept '07 start) Faculty: D. Poole, M. Dulat STLF: Allison Elliott Tew, Ben Yu	Course-level goals: complete Topic-level goals: complete	Attitudinal survey developed and administered at start and end of both sections of fall term. Parallel assessment in progress with CPSC 210 (the course that will eventually replace CPSC 211)	Subversion repository has been developed that will facilitate distribution of code to students for labs and lectures. A subversion plug-in for the Eclipse IDE will be used to minimize the number of different tools that students have to master.
CPSC 213: Introduction to Computer Systems (Sept '07 start) Faculty: G. Tsiknis STLF: Ben Yu	Course-level goals: complete Topic-level goals: complete	Pre and post-tests developed and administered during summer term.	Two-stage exam conducted in summer term. Results published in ICERI 2009 and further analysis appeared at SIGCSE 2010.
CPSC 221: Basic Algorithms and Data Structures (Sept '07 start) Faculty: K. Voll, E. Knorr STLF: Ben Yu	Course-level goals: complete Topic-level goals: complete	Post-test developed and administered at the end of summer term. Attitudinal survey revised and administered at the end of 2009 fall term.	Use JITT, in-class group problem solving and peer instruction, clickers or non-electronic clicker equivalents, and web-based quizzes to shift focus of courses to higher-level analysis and problem solving.
CPSC 260: Object-Oriented Program Design (Sept '09 start) Faculty: D. Acton STLF: Allison Elliott Tew, Ray Lister	Topic-level learning goals: complete	Pre-test developed and administered in 2009/2010 that measure retention of learning from APSC 160.	A series of clicker questions has been developed.
CPSC 304: Introduction to Relational Databases (Sept '09 start) Faculty: E. Knorr, R. Pottinger, R. Ng STLF: Ben Yu	Topic-level goals: draft	Attitudinal survey developed and administered at start and end of term. Pre and post-tests developed to assess change in learning. Student interviews conducted during fall term.	Clicker questions developed and used in fall offering of course. Two-stage exams conducted in both midterms of fall 2009 term. A set of new tutorials has been developed and tested in spring 2010 in response to poor attendance in previous terms. The new tutorials are designed to incorporate active learning and have resulted in higher attendance. Tutorials were improved upon for summer 2010 offering of course to include reflection exercises such as the development of a concept map.
CPSC 310: Introduction to Software Engineering (May '10 start) Faculty: M. Allen STLF: Allison Elliott Tew, Ben Yu	Course-level and topic-level learning goals: in progress	Diagnostic test developed to assess student preparation in learning.	New lecture material under development on topics that are more relevant (e.g., distributed version control systems).

CPSC 317: Internet Computing (Sept '09 start) Faculty: D, Acton, N. Hutchinson STLF: Allison Elliott Tew	Course-level goals: complete Topic-level goals: complete	Conducted initial survey to gather baseline data on student experience in course. Baseline data collected in the form of per-question analysis of exam data and attitudinal survey.	Developed group based, in-class learning activities and associated discussion questions focused on specific learning goals. These methods will be administered for the first time in Spring 2012.
CPSC 320: Intermediate Algorithms and Data Structures (Sept '09 start) Faculty: K. Voll		A test of expected prerequisite knowledge was developed and administered at the start of the term.	
CPSC 322: Artificial Intelligence (Summer '08 start) Faculty: G. Carenini, K. Leyton-Brown Post-doc: Frank Hutter Graduate student: Byron Knoll STLF: Ben Yu	Course-level goals: complete Topic-level goals: complete	A large body of questions has been developed to be used as the core of future exams. Conducted survey on student use of practice problems and perceived usefulness for their learning.	A set of 19 practice problems complete with solutions have been developed and made available at www.aispace.org/exercises.shtml 12 of these 19 exercises are integrated with AI Space applets. Background reading for each exercise was also identified in the course textbook. These exercises were also integrated into webCT and two quizzes for each problem were created. An additional set of 19 quizzes covering 7 of the practice problems were made available towards the end of the term. Two new AI Space applets have been developed.
CPSC 404: Advanced Database Systems (Sept '09 start) Faculty: E. Knorr STLF: Ben Yu	Topic-level learning goals: draft	Attitudinal survey developed and administered at start and end of term. Pre and post-tests developed to assess change in learning.	
CPSC 410: Advanced Software Engineering (Sept '11 start) Faculty: E. Wohlstadter	Learning goals revised to provide a stronger connection between CPSC 410 and its major prerequisite CPSC 310.		
CPSC 422: Intelligent Systems (Sept '09 start) Faculty: C. Conati, K. Leyton-Brown Post-doc: Frank Hutter	Learning goals under development.		All assignments have been revised with respect to learning goals and two new assignments have been developed.
CPSC 444: Advanced Methods for Human-Computer Interaction (Sept '10 start) Faculty: J. McGrenere	Learning goals drafted and under revision		Added practical component to each tutorial in response to feedback from students. Reworked project and labs to streamline descriptions and milestones. Improved tutorial instructions for TAs Created a new lab to teach Android phone development skills.
APSC 160: Introduction to Computation in Engineering Design (Sept '09 start) Faculty: P. Carter, E. Knorr STLF: Ray Lister, Ben Yu	Topic-level goals: complete	Attitudinal survey developed and administered at start and end of term. Analysis pending. Surveys assessing impact of Peer Instruction conducted in week 4 and week 8 of term. Increased number of midterms from 1 to 2 in an effort to provide students with more regular and more accurate feedback on their	A series of approximately 30 screencasts have been developed that introduce students to basic concepts. Students are asked to study the screencasts before coming to class. Clicker questions have been developed to assess students' comprehension of the concepts presented in the screencasts. A series of in-class problem sets have been developed that allow students to further develop their understanding of the concepts learned in

		progress. Piloted a new Computing Attitudes Survey (CAS) in the Fall of 2011 as part of the survey validation process.	the screencasts. The new format was incorporated into all four sections of the course offered in 2009/2010. Over 800 students were enrolled. Feedback from students on surveys has been overwhelmingly positive. Analysis of learning gains is in progress.

Learning goals for core courses (CPSC 110, 111, 121, 210, 211, 213, 221, 310, 313, 320): A comprehensive set of learning goals (both course-level and topic-level) has been developed for most 1st and 2nd year core courses. Most of these courses use LGs regularly to some extent in class (e.g., many 111 instructors now show the LGs associated with each unit as they lecture on the unit). CPSC 313 also has rough draft LGs. Draft course-level learning goals for the new CPSC 110 and CPSC 210 have been completed.

CPSC 260: Object-Oriented Program Design: Don Acton and Ben Yu are investigating the correlation of student performance with different components of this course.

Attitudinal Surveys: Survey instruments have been developed for CPSC 101, 111, 221, 317, 320, 404, and APSC 160. These instruments will facilitate the tracking of students' attitudes about the curriculum, their interest in Computer Science, and their expectations throughout their undergraduate years.

Curriculum

Code communication in APSC 160, CPSC 111, and CPSC 260: Exploring how students' ability to communicate about code changes during our core courses. A style of question that involves explaining the purpose of code is used across several exams to see how and whether students progress in their ability to succinctly and abstractly describe the purpose of code fragments.

Research

Computing Attitudes Survey (CAS): Allison Tew is in the process of developing and validating the Computing Attitudes Survey (CAS), a new assessment instrument to gauge student attitudes and perceptions about learning computer science. The CAS is based on the Colorado Learning Attitudes about Science Survey (CLASS) and extends that work to include specific computing issues such as debugging and data representation. The CAS will be applicable to a broad range of students and was piloted in three introductory courses in Fall of 2011: CPSC 101, CPSC 110 and APSC 160. We plan to run the survey as a pre and post test in each of these courses in Spring 2012.

Longitudinal Study of Student Learning: Allison Elliott Tew is designing a research study into assessment of student learning across a sequence of software design courses running from 1st to 4th year. Implementation details are currently under development. Initial meetings have been held with faculty who teach the courses. The first step is to move from learning goals that focus on particular courses to learning goals that capture the progression from novice to expert over a sequence of courses.

PeerWise: Conducted study of the use of PeerWise (an online collaborative multiple-choice question repository) by students in 2nd and 4th year courses in 2007/08. Surveyed students about how they use PeerWise and whether they feel submitting or answering questions helps them learn.

Self-theories: Conducted a study in 2007/08 of impact of students' self-theories relating to learning and ability on their success and persistence in beginning programming courses.

Learning Goals: Explicit use of learning goals in the classroom to aid student learning has been explored and is the subject of an article has been published in the Journal of College Science Teaching. Explicit use of learning goals has also spread to the Computer Science and Engineering department at UC San Diego, home institution of our first STLF.

Just-in-time-teaching in APSC 160: Instructor has developed screencasts to introduce basic content to students. Students are expected to watch one or more screencasts before coming to class and are assessed on their grasp of this introductory material using clicker questions at the start of class. A collection of in-class problem sets has also been developed that will allow students to explore their understanding of more advanced content. We plan to conduct an assessment of retention of learning at the start of the follow-on course (CPSC 260) in the Fall and compare with results from last year where students had taken APSC 160 with more traditional instruction.

Just–in-time teaching in CPSC 121: Instructor has identified a subset of learning goals called `pre-class` learning goals. These are goals that students are expected to meet before coming to class. On-line tests have been developed to assess student learning for those goals. A set of in-class problems have been developed that address more advanced learning goals. Comparative survey work indicates dramatic increases in percentages of students that use the textbook and find it useful to their learning.

Just-in-time-teaching in CPSC 221: One instructor taught both sections in 2008/09 Winter term 2. Students in one section are seeing a JITT approach and the use of in-class activities involving peer instruction and discussion. Students in the other section are receiving more traditional instruction. Students in both sections are writing the same exams and completing the same homework assignments.

Parson's puzzles: Conducted a study in 2007/08 of a new type of exam question for assessing similar skills to code writing questions. Results have been published in the proceedings of the Fourth International Computing Education Research Workshop.

Decomposition techniques in teaching proof by induction: Kim Voll applied a decomposition technique when teaching proof by induction in CPSC 121 in spring 2010. Ben Yu is currently interviewing students from both sections of the course taught last term using a think-aloud protocol developed in conjunction with Wendy Adams (UC). The results will be analyzed to determine if students taught with the decomposition technique demonstrate a stronger ability to perform proof by induction.

Earth and Ocean Sciences Department

Earth & Ocean Sciences received full funding from CWSEI in 2007 and began the efforts listed below in Summer 2007. The EOS-SEI program is making excellent progress with 19 courses currently at various stages of transformation and more than 10 additional courses "unofficially" being improved using the principles of research-based effective pedagogy. Over 60% of EOS faculty are involved in the SEI in some capacity (committees, working groups and/or making changes to their courses). The overarching goal of the EOS-SEI is to promote cultural change in our approach to teaching and learning and establish sustainable processes to continue and improve the work accomplished during the CWSEI project.

SEI Director: Francis Jones (Acting Director), Sara Harris (on leave)

STLFs: Francis Jones, Brett Gilley, Erin Lane (emeritus), Joshua Caulkins (emeritus), Ben Kennedy (emeritus)

Faculty (instructors teaching targeted courses): S. Allen, G. Andrews, R. Beckie, M.L. Bevier, M. Bostock, G. Dipple, E. Eberhardt, J. Finnis, R. Francois, M. Grey, S. Harris, F. Herrmann, K. Hickey, W. Hsieh, M. Jellinek, C. Johnson, M. Kopylova, M. Maldonado, U. Mayer, S. Mills, R. Mindell, J. Mortensen, K. Orians, R. Pawlowicz, J. Scoates, P. Smith, R. Stull, S. Sutherland

Faculty (others involved in working groups, committees, or ad-hoc support): P. Austin, M. Bustin, K. Grimm, L. Groat, P. Hammer, E. Hearn, O. Hungr, T. Ivanochko, M. Lipsen, J. Monteux, D. Oldenburg, K. Russell, D. Steyn, C. Suttle, P. Tortell, L. Ver, D. Weis, D. Winget

Students: L. Bailey, L. Beranek, J-F. Blanchette-Guertin, A. Caruthers, D. Cassis, J. Dohaney, R. Eso, L. Gurney, M. Halverson, S. Henderson, T. Hirsche, K. Hodge, A. Jolley, K. Ko, P. Lelievre, C. Leslie, C. Livingstone, K. Lucas, J. Mcalister, K. Rasmussen, J. Rhajiak, E. Schaeffer, B. Smithyman, K. Smet, R. Taylor, D. Tomkins, D. Tommasi, C. Wong

Course Transformation

Course	Learning Goals	Assessments	Improved methods
EOSC 111: Laboratory Exploration of Planet Earth (Sept '07 start) Faculty: S. Harris STLF: Brett Gilley Transformation completed in Fall '08 w/ ongoing updates to pre-post assessment, lab activities, and quizzes.	Course-level goals: complete Lab-level goals: complete	Individual and group quizzes 3rd draft of Pre/Post assessment complete for all topics Post-lab surveys for each lab End-of-term survey	Invention activities (Introduction, Plankton & Marine Ecosystems) Student-derived methods (Earthquakes, Groundwater, Dinosaurs, Waves, Estuaries) Contrasting cases (Sediments & Sedimentary Rocks)
EOSC 112: The Fluid Earth: Atmosphere and Ocean (Jan '08 start) Faculty: R. Francois, S. Harris, W. Hsieh STLF: Erin Lane	Course-level goals: complete Lecture-level goals: complete	Midterm & end-of-term surveys Online quizzes Validated pre-post survey Student engagement observations Student workloads questions	Widespread use of thought-provoking clicker questions Relevance slide added to each lecture, relevance added throughout class.
EOSC 114: The Catastrophic Earth: Natural Disasters (Sept '07 start) Faculty: R. Stull, E. Eberhardt, M.L. Bevier, S. Sutherland, J. Finnis, G. Andrews STLF: Francis Jones (~1000 students per yr) Transformation completed in Spring '10. **New in 2010:** Introduction of group exams, overseen by Brett Gilley and Roland Stull.	Course-level goals: complete Lecture-level goals for all lectures: complete	Midterm & end-of-term surveys Pre-course diagnostic on basic skills Online homework based on text readings introduced Fall 2008 Attitudes survey	Vista Course Management System and a custom website used extensively for content delivery, quizzing, surveying, logistics. Use of thought-provoking clicker questions in all lectures Pre-post question "wrappers" around video clips to focus and assess student learning from videos Custom text introduced. Off-schedule pre-exam review/question sessions Fall '09: Preliminary experiment with PeerWise in one section. Not continued beyond Fall '09. Multiple sequential instructors with one lead instructor and administrative support.

EOSC 210: Earth Science for Engineers (Jan '08 start) Faculty: E. Eberhardt, U. Mayer, S. Sutherland STLF: Brett Gilley Transformation completed in Dec '09 with some ongoing support.	Course-level goals: complete Lecture-level goals: complete Goals for all labs: complete	End-of-term survey Mineral exam Peerwise	Use of PeerWise (http://peerwise.cs.auckland.ac.nz/) for student generation of questions Widespread use of clicker questions (4-8 in each 1.5 hour lecture), focus attention, test understanding, and drive discussion Small group or pair discussions in most classes Many case studies relevant to lectures Labs redesigned with new activities linked to learning goals
EOSC 211: Computer Methods in Earth, Ocean & Atmosph. Sciences (Jan '09 start) Faculty: R. Pawlowicz, C. Johnson STLF: Joshua Caulkins	Course-level goals: complete Lecture-level goals: complete Learning goals for Labs/Assignments: draft	Pre-post assessment: Administered in Teach 1 and edited for Teach 2, can be used "as is" for all future terms Midterm and end-of-term surveys New types of exam questions based on computer science concepts	In-class worksheets for every lecture Pair-programming used in all labs and assignments. Name-sticks used to call on students during lectures and in-class discussions Post-lecture Interviews Lab interviews
EOSC 212: Topics in the Earth & Planetary Sciences (Jan '08 start) Faculty: M. Jellinek, M. Bostock STLF: Francis Jones (~30 students per yr) Final transformation term was Fall'09, but further refinements of generic science thinking activities and assessments were carried out in Fall '10, primarily by the instructor (M. Jellinek), with minor input and support from F. Jones.	Course-level goals: complete Focus is on science thinking skills rather than content	End-of-term survey for project evaluation Quizzes on readings for both individual and teams, using Team Based Learning strategies Two projects (presentation and poster), including feedback at multiple stages of delivery Pre-post test related to model-based reasoning Peer assessment of some homework and both projects Regular graded abstract writing and question-posing assignments Student participation in rubric design for reading, writing and questioning	Vista Course Management System used extensively for content delivery, quizzing, surveying, logistics Team Based Learning elements: permanent teams, individual/team quiz protocols & in-class team activities Content from Scientific American and other articles and lectures Three modules chosen to highlight departmental research strengths Guest speakers for each module Instruction and practice at developing science article reading, questioning & discussing skills Project topics are student-determined Question posing, abstract writing and model based reasoning rubrics are used In Fall 2010, the question posing aspect was more closely guided so students know whether to ask content or discussion oriented questions. Capstone week introduced to revisit core skills and learning goals Two instructors with roughly half the classes attended by both
EOSC 220: Introductory Mineralogy (Jan '08 start) Faculty: M.L. Bevier STLF: Joshua Caulkins	Course-level goals: complete Lecture-level goals: complete	Midterm and end-of-term surveys Lab quizzes	In-class activities and discussions are part of each lecture. 3x5 cards used for student responses and feedback. Labs reworked and provided more structure to students and TAs Students create their own reference "mineral

			book" that can be used later for studying.
EOSC 221: Introductory Petrology (Sept '07 start) Faculty: M. Kopylova STLF: Brett Gilley Transformation completed in April '09.	Course-level goals: complete Lecture-level goals: complete Lab goals: complete	Pre/post assessment	Labs rewritten - more structure activities linked to goals Small group lecture activities in each lecture 3x5 cards for ongoing assessment of students and the course Many smaller quizzes after each module Improved course framework (spaced lectures that do more to highlight differences rather than massed lectures, covering all of one rock type).
EOSC 222: Geological Time (Sept '11 start) Faculty: P. Smith STLF: Francis Jones (~50 students per yr) First transformation teaching term Spring '11.	Course-level goals: first draft complete Module and lab-level goals: under development	Weekly lab exercises Midterm End of term lab exam Final exam Observations during first term will be used to identify opportunities for both smaller scale in-class assessments, and self-test quizzing.	Half the content is being re-worked by P. Smith. Four of ten labs are being re worked with the assistance from an experienced teaching assistant. Complete lecture observations (student engagement plus in-class opportunities) will be conducted in Spring 2011. We will be aiming for closer coupling between lab exercises and classroom learning.
EOSC 252: Introduction to Experimental Geophysics (Sept '09 start) Faculty: F. Herrmann STLF: Francis Jones (~15 students per yr) First teaching term Jan '10 Transformation project adjourned prior to January 2011 teaching term for various logistical reasons. However, some support to ensure labs and class work are well aligned will be provided.	Course-level goals: agreed upon Lecture-level goals: first versions	Weekly lab or homework exercises supported by TAs One midterm One final exam In-class demonstrations assessed for "participation". The beginnings of regular on-line self-test quizzing based on assigned readings. More to come the time the course is taught. Extensive end of term survey about initiatives and preferences.	Enhanced context for all material by: 1. Reworking four Lab exercises 2. Re-compiling all lab exercises into a consistent format, which recognizes progression of learning from one exercise to the next. 3. Dropping two in favor of a new "capstone exercise" (a context rich exercise using new forms of data (borehole well logs) and lab results from earlier work). 4. Projects involving student-chosen topics, and 3-stage deliverables with TA and peer feedback. 5. Guided demonstrations introduced to four class lectures, including pre-demonstration "prediction" worksheets.
EOSC 321: Introduction to Igneous Petrology (Jan '10 start) Faculty: M. Kopylova STLF: Brett Gilley Transformation completed in Dec '11.	Course-level goals: complete Lecture-level goals: complete	End-of-term survey '09 & '10 Focus groups Mineral quizzes, exams, group project	Student focus group Development of several new labs "Wake up" activities in each lecture Distributed mineral quizzes (as opposed to one quiz in week 1) Improved exam creation and marking/grading scheme Exams questions tied to learning goals Tectonic setting group project with group contract, in presentations of project students required to incorporate the data presented by the other students and come to their own conclusions.

EOSC 322: Metamorphic Petrology (Sept '08 start) Faculty: G. Dipple STLF: Erin Lane	Course-level goals: complete Topic-level goals: complete	Midterm survey Pre-reading quizzes	Rock sample and relevance in lectures Just-in-Time-Teaching (pre-readings and online quizzes given prior to module)
EOSC 326: Earth and Life Through Time (Jan '10 start) Faculty: S. Sutherland STLF: Francis Jones (~160 students per yr) Second transformation teaching term- Sept '10	Course-level goals: complete Module-level goals: complete (14 modules) with minor revisions in progress	Pre-requisite self-test, plus corresponding catch up material Weekly online exercises based on assigned readings from text and elsewhere. Regular use of clickers in class Weekly "active Friday" worksheets (see "Improved Methods") Midterm and final exams plus a comprehensive end-of-term survey	New text to help remove low level content from class. Clicker questions are improving as experience is gained. Weekly homework based on assigned readings helps keep students on task. Students do these once for grades, then they are re-opened for practice before exams. Weekly "Active Fridays" allows 1/3 of all classes to be 100% peer instruction, active learning. Work is guided, and instructor plus 2 teaching assistants circulate during work. Two hands-on lab exercises substitute for 2 weeks of lectures. Deliverables are completed during class in groups.
EOSC 329: Groundwater Hydrology (Jan '10 start) Faculty: R. Beckie STLF: Francis Jones, Joshua Caulkins (~160 students per yr)	Course-level goals: complete Module-level goals: draft – need distributing among modules. Learning goals for Labs – some complete, others need refining.	Pre-post assessment Clicker questions introduced into nearly all lectures – still a work in progress. Weekly labs are taught & marked by TAs. Some lab materials were moved to Vista to improve efficiency and feedback. Weekly TA meetings with the instructor help ensure consistency in all four lab sections. Midterm and final exams plus a comprehensive end-of-term survey.	Lab questions have been edited and expectations made more explicit. Classroom observations and post-lecture interviews Lab exercises were substantially refined and aligned with learning goals. TAs have well developed guidance for instructing and running labs. Introduced three case studies to correspond with lab work. Some small group work during lectures. Clickers added to all lectures to help leverage Socratic teaching to advantage all students.
EOSC 331: Introduction to Mineral Deposits (Jan ' 10 start) Faculty: J. Scoates, K. Hickey STLF: Brett Gilley	Course-level goals: complete Lecture level goals: complete Lab-level goals: complete	End-of-term survey Sketches in first and last labs Smaller quizzes replace midterms	New course frameworks developed. Reduced length of midterms, inserted framework activity after each quiz. Activities in many lectures Rewrote all labs, labs now have "checkpoints" and are handed in at the end of lab. How does a geologist sketch activity Poster session activity –successful model Poster Rubric Summative "deposits in space and time" activity Improved final exam format
EOSC 332: Tectonic Evolution of North America (Sept '08 start)	Course-level goals: draft Module-level goals: draft	Pre/Post Assessment rewritten for Jan 2010 (validated with former students)	Activities and discussions planned for some lectures. Just-in-Time-Teaching (pre-readings and

Faculty: J. Mortensen STLF: Brett Gilley		Midterm survey Peer Review Essay assignment End-of-term survey	online quizzes given prior to each module)
EOSC 355: The Planets (Sept '08 start) Faculty: C. Johnson STLF: Francis Jones (~70 students per yr) New course, taught 1st time in Spring 2009. Second teaching term Spring 2010 **Fall 2010**: incorporation of a second instructor is being supported and observed by STLF. This is being done as a "transfer" and sustainability experiment.	Course-level goals: complete Module-level goals: finalized for Spring 2010 term.	Pre-course skills diagnostic and "attitudes toward planetary sciences" Midterm survey for improving course delivery and focus Frequent in-class quizzes Clickers, major capstone homework exercises for each of 3 modules, in-class team-based worksheets used to set up or practices lecture content and skills. Major project, including 3-stage deliverables, and peer assessment.	Vista Course Management System used for content delivery, quizzing, surveying, logistics. Use of permanent teams for quizzes and in-class worksheet-based activities Clickers used for pre-lecture prediction and mid-lecture discussions. Online and in-class quizzes, especially to ensure accountability and assess comprehension of basic content, thus permitting higher level in-class activities & lectures. No final exam Major poster presentation projects are a primary source of grades.
EOSC 372: Introductory Oceanography: Circulation and Plankton (Jan '09 start) Faculty: S. Allen, K. Orians, M. Maldonado, E. Lane STLF: Erin Lane	Course-level goals: complete Lecture-level goals: complete Assignment learning goals: complete	Mid-term survey End-of-term survey Daily online quizzes Pre-requisite knowledge diagnostic quiz Draft post test Student workloads questions	Widespread use of thought-provoking clicker questions Daily assignments with online quizzes In class demonstrations and analogies developed
EOSC 373: Introductory Oceanography: Climate and Ecosystems (Sept '09 start) Faculty: M. Maldonado, S. Allen, R. Francois, E. Lane STLF: Erin Lane	Course-level goals: complete Lecture-level goals: complete	Mid-term survey Draft diagnostic test Daily online quizzes	Widespread use of thought-provoking clicker questions Daily assignments with online quizzes
EOSC 472: Introduction to Marine Chemistry and Geochemistry (Sep '09 start) Faculty: K. Orians STLF: Joshua Caulkins	Course-level goals: complete, editing for new content Lecture-level goals: draft, editing for new content	Midterm and end-of-term surveys Reading quizzes introduced. Reworked homework sets. Term papers enhanced to be a "critical review paper" which includes greater depth of comprehension	Weekly worksheet activities Anonymous peer-reviewed writing assignment with instructor feedback Post-lecture student interviews Investigating new textbook options, perhaps introducing a packet of articles Name sticks used during lectures.

The following courses have undergone improvement without specific STLF help, or with ad-hoc support

EOSC 110: Using the Geoscience Concept Inventory to measure student learning - Faculty: M. Bevier
EOSC 116: Faculty: S. Sutherland
ATSC 201: Just-in-Time Teaching and clickers - Faculty: R. Stull
EOSC 223: Pre-post assessments and in-field assessments - Faculty: M. Bevier, STLF: J. Caulkins
EOSC 315: Clickers - Faculty: M. Lipsen
EOSC 324: No longer offered - Faculty M. Bevier
EOSC 328: GPS tracking of students, in-field assessments - Faculty: K. Hickey, STLF: J. Caulkins
EOSC 340: Just-in-Time Teaching and clickers - Faculty: S. Harris & P. Austin
EOSC 350: Team Based Learning - Faculty: D. Oldenburg

ENVR 200 & 300: Team projects, studying metacognition - Faculty: K. Chan, S. Harris, T. Ivanochko, M. Johnson, D. Steyn

Curriculum

Service Courses Curriculum Committee evaluated precedents, conducted surveys, and analyzed student data to articulate a list of learning goals for all service courses under the subheadings "Knowledge and Major Concepts", "Skills", and "Habits and Attitudes". The list was revised based on faculty input, was presented at the department's retreat in April 2009, and adopted by the department. Goals are posted on the departmental website.

Atmospheric Science Curriculum Committee defined program goals. (S. Allen, chair)

Environmental Science Curriculum Committee conducted student focus groups and extensive data analysis on student enrollment data and developed a set of recommendations and a revised curriculum (D. Steyn, chair)

Geophysics Curriculum Committee reinstated the Geophysics Majors program (E. Hearn, chair)

Geology Curriculum Committee proposed reinstating the Geology Majors program (K. Russell, chair)

Oceanography Curriculum Committee is actively working to define program goals & build links among courses. They have also created two new combined majors in Oceanography programs (with biology and with physics), and a new oceanography minor. (S. Allen, chair)

TA Development

Established a **TA training course** for graduate students (EOSC 516: Teaching and Learning in Earth & Ocean Sciences)
Course is run primarily by graduate students who have facilitator training. Enrolment is about 15/year

Learning goals: Course level goals, Learning goals for each session
Assessments: Using Physics' Teaching Attitudes Survey as Pre/Post, Formative Evaluation after each session, Summative Evaluation
Methods and materials: Mini-lesson practice, Group discussions, Lab redesign project

Research

Student Attitudes about Earth Science Survey (SAESS): Survey developed to gauge the students' attitudes and beliefs about learning earth & ocean sciences. The survey is administered in both majors- and non-majors courses early in the term (pre-) and late in the term (post-) to measure the effects of courses on student attitudes. It has been used in >25 courses both at UBC and other institutions. More than 8000 students have participated since the survey began.

Classroom Observations, Protocol & Results: We developed an objective, quantitative classroom observation protocol to measure student engagement in a large first year Oceanography course. Observation data show that student engagement is strongly correlates to teaching practices and is higher when instructors employ active learning techniques. Observations of three instructors with different teaching expertise showed similar trends in engagement. The classroom observation data help identify best teaching practices and provide continual feedback to instructors.

Undergraduate Thesis Research: Jamil Rhajiak completed an Honours thesis entitled "Understanding Geological Time: A Proposed Assessment Mechanism for Beginner and Advanced Geology Students" (2009). Alison Jolley completed an honours thesis entitled "Identifying Landscapes and their Formation Timescales: Comparing Knowledge and Confidence of Beginner and Advanced Geoscience Undergraduate Students" (2010). Carrie Wong is currently working on an honours thesis investigating spatial visualization abilities of beginner and advanced earth science students.

Other Research: Effects of multiple instructors in single courses; using pair programming in EOSC 211; pre-post test results from various courses; impacts of group exams; effects of instructor interventions on low-performing students; developing field expertise; developing scientific thinking skills; student workloads and comparative workloads; changes in student evaluations.

Other

EOS-SEI Times: Approximately monthly newsletter containing results from courses, tips and information for instructors (17 editions so far)

Brown Bag Seminars: Both weekly drop-in sessions called "The STLF is IN" and special topics discussions.

Learning Goals Workshops and clicker workshops: several facilitated by STLFs for participants outside EOS.

Visitors: Cathy Manduca, director of the Science Education Resource Center at Carleton College; Eric Riggs, co-director of the Center for Research and Engagement in Science and Mathematics Education, Purdue University; Leslie Reid, Tamaratt Teaching Professor, University of Calgary; Frank Granshaw, Portland Community College; Anne Marie Ryan, Dalhousie University

Exit Survey: An online survey has been developed for graduating 4th year EOS students from all streams. The exit survey will provide us with student perspectives on the EOS academic program, career goals and curriculum recommendations. This information will help us improve our program structure, content, and courses. The survey was initiated in April 2009 and administered annually since then. The results of the 2010 and 2011 Graduating Exit Surveys have been processed. Future considerations may include an alumni survey.

Life Sciences Program

The Life Sciences Program (Depts. of Zoology, Botany, and Microbiology & Immunology) received its first funding from CWSEI in 2007. The funding was renewed and extended in 2011with three new STLFs starting in late 2011 and beginning of 2012. The new funding will allow STLFs to work with all second year core courses in the newly designed and implemented Biology Program at UBC. . We are currently implementing interactive activities and peer discussion in second year core courses as well as some first and third year courses. Some examples of these are: iClicker questions, worksheets, case studies, learning activities, and invention activities. We have also implemented learning goals and pre-reading assignments in most courses work on. In addition, conceptual inventories in information transfer and community and population ecology have been developed and are used to evaluate the effectiveness of various class activities.

SEI Director: P. Schulte
STLFs: J. Taylor, M. Hansen, M. Banet, B. Clarkston, L. McDonnell, H. Yurk (emeritus), T. Kelly (emeritus)
Faculty (instructors teaching targeted courses): K. Smith, G. Spiegelman, G. Bradfield, W. Goodey, R. Turkington, M. O'Connor, E. Hammill, P. Kalas, S. Chowrira
Faculty (others involved in working groups, committees, or ad-hoc support): G. Bole, C. Pollack, A. O'Neal, K. Nomme, B. Couch
Skylight Affiliate: G. Birol
Students and Post-Doctoral Fellows: T. Deane, E. Jeffrey, R. Oh, M. Tseng, N. Wang, P. van Stolk

Course Transformation

Course	Learning Goals	Assessments	Improved methods
BIOL 111: Cell and Organismal Biology (Sept '07 - Sept '08) Faculty: K. Nomme, J. Klenz Skylight Liaison: G. Birol	Course-level goals: complete Topic-level goals: complete	Midterm student evaluations Focus groups Biology attitudinal survey Clicker questions	Case studies Group activities Vista reading quizzes Peer tutor support Intentional alignment of topics with student work and assessment Clicker questions
BIOL 112: Cell Biology (Sept '07 start) Faculty: E. Gaynor, T. Kion, G. Spiegelman, STLF: Jared Taylor	Course-level goals: complete Topic-level goals: complete	End-of-term surveys Student interviews to assess problem solving abilities End-of-term assessment of learning and invention groups to assess transfer abilities Biology attitudinal survey	Developed and refined a series of invention/investigation activities for in class once per week. Just-in-Time Teaching incorporated with pre-class readings. In-class writing assignments iClickers End of week problems PeerWise used in all sections PeerWise workshops were implemented in an attempt to give the students some guidance in writing better multiple choice questions.
BIOL 121: Ecology, Genetics and Evolution (Sept '07) Faculty: C. Pollock, G. Bole, P. Kalas, B. Couch, A. O'Neill Skylight Liaison: G. Birol	Course-level goals: complete Topic-level goals: complete (revised and extended for the ecology unit in '11)	Mapping of multi-section course outcomes onto assessments Biology attitudinal survey Meiosis concept inventory (in preparation)	Peer tutors Learning centre PeerWise used in some sections. Writing project with Rosie Redfield, 2008/09 iClickers implemented in most sections Testing of conceptual inventory in community and population ecology ('10). The conceptual inventory in community and population ecology has been used to evaluate the effectiveness of in-class activities (Kalas '11).

BIOL 201: Cell Biology II: Introduction to Biochemistry (Jan '08 – Sept '08) Faculty: W. Bingle, S. Chowrira, J. Richards STLF: Jared Taylor	Lecture -level goals: complete	Chemistry concept pre-test Focus group interviews Focus group follow-up survey (entire class) Biology attitudinal survey	Recommendations provided to faculty.
BIOL 204: Vertebrate Structure and Function (Jan '08- May '08) Faculty: B. Milsom, A. O'Neill	Course-level goals: complete Topic-level goals: complete	Clicker questions Post test: Vista Reading/Content quizzes	New study questions Midterm teaching evaluations Improvement of group activities and discussions in class Revised course content and lecture materials incorporating real life examples. Enhanced problem solving approach including comparisons.
BIOL 230/304: Fundamentals of Ecology (Sept '09 start) Faculty: R. Turkington, W. Goodey, E. Hammill STLF: Malin Hansen	Topic-level/ class specific goals: completed and provided to students Learning goals have been linked to exam question, iclicker questions and pre-reading questions.	The CLASS pre and post biology attitude surveys have been used in all sections each term (2009-2011). A pre/post conceptual survey for community and population ecology has been developed and is used. Student interviews have been conducted to assess class activities and methods and to validate conceptual survey. Midterm survey has been developed and is used to assess class activities and methods.	iClickers are used. Pre-reading assignments with multiple choice and open ended question (with feedback) are issued each week. Small group in-class discussions have been incorporated. Twenty-three on-line article based practice problems/case studies have been developed. Some of them have been implemented as in-class learning activities. Three mandatory field labs have been implemented. Two tutorials have been designed and implemented (for summer courses only). The conceptual inventory in community and population ecology has been used to evaluate the effectiveness of in-class activities (Instructor: Roy Turkington and Wayne Goodey '11). The effectiveness of using analogies when teaching ecology was evaluated using optional tutorials ('11).
BIOL 306: Advanced Ecology (Jan '10 start) Faculty: G. Bradfield, W. Goodey, M. O'Connor STLF: Malin Hansen	Topic-level/class specific goals: completed and provided to students	The CLASS pre and post biology attitude surveys have been used in all sections each term ('10-'11). A pre/post conceptual survey for advanced ecology has been developed and is used. Student interviews have been conducted to assess class activities and methods and to validate conceptual survey. Mid-term survey has been developed and is used to assess class activities and methods.	iClickers are used. Pre-reading assignments with multiple choice and open ended questions (with feedback) are issued each week. Small group in-class discussions have been incorporated. Twenty-three on-line article based practice problems have been developed. Some of them were implemented as in-class learning activities in '11 (approximately one learning activity per week). Three mandatory field labs have been implemented. Two tutorials have been designed and implemented (for summer courses only).
BIOL 310: Introduction to Animal Behaviour (Jan '11 start) Faculty: W. Goodey	Topic-level/class specific goals: completed and provided to students Learning goals have been linked to exam question,	The CLASS pre and post biology attitude surveys have been used in all sections each term ('10-'11). A pre/post conceptual/attitudinal survey has been developed by the	iClickers are used. Pre-reading assignments with multiple choice questions (with feedback) are issued each week. Small group in-class discussions have been

STLF: Malin Hansen	iclicker questions and pre-reading questions	instructor and is used. Mid-term survey will be developed and used.	incorporated. An entire 50 min lecture per week is devoted to an in-class group discussion activity. Mandatory field labs have been part of the course for some years. Student project and associated poster presentation have been part of the course for some years.
MICB 302: Immunology (Sept '11 start) Faculty: P. Johnson STLF: Jared Taylor	Learning goals: in the process		
MICB 325: Microbial Genetics (Jan '11 start) Faculty: T. Beatty STLF: Jared Taylor	Learning Goals: complete	A newly developed Bacterial Gene Regulation Concept Inventory is being used in a trial run.	Currently tutorial/homework questions are being converted into clicker questions that will be used during a weekly 50-minute tutorial lecture. Currently undergoing transformation to use a full active learning with JiTT format.

Transformations in the following courses have been undertaken by individual faculty members (with advice provided by CWSEI-Life Science Departmental Director)

Microbiology 300: Microbial Ecology (Faculty: W. Mohn) – Course-level and topic-level learning goals completed, survey, in-class group problems, poster made by learning group, in-class and out-of-class student learning group problems, clickers.

Microbiology 409: Advanced Microbial Genetics (Faculty: S Hallam) – Course-level and topic-level learning goals completed, student survey, in-class workshops suing groups of students, clickers.

Curriculum

Evidence Based Approach to Curriculum Design:

- **Concept Inventories:** Jared Taylor and Liz Imrie with help from George Spiegelman developed gene regulation concept inventory in BIOL 112 which has now been validated and is being deployed in some large classroom settings. A smaller version of the inventory has been used in Biology 112 as a pre-test, and they plan on running the full inventory as a post-test. Additionally, the inventory is being deployed in MICB 325 as both a pre and post-test. Malin Hansen developed a concept inventory in population and community ecology which has been validated and is used to evaluate the effectiveness of in-class activities in both BIOL 121 and BIOL 230/304.
- **4th year Biology Satisfaction Survey:** Evaluation of Student Satisfaction and Skills by Harald Yurk and Gülnur Birol provided evidence about student satisfaction and areas for improvement in the program.
- **Attitudinal Survey:** The CLASS pre and post biology attitude surveys have been used in several first, second, third and fourth year courses between 2009-2011. This is part of a longitudinal study where we investigate shifts in students' attitudes towards biology from first to fourth year.
- **Ecological Attitude Surveys:** Harald Yurk conducted surveys on ecological attitudes of students before and after ecology instruction and at different program levels 1st, 3rd, and 4th year, and grad students. The survey use was based on the learning goal that ecology education should build an informed citizenry which can be measured as an attitude change towards environmental issues.
- **Chemistry Concepts:** Jared Taylor conducted a review of UBC biology courses to determine the required chemistry knowledge. As a starting point, the required courses for the Cell Biology and Genetics (CB&G) program were analyzed to determine the relevant chemistry content. This was followed by a general survey of other UBC biology courses. The report provided important insight into decisions regarding the chemistry content.
- **Concept Tests:** Investigating Conceptual Understanding of Natural Selection: Harald Yurk has been assessing conceptual understanding of natural selection in 1st and 3rd year students before and after instruction, using a multiple choice survey (Conceptual Inventory of Natural Selection, CINS, developed at San Diego State University). The CINS measures the presence and absence of the seven key principles of natural selection plus three other concepts that are related to natural selection but are not considered key concepts, such as speciation. Harald also used another short answer instrument in BIOL 336 to test for common misconceptions about natural selection.
- **UBC PAIR data**
- **Focus Group Interviews:** e.g. BIOL 111, BIOL 121, BIOL 201, 4th year students 2007-2009
- **Learning Objectives:** At present 16 out of 51 biology courses (200 level and up) have topic level learning objectives, some of which were developed by faculty members only and some other with the help of STLFs. In addition, all first year biology lecture courses have topic level learning objectives. These objectives are helpful to guide the work of discipline specific committees in identifying the depth and breadth of concepts.

Organizational Planning:

- Biology Program curriculum working group has proposed extensive changes to the program. G. Birol is on the committee with faculty from Botany and Zoology.
- Established a methodology for developing learning objectives (e.g. Angie O'Neill's work within the scope of BIOL 204 resulted in development of 3rd year physiology courses' learning outcomes with Trish Schulte and Agnes Lacombe)
- Developed a comprehensive project plan for the new upper level ecology courses led by Diana Srivastava with the help of Harald Yurk 2007/2008.

Research

CWSEI funded:

- **Learning Objectives:** Jared Taylor in collaboration with Beth Simon, STLF in Computer Science, conducted a study of student and faculty perceptions of the usefulness of learning goals. Their paper on this work is accepted for publication in the Journal of College Science Teaching.
- **Invention Activities:** Jared Taylor, George Spiegelman and Karen Smith are conducting a study of the effectiveness of invention activities and learning group activities in developing students' reasoning/problem solving skills and ability to transfer knowledge to novel situations.
- **Biology Attitudinal Survey:** Gulnur Birol and Malin Hansen are working on a study that compares student attitudes in first and third year courses. The CLASS pre and post biology attitude surveys have been used in several first, second, third and fourth year courses between 2009-2011. This is part of a longitudinal study where we investigate shifts in students' attitudes towards biology from first to fourth year.
- **Learning Activities/Case Studies:** The concept inventory in population and community ecology has been used to evaluate the effectiveness of in-class activities in both BIOL 121 and BIOL 230/304.
- **Use of analogies to teach ecology:** The effectiveness of using analogies when teaching ecology was evaluated using optional tutorials in BIOL 230/304 in the fall of 2011.
- **Student Satisfaction Survey:** Harald Yurk and Gülnur Birol investigated student satisfaction within the biology program. In April 09, 2009, student responses were collected in fourteen forth year biology courses. The analysis of the data is completed. As part of the project, we are planning to conduct surveys with potential employers of life science graduates to assess needs of employers with regard to the biology curriculum and general scientific skill sets. A special assistant has been hired for this latter project.
- **Writing Assignment Study:** Rosie Redfield and Tamara Kelly conducted a study on the effect of different types of assignments on student's writing and clarity of thought January – April 2008.

Spin-off projects with funding from other resources (e.g. TLEF, Skylight, Faculty/Graduate Student Teaching Certificate Program) in addition to CWSEI funding:

- **Course Curriculum Mapping in a Multi Section Course:** Angie O'Neill, Gülnur Birol and Carol Pollock have submitted a paper on the teaching and assessment of learning outcomes in a multi-section first year biology course.
- **Non-majors Biology Course Development:** Kathy Nomme and Gülnur Birol are conducting a study on student attitudes and beliefs towards biological sciences in a non-majors first year biology course using focus group interviews, midterm evaluations and attitudinal survey data.
- **Study Habits of Students in a 2nd year Biology Course:** Gülnur Birol, Lacey Samuels, Ellen Rosenberg and Joanne Nakonechny are conducting a study on students' study habits in BIOL 200 using both quantitative and qualitative data collected over a period of three years.
- **Questions for Biology:** Two Skylight grants were obtained to begin developing concept questions for first year Biology courses using material collected in BIOL 112 and BIOL 121. People involved are Jared Taylor, Gulnur Birol, Leah MacFadyen, George Spiegelman. Karen Smith, Tracy Kion, Carol Pollock, Angie O'Neill, Pam Kalas, Carol Pollock and Jennifer Klenz.

Other

- **BIOL 310: September - December 2008** Leticia Aviles and Harald Yurk conducted a study on the usefulness of group discussions in class through in-class observations and focus groups.
- **MICB 202: January – April 2008:** Yiannis Himaras did a MICB 448 project under the supervision of Tracy Kion and Gülnur Birol to conduct an exploratory project to investigate student learning in MICB 202.

Mathematics Department

Starting in 2008, the UBC Mathematics Department is participating in the Carl Wieman Science Education Initiative (CWSEI) to improve undergraduate science education. In 2010 the Math-CWSEI program has undergone a major expansion thanks to the generous donation by Prof. David Cheriton, UBC alumnus, now Professor of Computer Science at Stanford University.

An important first step for the Math CWSEI in all the courses involved in the project is to write down a set of learning goals. Learning goals (also called "learning outcomes" or "learning objectives") make explicit what the students are expected to be able to do at each stage of the course. They are useful to instructors in preparing tests, and assessing the success of a course. In lower level courses, where the students and instructors may start out thinking about the material in radically different ways, learning goals can help to focus the instruction at the appropriate level. They provide a communication channel for successive instructors in a given course, so that effort in improving pedagogy is transmitted. Made available to students, they help students assess their understanding and to prepare for exams.

An important last step for all the projects in the Math CWSEI is the archiving of materials in the SEI Course Materials Archive. This archive contains material developed by departments participating in the CWSEI at UBC, and is intended to be an open resource for educators.

In 2008-2009 our projects were concentrated in two areas.

The first area, soon to be completed after final observations, is computing and computer labs in Math 152, Math 256 (Mech 221), Math 257/316, Math 253 (Mech 222), and Math 307. These courses have all recently introduced computing as an intrinsic part of the course. The Math CWSEI helped in the creation of tutorials and lab materials, assisted in integrating the computational component into the course material and developing testing methods, and assessed the effectiveness of the computational component.

The second area, also in its final year of observations, is support for the Math 180/184 workshops and the Basic Skills Test. The Math CWSEI helped to assess the effectiveness of the problem-solving workshops and assisted in the study of how well the Basic Skills Test predicts success in a first-year Calculus course. The Basic Skills Test is under further review and will hopefully evolve as part of a more comprehensive incoming assessment strategy.

In 2009-2010 our focus was mainly in-depth assessment of student activities and engagement, improvements to course materials based on data collected in the previous year, and better coordination of workshops and labs with course lectures. Development for work on Math 220, a course dedicated to proof skills, began in early 2010. Study and transformation of this course will be a multi-year project with tracking of skills to later courses. In addition to the existing projects, the Math CWSEI also helped in developing and implementing assessment strategies to measure students' attitudes toward computer labs in Math 102 and Math 103, as well as the effectiveness of a new online homework system in use in a number of first year Calculus courses. The Math CWSEI also provided resources to help with the course transformation in Math 318.

SEI Director: Costanza Piccolo (current), Stephanie van Willigenburg (2009-10), Richard Froese (2008-09)

STLF: Warren Code, Sandra Merchant, Joseph Lo, Katya Yurasovskaya Paul Ottaway (emeritus, Sept-Dec '09)

Faculty: Currently involved: A. Chau, M. Doebeli, R. Froese, R. Gupta, F-S. Leung, P. Loewen, M. MacLean, A. Rechnitzer, G. Slade, M. Ward, B. Wetton. Involved in past projects: R. Anstee, L. Keshet, A. Peirce.

TA's and Postdocs: Currently involved: P. Bell, A. Herrera, V. Kapoor, R. Liang, M. Raggi, A. Zaman. Involved in the past: M. Berube, D. Karslidis, A. Lindsay, R. Schwarz, A. Raghoonundun (with Skylight support), G. de Oliveira, W. Thompson, M. Willoughby.

Course Transformation

Course	Learning Goals	Assessments	Improved methods
MATH 104/184: Differential Calculus for Social Sciences (Jan '10 start) Faculty: M. MacLean STLF: Warren Code TA: M. Raggi ('10), L. Robson ('11) Poster: MAPS: Math Attitude and Perceptions Survey (developed by STLFs Warren Code, Joseph Lo, Sandra Merchant)	Course-level goals: second draft complete Topic-level goals: second draft complete and incorporated into weekly "learning guides" for instructors with specific textbook examples for each goal.	*All sections*: -Attitude survey with short diagnostic test -Instructor interviews -Class observations *MacLean's sections*: -Midterm and end-of-term surveys -Clicker session data -In-class activity audio + written Methods Comparison ('11) -Math 104 Calculus Diagnostic to measure student calculus background from high school. -Topic quizzes for Related Rates and Linear Approximation.	*All sections*: -Developed weekly "learning guides" for instructors to enhance coordination; guides incorporate learning goals, practice problems and pedagogical approaches and issues. -Developed common online and paper homework assignments. -Facilitated weekly instructor meetings *MacLean's sections*: -Developed in-class activities and clicker questions. Methods Comparison ('11) -Structured class notes, lesson plans, clicker questions and pre-reading assignments for the Related Rates and Linear Approximation weeks, with evidence of better conceptual learning over more traditional instruction.

MATH 180/184: Differential Calculus (Workshop component) (Sept '08 start) Faculty: R. Gupta, A. Chau, R. Anstee STLF: Costanza Piccolo (2008-10), Warren Code ('11) TA: V. Kapoor, R. Schwarz, A. Zaman Transformation completed in Fall '11.	Course-level goals: complete Workshop goals: complete	Midterm and end-of-term surveys on workshop activities and student attitudes. Weekly quizzes Class observations	Workshops 1-12 complete: added workshop-level learning goals and list of required basic skills; created new problems with course-specific applications; developed problem solving strategies. Program Structure and Management: Expanded the administrative structure and TA training; developed problem database (with Skylight support) to ease weekly production of workshop material.
MATH 110: Differential Calculus (Sept '10 start) Faculty: F. S. Leung STLF: Joseph Lo	Course-level goals: complete Workshop goals: complete	Diagnostic Test on Basic Skills Attitude and study habit survey Midterm class and workshop surveys Class observations of workshops and lectures	New workshop format developed to address low student engagement in workshop activities. Online homework assignments used in all sections. Archiving of course material for future use Weekly remedial work on basic skills.
MATH 152: Linear Systems (Computer Labs component) (Sept '08 start) Faculty: B. Wetton STLF: Warren Code (current), Costanza Piccolo ('08-'09) TA: A. Lindsay Transformation completed in 2010. Poster: Redesign of Computer Labs for Engineering Students in a Linear Algebra Course	Course-level goals: complete Topic-level goals: complete	End-of-term lab surveys Pre/post-tests on Matlab syntax and basic programming structures. Pre/post-tests on translation of word problems into linear systems. Lab observations and TA interviews to determine student difficulties and completion rates.	Labs rewritten to tie in more closely with the course material, and revised after a full term of use. Paper-based homework, midterm exam and final exam questions developed to test/practice Matlab syntax and basic programming structures. Lecture notes revised to include Matlab material.
MATH 210: Introduction to Mathematical Computing (Sept '11 start) Faculty: D. Schotzau STLF: Joseph Lo	Topic-level goals: complete	Diagnostic test on series Computer-based exams Student survey Class and lab observations	Course curriculum has been substantially changed. All standard course materials (course outline, lecture notes, assignments and exams) have been redeveloped.
MATH 220: Mathematical Proof (March '10 start) Faculty: A. Rechnitzer STLF: Katya Yurasovskaya (current), Sandra Merchant ('10)	Course-level goals: first draft complete. Topic-level goals: first draft complete	Proof diagnostic pre/post test Midterm and end-of-term survey Student interviews after lectures to monitor difficulties and effectiveness of class activities.	Additional practice problems and solutions were prepared for midterm 2 and the final exam. In-class proof activities were run. More activities will be developed.
Math 230/335: Mathematics for Elementary Teachers (June '11 start) Faculty: S. van Willigenburg, J. MacDonald STLF: Katya Yurasovskaya	Course-level goals – complete Topic-level goals- complete Comments by instructor added as a teaching aid for future instructors.	Diagnostic pre/post test, which also includes survey-type questions on student career plans and attitudes/beliefs regarding mathematics.	A list of study tips for students specific to the course and the audience. A set of study skills and tips relevant to future teachers of elementary educations students. A website with resources and useful links has been put together for future departmental use.

Math 253 (Mech 222): Multivariable Calculus (Computer Labs component) (Sept '08 start) Faculty: P. Loewen STLF: Warren Code TA: M. Willoughby, W. Thompson Poster: How do novices spend time programming in MATLAB?	Goals incorporated into weekly learning guides and lab documents. Substantial detail added in the second year.	Weekly surveys of student completion rates and attitudes. Lab observations and TA interviews to determine most significant student difficulties. Automated student session logging to measure time spent on various tasks and frequency of common syntax errors (improved from trial run in Math 256). Pre-lab quiz late in the term to track basic skills and measure interpretation of MATLAB code.	Labs have been updated to tie in more closely with the course material, and have been further revised based on data from the first implementation with evidence of more collaboration, higher completion rates and more positive student attitudes due to the revisions. MATLAB resource web page developed for student reference, especially for those with weaker backgrounds.
Math 256 (Mech 221): Differential Equations (Computer Labs component) (Sept '08 start) Faculty: B. Wetton STLF: Warren Code (current), Paul Ottaway (Sept-Dec '09), Costanza Piccolo (08-09) TA: W. Thompson Transformation completed in 2010. Poster: How do novices spend time programming in MATLAB?	Learning goals: complete	Lab observations and TA interviews to determine most significant student difficulties. End of term student attitude surveys. Trial run of automated student session logging to measure time spent on various tasks and frequency of common syntax errors.	New labs have been developed and revised based on feedback from the first two offerings. Matlab demonstrations have been used in lectures. Targeted questions have been designed for the final exams and used to assess learning in the lab sessions. MATLAB resource web page developed for student reference, especially for those with weaker backgrounds.
Math 257/316: Partial Differential Equations (Computer Labs component) (Sept '08 start) Faculty: A. Peirce STLF: Costanza Piccolo TA: G. de Oliveira Transformation completed in Fall '11.	Topic-level goals: complete	Student survey about attitudes towards the use of spreadsheets and the learning of numerical methods in the course.	Course-specific, online Excel tutorials are completed; sets of homework assignments, in-class demos using spreadsheets, and a Powerpoint presentation on numerical methods have been developed.
Math 305: Applied Complex Analysis (Sept '10 start) Faculty: M. Ward STLF: Joseph Lo TA: P. Bell	Topic-level goals: complete	Diagnostic assignment on series End-of-term survey	This is a newly-developed course. All standard course material (course outline, lecture notes, assignments, and exams) has been developed from scratch.
Math 307: Applied Linear Algebra (Computer Labs component) (Sept '08 start) Faculty: R. Froese STLF: Costanza Piccolo TA: A. Raghoonundun Transformation completed in Fall '11.	Course-level goals: revision is completed Topic-level goals: revision is completed	Student surveys Pre-reading/diagnostic quizzes Special homework assignments with extensive use of Matlab	Lecture Notes have been updated extensively. Matlab/Octave resource page has been developed. Basic Matlab/Octave tutorials have been developed, including a set of practice problems on basic syntax and programming.
MATH 318: Probability with Physical Applications	Course-level goals: complete	Tracked scores on computer-based homework exercises and	Octave/Matlab-based questions drafted for each of the homework assignments, as well as to each of the two midterms and the final

(Computer-based component) (January '10 start) Faculty: G. Slade Postdoc: Richard Liang Transformation completed in Fall '11.	Topic-level goals: complete	exam questions. Mid-semester and end-of-semester attitude surveys	exam. Octave resource webpage constructed (based on the Math 307 resource page) to assist the students in getting started with using Octave.
MATH 360: Mathematical Modeling in Science (January '10 start) Faculty: M. Doebeli STLF: Costanza Piccolo (current), Sandra Merchant ('10)	Course-level goals: complete	Computer-based exams Midterm student survey Class observations	Metlab-based in-class activities were developed for weekly labs.

Physics and Astronomy Department

Physics & Astronomy received seed funding in 2007 and began the efforts listed below in the Fall of that year. The department moved to full funding starting in 2008 and now has a complement of five STLFs: Peter Newbury, Louis Deslauriers, and Cynthia Heiner are full-time, Jim Carolan is an emeritus faculty member, and James Day and Ido Roll are part-time.

SEI Director: Geog Rieger, Mona Berciu (emeritus), Doug Bonn (emeritus)
STLFs: Jim Carolan, James Day, Louis Deslauriers, Peter Newbury, Ido Roll, Cynthia Heiner
Faculty: D. Bonn, J. Folk, B. Gladman, J. Iqbal, D. Jones, A. Kotlicki, K. Madison, J. Matthews, H. Richer, I. Stairs, M. Van Raamsdonk, S. Reinsberg, G. Rieger, L. Van Waerbeke, C. Waltham, C. Wieman, J. Zibin, S. Burke, D. Witt.
Students: S. Martinuk, D. Mazur, B. Ramshaw, M. Warren, S. Vafaei, C. Veenstra, R. Wong, N. Holmes, E. Schelew, T. Vernstrom

Course Transformation

Course	Learning Goals	Assessments	Improved methods
ASTR 310: Exploring the Universe I: The Solar System (Summer '08 start) Faculty: B. Gladman,, H. Richer STLF: Peter Newbury Grad Students: M. Milkeraitis, S. Lawler, M. Gendre, S. Vafaei	Course-level goals: complete Topic-level goals: complete	Improved midterm and final exam questions based on assessing learning goals.	Created 6 activities for tutorials including guidelines for TAs for facilitating the activities. Using MasteringAstronomy for Just-in-time teaching (Gladman) Aligning lecture material with learning goals Peer instruction using clickers (Richer) Using Lecture-Tutorial workbooks (Richer)
ASTR 311: Exploring the Universe II: Stars and Galaxies (Summer '09 start) Faculty: I. Stairs, J. Heyl, L. Van Waerbeke, J. Zibin. STLF: Peter Newbury Grad Student: M. Gendre, T. Vernstrom	Course-level goals: complete Topic-level goals: complete	Developed pre/post concept test for tutorial activities Improved final exam based on learning goals. Light and Spectroscopy Concept Inventory (LSCI) pre- and post-test (Stairs) Pre-, Post-testing with the Test of Astronomy Standards (TOAST).	Developed 7 50-minute activities for tutorial sessions including guidelines for TAs for facilitating the activities. Intense focus on learner-centered instruction: peer-instruction with clickers, lecture-tutorial workbook, in-class worksheets (Stairs).
PHYS 100: Introductory Physics (Sept '07 start) Faculty: G. Rieger, A. Kotlicki STLF: Ido Roll (current), Jim Carolan, Louis Deslauriers Grad Student: S. Martinuk	Course-level goals: complete Topic-level goals: complete Lab goals revised towards skills development	Conducted study on impact of learning goals on student self assessment of understanding Lab diagnostic developed & interviews conducted. Improved the lab skills assessment - given to students on the first and last weeks of the term. Conducted study comparing different forms of invention activities and support for group work.	Provided feedback for clicker question improvement and more student engagement in lectures. Lab write-ups revised for '09 and again for '10. Revised the labs – they now include a homework component in which students do the actual experiments prior to coming to the lab for data analysis. The labs and homework build on top of each other so that each component is required for the subsequent task.
PHYS 101: Energy and Waves (Sept '07 start) Faculty: F. Bates, G. Rieger, C. Heiner, J. Iqbal, A. Mackay STLF: Cynthia Heiner (current), Peter Newbury	Course-level goals: compete Topic-level goals: complete	Conducted survey targeting students approach to and learning from pre-readings, clickers, and in-class worksheets. .	Developed new lab experiments on measurement/uncertainty and interference. Developing in-class activities and worksheets (Rieger)
PHYS 102: Electricity, Light and Radiation (Sept '09 start) Faculty: F. Bates STLF: Peter Newbury		Creating pre-lab exercises using PhET simulations	Revising lab experiments
PHYS 107 & 109: Physics 1 lab and Intro to Experimental	Course-level goals: complete	Developed & validated physics	Developed 15 invention activities on data

Physics (Sept '07 start) Faculty: D. Bonn STLF: James Day, Ido Roll Grad Student: N. Holmes	Topic-level goals: complete	lab pre-post diagnostic. Conducted study on the impact of invention activities completed preceding versus following a lesson. End-of-term survey Conducting study on the impact of structure in invention activities Conducting study on how students practice their scientific reasoning skills during invention activities and whether these skills improve over the term Statistics diagnostics added to gauge cumulative effect of state-focused invention activities.	interpretation and analysis. Developed marking rubrics for all labs and for formal reports. Incorporated classroom discussion of pros and cons of novel student solutions to invention activity problems. Invention activities and associated instruction now delivered by computer (the Invention Support Environment).
PHYS 107: Enriched Physics I (Sept '10 start) Faculty: I. Affleck STLF: Jim Carolan	Course-level goals: complete Topic-level goals: under development	Pre and post concept surveys completed ('10 and '11) Lecture observations Student post course interviews completed for '10 and in progress for '11. Pre and post problem solving skills surveys completed '11.	Clicker use – developed Online pre reading quizzes – developed In-class activities – worksheets developed
PHYS 153: Elements of Physics (Sept '10 start) Faculty: S. Burke, D. Witt, A. Kotlicki STLF: Cynthia Heiner (current), Louis Deslaurier	Course-level goals: complete Topic-level goals: complete	Compared student performance on exams in transformed course vs. earlier traditional version.	Bank of clicker questions In-class activities for entire term Peer instruction Learning goals were referred to throughout the course for aligning material and for creating exams.
PHYS 153: Elements of Physics (LAB) (Nov' 11 start) Faculty: J. Young, M. Hasinoff, B. McCutcheon, D. Witt, B. Unruh, E. Koster. STLF: James Day	Course-level learning goals: complete	Two final lab exams created, closely aligned with course-level learning goals.	Three tutorials created to provide students with basic skills needed for the rest of course (i.e. use of spreadsheet and basic stats, uncertainty analysis, and linear regression). Rubrics created for individual labs. Brief pre-lab exercises created. Implementation of online post-lab submission.
PHYS 200: Relativity and Quanta (Sept '08 start) Faculty: M. Van Raamsdonk STLF: Louis Deslauriers	Course-level goals: complete Topic-level goals: complete	Lecture observations Final exam questions Analyze Mid-term Midterm & end-of-term survey Observe HW sessions	Weekly interactive tutorials developed Improved clicker questions
PHYS 250: Introduction to Modern Physics (Jan '09 start) Faculty: L. Deslauriers, C. Wieman STLF: Louis Deslauriers	Course-level goals: complete Topic-level goals: complete	Development of an extended Quantum Mechanical Conceptual Survey Lecture observations Final exam questions Dual individual/group exam (we filmed them in Sum 2010) Analyze Mid-term	Weekly tutorials developed Bank of clicker questions In-class activities for entire term Measurement of long term retention for the quantum part of course Demonstrated a successful intervention with lower performing students

		Midterm & end-of-term survey Observe HW sessions Measuring long term retention of quantum concepts	
PHYS 304: Quantum Mechanics (Jan '10 start) Faculty: K. Madison STLF: Louis Deslauriers	Course and topic-level goals: 80% complete	Lecture observations Observe HW sessions Measured effect of BONUS clicker questions on student engagement during voting period. Compared student performance to previous terms – transformed course scores are consistently higher Measured student engagement in general. Compared it to other course the eng phys cohorts were taking at the same time.	Creating a bank of clicker questions Designing in- class activities for every lecture Improved engagement during clicker questions by adding BONUS questions.
PHYS 315: Physics of Materials (Sept '11 start) Faculty: V. Hinkov STLF: James Day	Course-level goals: complete Topic-level goals: complete	Homework assignments closely aligned to learning goals.	New clicker questions drafted & older clicker questions improved. Training on delivery of clicker questions and subsequent results. In-class group activities Implementation of pre-reading. One lecture video taped so that instructor can associate objective feedback on style with actual footage. Formative midterm and year-end feedback form created.
PHYS 401: Electromagnetic Theory (Sept '11 start) Faculty: D. Bryman STLF: Peter Newbury	Course-level goals: draft Topic-level goals: drafted for 1 of 3 topics		Creating in-class worksheets and clicker questions aligned with learning goals. Focus on moving from instructor-centred to student-centred instruction.
PHYS 408: Optics (Sept '09 start) Faculty: D. Jones STLF: Louis Deslauriers	Course-level goals: complete Topic-level goals: complete	Development of a Optics Conceptual Survey Lecture observations Final exam questions Analyze Mid-term Observe HW sessions Compared student performance to previous terms – transformed course scores are consistently higher Measured student engagement in general. Compared it to other course the eng phys cohorts were taking at the same time.	Created a bank of clicker questions In-class activities for entire term Developed a remedial tutorial for students lacking pre-requisite in signal processing (Fourier Transforms)

PHYS 450: Quantum Mechanics (Jan '09 start) Faculty: J. Folk STLF: Louis Deslauriers	Course and topic -level learning goals: 95% complete	Lecture observations Analyze Mid-term Observe HW sessions Conducting study on impact of student peer discussions vs. classic instruction on students' knowledge retention	Created a bank of clicker questions (including isomorphic questions to test longer-term retention)

PHYS 170 & 270 – Mechanics diagnostic surveys are being administered annually to monitor conceptual learning gains and aid future course development. Clicker usage is being encouraged in the large multi-section engineering course, PHYS 170, with lecture observation and advice from STLF Jim Carolan
PHYS 101 & 108 - clicker usage is being developed and improved in these large freshman courses with extensive observation and advice from STLF Jim Carolan

Curriculum

Extensive diagnostic testing by Jim Carolan and Louis Deslauriers is starting to uncover information that will inform upcoming curriculum decisions. These will likely include a new 'terminal' physics stream that starts with PHYS 100, but does not then go into the usual 101/102 sequence for which the students' mechanics preparation is insufficient. Extensive testing of first and upper year students using an electricity and magnetism concept survey (BEMA) is providing information on learning gains and retention. The results from the survey are being used in decisions about merging the Eng. Phys and Honours Phys. streams of E&M. These results will also feed into upcoming decisions about the freshman treatment of E&M concepts. Efforts are also getting underway to optimize the way in which various E & M topics are covered in various courses, at all levels, to formulate a set of coherent learning goals for all such courses and to insure that all faculty wills strive to achieve these learning goals in the future.

The large first-year physics courses (PHYS 101 & PHYS 102) include 6 3-hour lab experiments. Because it is so difficult to sync the concepts presented in multiple lecture sections with the experiments, we are trying to convert the lab experiments to self-contained "learning units." These would include pre-lab exercises and lab activities that contain all the necessary information. Wherever they are in the sequence of lectures, instructors could use these experiments to preview what's coming next, to reinforce what they're currently covering, or to wrap up already-covered topics. The development and testing of several activities and pre-lab exercises started in the small, Summer PHYS 102 section, in preparation of the full PHYS 102 course in January 2011.

TA Development

Graduate student Mya Warren spearheaded this effort and assembled a strong team (Joss Ives, Sandy Martinuk) to develop and run a very successful two-day workshop, which started in the beginning of 2007 Fall Term. The workshop was required for incoming graduate students and available to veterans as well. A system of mentor TAs was initiated to provide a structure in which senior graduate students can oversee other graduate students in the first year undergraduate courses and help to develop their teaching skills.

Further improvements to the TA training program have been implemented in Fall 2008 with more students contributing to the development and long-term continuity (Veenstra). An addition to the program in 2008 was the mentor TAs taking TAG's course in Peer Evaluation to prepare them for providing feedback to the TAs under their supervision. This program is enhanced by a new graduate course in pedagogy in Physics & Astronomy: PHYS 520, Teaching Techniques in Physics and Astronomy. This course exposed students to current PER literature and culminated in the development of a set of Invention Activities that will be deployed in courses next year.

In 2009, the TAs were asked for input on how to improve TA retention in first year labs and solve various other TA-raised issues. A major outcome of this process was the creation of a departmental committee with both faculty and TA representation, that will start operating beginning with the '10-'11 academic year, and whose tasks are to maintain the continuity and quality of the TA training program, to decide the assignment of TA jobs, to reward outstanding TAs and to solve various other TA issues. The TA training program took place again very successfully this year with a change to the model. There was a one day introductory workshop. Then 'super-TAs' were deployed in each of the large multi-section courses and given the task of developing a course-specific training as a follow-up through the early weeks of the term.

The TAs play a critical role in facilitating the new tutorial activities in ASTR 310 and ASTR 311. Each tutorial package includes extensive "TA Guidelines" for running the lab which not only list the steps necessary to run the activity but, when possible, explain the pedagogical justification for how and why each step is included. Before each tutorial, the TAs meet with the course instructor and STLF Peter Newbury to review the activity, with emphasis on why the steps are important and if necessary, what *not* to do because it could defeat the goal of the activity (for example, by describing an expert solution before beginning an invention activity.) We try to make the tutorials an authentic teaching experience for the TAs, by monitoring their presentation, giving them immediate feedback and welcoming their "colleague-to-colleague" feedback on the activity. Similar approaches to training the TAs for other large courses (i.e. PHYS 100 lab, PHYS 153 tutorials, etc.) are being tested and implemented in various first year courses.

Research

James Day & Doug Bonn, with further assistance from students Hiroko Nakahara and Brad Ramshaw, have been studying the effectiveness of invention activities to improve students' data interpretation and analysis skills and understanding. This has included classroom observation, pre/post testing with a lab diagnostic and data-mining of students' laboratory notebooks. The latter activity is being used to uncover evidence of transfer that may not be apparent in a multiple choice pre/post test. One paper on invention activities has been published in the November 2010 issue of the Physics Teacher.

Peter Newbury has completed pre- and post-testing of ASTR 310 and ASTR 311 tutorial exercises, such as the Human Orrery (The Physics Teacher, **48**, 9, 573-577 (2010)). The results were presented at AAS 216, May 23-27, 2010 in Miami, FLA. In Stair's ASTR 311 (Fall 2010) students wrote the Light and Spectroscopy Concept Inventory pre- and post-test. The results are used to compare the impact of interactive, learner-centered instruction to similar introductory astronomy courses across the U.S.

Louis Deslauriers, Georg Rieger, and Bing Dai are studying the impact of pre-reading on the sophistication of student questions during lectures. The study is taking place in Physics 101, 102 and 250. So far, results consistently show that pre-reading along with proper incentive leads to a doubling in the sophistication of student questions.

Louis Deslauriers, Joshua Folk, and Georg Rieger are studying the impact of learning goals on student self assessment of their understanding in Physics 100 and Physics 101.

Louis Deslauriers and Joshua Folk are conducting a study in PHYS 450 aimed at comparing the effect of peer discussions and classic instruction on students' knowledge retention.

Other

Widespread deployment of conceptual inventories to assess student understanding of mechanics and electricity & magnetism concepts. These include an extensive vertical survey from first to fourth year using the new lab diagnostic, a similar vertical survey using the BEMA diagnostic, and use of the FCI in freshman classes and sophomore mechanics.

Widespread deployment of CLASS student attitudes about science surveys in all first year courses, with testing done in Sept., at the end of the first term, and again at the end of the second term.

Participating in CWSEI-wide study on why some students do poorly (particularly focusing on high-failure-rate courses)

Louis Deslauriers has developed a math diagnostic to assess upper-level physics students' grasp of the math skills needed to succeed in the senior courses. This tool will be used to make judgments about curriculum and will feed discussions with the math department about their curriculum. This complements the math department's own efforts on entrance-level testing of math skills.

An archive system has now been developed and extensively tested as a tool to store course information.

Since March 2010, we have published a monthly newsletter focusing on various teaching activities taking place in conjunction with the CWSEI STLFs. Every month either an instructor involved in a transformation, or TAs involved with or students taking such transformed courses express their views about what works and what doesn't, and how things can be further improved. These 1-to-2 pages newsletters are distributed to the entire faculty in order to keep them informed about these various efforts and give them a contact person to talk to if they become interested in any particular aspect.

A very fruitful exchange of ideas and information has taken place with professor Marjan Zadnik from Perth, Australia, who has visited our department for 6 weeks during his sabbatical leave. We hope this will lead to strong ties for research and exchanges with his university in the future.

Peter Newbury and Cynthia Heiner have developed and successfully ran workshops on peer instruction and creating clicker questions.

Statistics Department

The Statistics CWSEI program started in 2007 and has concentrated on the transformation of STAT 200 – *Elementary Statistics for Applications.*

SEI Director: Bruce Dunham

Faculty: B. Dunham, N. Heckman, E. Yu

Course Transformation

Course	Learning Goals	Assessments	Improved methods
STAT 200: Elementary Statistics for Applications (2007 start) Faculty: B. Dunham, E. Yu, N. Heckman STLF: Gaitri Yapa	Course-level goals: complete Topic-level goals: complete Ongoing discussion for improvement, with faculty who are/will be teaching for the first time.	Compared the effectiveness of two different types of lab in helping students understand sampling distributions. On-going study to assess what students retain from STAT 200 several months after they have completed the course. A midterm exam assessment question given. Intervention used to address misconception identified in midterm exam. Planning final exam assessment question that targets the same misconception. A mid-course survey (paper based, not for credit) was given (very low response rate, but those who responded provided very useful comments). Planning to give an online survey (for credit) next term to increase responses. Planning post course knowledge retention surveys.	Extensive use of clickers to stimulate class discussion More assigned homework Labs improved to focus on key concepts that learners typically find difficult Used simpler marking methods to reduce assignment marking turnaround time to about one week. Planning to increase homework frequency further to engage students with course content more often. Planning to use clicker questions in a section that will be taught by a faculty member who has not used clickers before.
STAT 241/251: Elementary Statistics (Sept '11 start) Faculty: Y. Lim STLF: Gaitri Yapa	Course-level goals: first draft Topic-level goals: first draft	A midterm exam assessment question given. Intervention used to address misconception identified in midterm exam. Planning final exam assessment question that targets the same misconception. A mid-course survey (online, for credit) was given. Approximately 80% responded (total enrolled: 236). Planning two mid course online surveys (for credit)for next term to identify difficulties. Planning post course knowledge retention surveys.	Context rich problems included in assignments. Planning to use context rich problems in final exam. Planning to increase homework frequency further to engage students with course content more often. Planning to revise lab pre-reading to include objectives and emphasize use of software as a tool for Statistical analysis. (Currently working on labs 1 & 2). Planning to implement short quizzes on pre-reading material at start of labs. Planning to have a de-briefing at end of labs by TAs that includes participation by randomly chosen student(s). Planning to pre-select lab groups to maximize cooperative learning. Planning to use TA time for office hours to help answer student questions (currently no regular office hours, except on the three weeks that have no labs).

STAT 302: Introduction to Probability (Sept '11 start) Faculty: E. Yu STLF: Gaitri Yapa	Course-level goal: in progress Topic-level goals: in progress	Planning to give midterm and final exam assessment questions. Planning to give a mid-course survey.	Post course knowledge retention survey conducted (8 participants). Ongoing discussion on how to involve students from current term (taught by Math Dept) in the post course survey. Planning to increase homework frequency. Planning two in-class activities to target resolving currently observed misconceptions. Ongoing discussion on using pop quizzes to motivate students to keep up with course content, as there will be no clicker questions until a later term.

STAT 100 – Statistical Thinking: A rather novel introductory course in the discipline, STAT 100 involves six "modules", each on a different theme in statistical science accessible to learners who have not had previous exposure to the discipline. The course was offered for the second time in 2009, and after the first run it was decided by the teaching team (of five instructors) that clickers would be used in future to help improve student engagement. This idea was implemented, and in-house training and support was offered by Eugenia Yu. In total about half of the faculty in the department now have used clickers in their teaching.

STAT 335 – Statistics in Quality Assurance: This course was revived in 2008, having not been offered for some years. The new incarnation of the course was enhanced using CWSEI methodology. In particular:

(a) Learning outcomes were devised.
(b) Detailed books of notes covering the material were created and posted online.
(c) In-class activities were used in the lectures, during which the students would work in groups on an activity, aided by the support of the instructor.
(d) Laboratory activities involving group work were used to illustrate concepts using computer applications.

STAT 447 – Time Series and Forecasting: Having been twice previously offered as a "topics" course, this "new" addition to the department's upper-level offerings was improved this year by instruction that placed less emphasis on the traditional lecture. In a similar fashion to STAT 335, students worked in groups on activities within the classes, with instructor support. Often concepts were introduced informally in an activity before a more formal presentation of the idea was provided in a short lecture. Solutions to an in-class activity were posted shortly after the class for timely feedback. As measured by student performance and satisfaction, this change in instruction style has been successful.

Research

Student Attitude Surveys

Near the start and end of STAT 200, students are expected to complete an on-line attitude survey. The survey attempts to gauge how students perceive the relevance of the discipline, their enthusiasm for studying it and how they go about learning in Statistics. A robust method of analyzing the resulting data has been devised that uses a re-sampling method known as bootstrapping. The approach has been encoded in R (a freely available package for statistical computing), and a user guide created. Anyone wishing to implement our method on their own data should contact Dr. Bruce Dunham at b.dunham@stat.ubc.ca. A description of the method, and our findings from the analysis of our data, are being written up for future publication.

WeBWorK Online Homework Tool

A TLEF grant application for a three year project has been submitted.
Question templates for different types of questions (multiple choice, short answer, etc. that includes algorithmic generation of key variables) are being developed with help from Djun Kim. Five templates completed.