# Earth and Ocean Sciences Department

**Overview**

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 12 courses currently at various stages of transformation and 9 more 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.

**People Involved**

**SEI Director:** Sara Harris

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

**Faculty (instructors teaching targeted courses):** S. Allen, G. Andrews, M.L. Bevier, M. Bostock, G. Dipple, E. Eberhardt, J. Finnis, R. Francois, M. Grey, S. Harris, W. Hsieh, M. Jellinek, C. Johnson, M. Kopylova, U. Mayer, S. Mills, J. Mortensen, R. Pawlowicz, R. Stull

**Faculty (others involved in working groups, committees, or ad-hoc support):** P. Austin, M. Bustin, K. Grimm, L. Groat, P. Hammer, E. Hearn, K. Hickey, O. Hungr, M. Lipsen, M. Maldonado, K. Orians, K. Russell, J. Scoates, L. Ver, P. Smith, D. Steyn, S. Sutherland, P. Tortell

**Students:** L. Beranek, D. Cassis, J. Dohaney, R. Eso, L. Gurney, M. Halverson, K. Hodge, P. Lelievre, C. Leslie, J. Mcalister, J. Rhajiak, B. Smithyman

**Course Transformation**

| Course | Learning Goals | New Assessments | Improved methods |
|---|---|---|---|
| **EOSC 111: Laboratory Exploration of Planet Earth** (Sept '07 start)<br>Faculty: S. Harris<br>STLF: Brett Gilley | • Course level goals: completed and reviewed by advisory committee<br>• Lab level goals: draft<br>• Future revisions of goals needed in light of departmental service course goals | • Individual and group quizzes<br>• 3rd draft of Pre/Post assessment complete for all topics<br>• Post-lab surveys for each lab<br>• End-of-term survey | • Invention activities (Introduction, Plankton & Marine Ecosystems)<br>• Student-derived methods (Earthquakes, Groundwater, Dinosaurs, Waves, Estuaries)<br>• Contrasting cases (Sediments & Sedimentary Rocks) |
| **EOSC 112: The Fluid Earth: Atmosphere and Ocean** (Jan '08 start)<br>Faculty: R. Francois, S. Harris, W. Hsieh<br>STLF: Erin Lane | • Course level goals: draft<br>• Lecture level goals: drafts for all lectures | • Midterm & end-of-term surveys<br>• 16-question draft pre-post test on student misconceptions in oceanography & climate change<br>• Student engagement observations | • Widespread use of thought-provoking clicker questions<br>• Peer instruction<br>• Relevance slide added to each lecture, relevance added throughout class |
| **EOSC 114: The Catastrophic Earth: Natural Disasters** (Sept '07 start)<br>Faculty: R. Stull, E. Eberhardt, M.L. Bevier, S. Sutherland, J. Finnis, G. Andrews<br>STLF: Francis Jones<br>**Transformation is concluding, but further refinements are expected.** | • Course level goals: complete<br>• Lecture level goals for all lectures complete | • Midterm & end-of-term surveys<br>• Pre-course diagnostic on mapping skills and use of ratios<br>• Online homework based on text readings introduced Fall 2008<br>• Attitudes survey | • Widespread use of thought-provoking clicker questions by most instructors<br>• Pre-post question "wrappers" around video clips to focus and assess student learning from videos<br>• Custom text introduced<br>• Off-schedule pre-exam review/question sessions |
| **EOSC 210: Earth Science for Engineers** (Jan '08 start)<br>Faculty: E. Eberhardt, U. Mayer<br>STLF: Brett Gilley | • Course level goals: draft<br>• Lecture level goals: drafts for all lectures; 2nd draft of for 60% of lectures (used Fall 2008) | • End of term survey<br>• Plan to use PeerWise for student generation of assessment questions | • Widespread use of thought-provoking clicker questions<br>• Small group or pair discussions in all classes<br>• Examples and relevant case studies added to many lectures |
| **EOSC 211: Computer Methods in Earth, Ocean & Atmosph. Sciences** (Jan '09 start)<br>Faculty: R. Pawlowicz<br>STLF: Josh Caulkins | Currently in planning stage, working group established<br>• Course level goals: draft<br>• Module and lecture level goals: currently drafting | • In preparation | • In preparation |

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| | **EOSC 212: Topics in the Earth & Planetary Sciences** (Jan '08 start)<br>Faculty: M. Jellinek, M. Bostock<br>STLF: Francis Jones | • Initial version of course level goals<br>• Topic level goals: draft | • Preliminary diagnostic about reading, comprehension, and the structure of scientific papers<br>• Midterm and end-of-term surveys<br>• Module quizzes<br>• Two projects (presentation and poster) | • Team Based Learning elements, including individ/team quiz protocols, in class team work activities<br>• Content from Scientific American and other articles and lectures<br>• Guest speakers for each module<br>• Instruction and practice at developing science article reading and questioning skills<br>• Projects topics student-determined |
| | **EOSC 220: Introductory Mineralogy** (Jan '08 start)<br>Faculty: S. Mills, M.L. Bevier<br>STLF: Josh Caulkins | • Course level goals: draft<br>• Lecture level goals: drafts for all lectures | • Draft midterm survey<br>• End of Term Survey<br>• Lab quizzes | • 2+ discussion activities per lecture<br>• Labs entirely reworked and provided more structure<br>• Poster project<br>• Create your own reference "mineral book" |
| | **EOSC 221: Introductory Petrology** (Sept '07 start)<br>Faculty: M.L. Bevier, G. Dipple, K. Russell, M. Bustin, J. Mortensen, J. Scoates, L. Groat<br>STLF: Brett Gilley | • Course level goals: draft<br>• Topic level goals: draft<br>• Class level goals: draft<br>• Lab goals: draft | • 2nd draft of pre/post assessment administered Spring 2009 | • Labs rewritten - more structure; activities linked to goals<br>• Lecture activities in small groups<br>• 3x5 cards for ongoing assessment of students and the course<br>• Quizzes after each module<br>• Improved course framework |
| | **EOSC 322: Metamorphic Petrology** (Sept '08 start)<br>Faculty: G. Dipple<br>STLF: Erin Lane | • Course level goals: draft<br>• Topic level goals: drafts for all modules | • Midterm survey | • Rock sample and relevance in lectures |
| | **EOSC 332: Tectonic Evolution of North America** (Sept '08 start)<br>Faculty: J. Mortensen<br>STLF: Brett Gilley | • Course level goals: draft<br>• Topic level goals: drafts for all modules | • Pre/Post Assessment given Spring 2009<br>• Midterm survey<br>• End-of-term survey | • Activities or discussions in some lectures<br>• "light" implementation of Just-in-Time Teaching (JITT)<br>• Online quizzes given prior to each module |
| | **EOSC 355: The Planets** (Sept '08 start)<br>Faculty: C. Johnson<br>STLF: Francis Jones<br>Notes: New course, taught 1st time in Spring 2009. | • Initial version of course level goals<br>• Module goals to be finalized after Spring 2009<br>• Initial versions of lecture level goals | • Pre-course skills diagnostic<br>• Pre-course "attitudes toward planetary sciences" survey and "Getting to know you" survey.<br>• Midterm survey<br>• Clickers, homework quizzes, in-class worksheets | • Team activities (worksheet based) in many lectures<br>• Thought-provoking clicker questions in many lectures<br>• Seven online quizzes per term<br>• No exams<br>• Poster presentations are primary source of grades |
| | **EOSC 372: Introductory Oceanography: Circulation and Plankton** (Spring 2009 start)<br>Faculty: S. Allen, K. Orians<br>STLF: Erin Lane | • Course level goals: draft | • In preparation | • In preparation |
| | **EOSC 110 (Using Geoscience Concept Inventory), EOSC 116, ATSC 201 (Just-in-Time Teaching), EOSC 223 (pre-post assessments), EOSC 315 (clickers), 324 (no longer offered), 350 (Team Based Learning), and ENVR 200 & 300 (team projects, metacognition)** are other dept. courses undergoing improvement without specific STLF help (or ad-hoc help). | | | |
| **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 subheading "Knowledge and Major Concepts", "Skills", and "Habits and Attitudes". The list was revised based on faculty input, and was presented at the department's retreat. A workshop for faculty teaching service courses is planned.<br>**Environmental Science Curriculum Committee** conducted student focus groups and extensive data analysis on student enrollment data. A set of recommendations and a draft revised curriculum has come out of this work (D. Steyn, chair)<br>**Geophysics Curriculum Committee** proposed reinstating the Geophysics Majors program (E. Hearn, chair)<br>**Geology Curriculum Committee** proposed reinstating the Geology Majors program (K. Russell, chair) | | | |

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| **TA Development** | Established a **TA training course** for graduate students (EOSC 516: Teaching and Learning in Earth & Ocean Sciences)<br>Course is run primarily by graduate students who have facilitator training. Enrolment is about 15/year<br>Learning goals: Course level goals, Learning goals for each session<br>Assessments: Using Physics' Teaching Attitudes Survey as Pre/Post, Formative Evaluation after each session, Summative Evaluation<br>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. 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. The survey has been administered in >25 courses both at UBC and other institutions. More than 6000 students have participated over the past 2 years.<br>**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 correlated 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.<br>**Undergraduate Thesis Research:** Jamil Rhajiak completed an Honours thesis entitled "Understanding Geological Time: A Proposed Assessment Mechanism for Beginner and Advanced Geology Students" |
| **Other** | **EOS-SEI Times:** Approximately monthly newsletter containing results from courses, tips and information for instructors (8 editions so far)<br>**Brown Bag Seminars:** Assessing Geoscience Programs; What should we teach?; Just-in-Time-Teaching; Setting Exams<br>**Learning Goals Workshops:** 3 facilitated by STLFs for participants outside EOS.<br>**Visitors:** Cathy Manduca, director of the Science Education Resource Center at Carleton College.<br>**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 will be initiated in April 2009 with a permanent version for annual use established by April 2010 along with sustainable analysis procedures. Future considerations may include an alumni survey. |

## Physics and Astronomy Department

**Overview**

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 four STLFs: Peter Newbury and Louis DesLauriers are full-time, Jim Carolan is an emeritus faculty member, and James Day is a postdoctoral fellow with a 20% appointment as an STLF.

**People Involved**

**SEI Director:** Doug Bonn

**STLFs:** Jim Carolan, James Day, Louis Deslauriers, Peter Newbury

**Faculty:** D. Bonn, J. Folk, B. Gladman, J. Iqbal, A. Kotlicki, J. Matthews, H. Richer, I. Stairs, M. Van Raamsdonk, C. Waltham, C. Wieman

**Students:** S. Martinuk, M. Warren, C. Veenstra, R. Wong, D. Mazur, B. Ramshaw, M. Gendre

**Course Transformation**

| Course | Learning Goals | New Assessments | Improved methods |
|---|---|---|---|
| **ASTR 101: Introduction to the Solar System** (Sept '08 start)<br>Faculty: Jaymie Matthews<br>STLF: Peter Newbury | • Course-level: complete<br>• Topic-level: extracting from first Term materials – 0% complete | | |
| **ASTR 102: Introduction to Stars and Galaxies** (Jan '09 start)<br>Faculty: Jaymie Matthews<br>STLF: Peter Newbury | • Course-level goals: 90% complete | | |
| **ASTR 310: Exploring the Universe I: The Solar System** (Summer '08 start)<br>Faculty: H. Richer, B. Gladman<br>STLF: Peter Newbury<br>Grad Student: Melanie Gendre | • Course-level goals: complete<br>• Topic-level goals: 95% complete | • Pre-post concept tests for Tutorial activities | • Created 6 activities for Tutorial sessions<br>• Improved flash card questions |
| **PHYS 100: Introductory Physics** (Sept '07 start)<br>Faculty: G. Rieger, A. Kotlicki<br>STLF: Louis Deslauriers, Jim Carolan<br>Grad Student: Sandy Martinuk | | • Conducting study on impact of learning goals on student self assessment of understanding | • Provided feedback for clicker question improvement and more student engagement in lectures. |
| **PHYS 107 & 109: Physics 1 lab and Intro to Experimental Physics** (Sept '07 start)<br>Faculty: D. Bonn<br>STLF: James Day | • Course-level goals: complete | • Developed & validated physics lab pre-post diagnostic | • Developed 15 invention activities on data interpretation and analysis |
| **PHYS 200: Relativity and Quanta** (Sept '08 start)<br>Faculty: M. Van Raamsdonk<br>STLF: Louis Deslauriers | • Course level goals: complete<br>• Topic level goals: complete | • Lecture observations<br>• Final exam questions<br>• Analyze Mid-term<br>• Midterm & end-of-term survey<br>• Observe HW sessions | • Weekly tutorials developed<br>• Improved clicker questions |
| **PHYS 250: Introduction to Modern Physics** (Jan '09 start)<br>Faculty: C. Wieman<br>STLF: Louis Deslauriers | • Course level goals: 1st draft complete<br>• Topic level goals: 1st draft complete | | |
| **PHYS 450: Quantum Mechanics** (Jan '09 start)<br>Faculty: J. Folk<br>STLF: Louis Deslauriers | • Course and Topic level learning goals 95% complete | • Lecture observations<br>• Analyze Mid-term<br>• Observe HW sessions<br>• 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) |

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| | **PHYS 170** – A mechanics diagnostic survey was administered to determine conceptual learning gains and aid future course development. Clicker usage is being developed in this large multi-section engineering course with extensive observation and advice from STLF Jim Carolan<br>**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. |
| **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. |
| **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 already submitted to the Physics teacher.<br><br>Peter Newbury and Melanie Gendre are readying results of ASTR 310 tutorial exercises, such as the Human Orrery, for presentation at conferences this summer and eventual publication.<br><br>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.<br><br>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.<br><br>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.<br><br>Participating in CWSEI-wide study on why some students do poorly (particularly focusing on high-failure-rate courses)<br><br>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.<br><br>An archive system has now been developed and extensively tested as a tool to store course information. |

## Computer Science Department

**Overview**

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 will have two full-time STLFs beginning in Summer 2009, and recruiting efforts for a third STLF are in progress. With three STLFs on board in 2009/10, the department expects to "close the loop" on the first- and second-year courses and make substantial progress on several third- and fourth-year courses.

**People Involved**

**SEI Director:** Kurt Eiselt

**STLFs:** Ben Yu, Gabriel Murray (part time), Beth Simon (emeritus)

**Faculty:** D. Acton, M. Allen, P. Belleville, G. Carenini, P. Carter, A. Condon, K. Eiselt, M. Feeley, H. Hoos, E. Knorr, K. Leyton-Brown, G. Tsiknis, K. Voll, S. Wolfman

**Course Transformation**

| Course | Learning Goals | New Assessments | Improved methods |
|---|---|---|---|
| ***CPSC 101: Connecting with Computer Science*** (Sept '07 start)<br>Faculty: M. Allen, A. Condon, S. Wolfman, H. Hoos<br>STLF: Ben Yu, Beth Simon | • Course-level: complete<br>• Topic-level: complete | • Performed study of instructor & student perception and use of learning goals<br>• Developing assessment to probe student understanding of JavaScript code | • Use clicker questions in class<br>• Developed broad set of clicker questions |
| ***CPSC 111: Introduction to Computation*** (Sept '07 start)<br>Faculty: P. Carter, K. Eiselt<br>STLF: Ben Yu, Beth Simon | • Course-level: complete<br>• Topic-level: complete | • Midterm & end-of-term survey<br>• Developed diagnostic test based on previous exams and course level learning goals.<br>• Developing programming concept assessment instrument to be administered at beginning and end of term. | |
| ***CPSC 121: Models of Computation*** (Sept '07 start)<br>Faculty: S. Wolfman, P. Belleville<br>STLF: Beth Simon | • Course-level: complete<br>• Topic-level: complete | | • 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 211: Introduction to Software Development*** (Sept '07 start)<br>Faculty: P. Carter, G. Tsiknis<br>STLF: Ben Yu, Beth Simon | • Course-level: complete<br>• Topic-level: complete | | |
| ***CPSC 213: Introduction to Computer Systems*** (Sept '07 start)<br>Faculty: M. Feeley<br>STLF: Ben Yu, Beth Simon | • Course-level: complete<br>• Topic-level: complete | | |
| ***CPSC 221: Basic Algorithms and Data Structures*** (Sept '07 start)<br>Faculty: K. Voll, E. Knorr<br>STLF: Ben Yu, Beth Simon | • Course-level: complete<br>• Topic-level: complete | • Developed diagnostic test based on previous exams (CPSC and Math), and course level learning goals | • 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 322: Artificial Intelligence*** (summer '08 start)<br>Faculty: G. Carenini, K. Leyton-Brown<br>STLF: Gabriel Murray, Ben Yu | • Learning goals have been developed in conjunction with exam questions; LGs currently being refined | • A large body of questions have been developed to be used as the core of future exams | |

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| | **Learning goals for core courses (CPSC 111, 121, 211, 213, 221, 310, 313, 320):** A comprehensive set of learning goals (both course-level and topic-level) has been developed for all 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.<br><br>**CPSC 260: Object-Oriented Program Design:** Don Acton and Ben Yu are investigating the correlation of student performance with different components of this course.<br><br>**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 CPSC 111, CPSC 211, APSC 260:** Exploring how students' ability to communicate about code changes during our core courses. Faculty share common questions or styles of question that involve explaining the purpose of code across several exams and analyze to see how and whether students progress in their ability to succinctly and abstractly describe the purpose of detailed code fragments. |
| **Research** | • **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. Conducting similar survey with CPSC 111 students in 2008/2009. Currently analyzing results.<br>• **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.<br>• **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.<br>• **Learning Goals:** Explicit use of learning goals in the classroom to aid student learning has been explored and is the subject of an article accepted for publication 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.<br>• **Just-in-time-teaching in APSC 160:** Instructor is developing videos to introduce content to students and working with the STLF to have the videos evaluated by APSC 160 students before the videos are presented to the entire class in 2009/10.<br>• **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. |

## Life Sciences Program

**Overview**

The Life Sciences Program (Depts. of Zoology, Botany, and Microbiology & Immunology) received funding from CWSEI in 2007 and began the efforts listed below in the Fall. We are currently testing survey tools in first year to measure development of expert attitudes; developing and testing an alternative form of tutorials in a large first year class; measuring changes in ecological attitudes, testing student learning in natural selection using a concept inventory test, developing and applying a 4th year satisfaction survey, and aiding in the development of the upper level ecology courses.

**People Involved**

**SEI Director:** G. Spiegelman

**STLFs:** J. Taylor, H. Yurk, T. Kelly (emeritus)

**Faculty participating currently: First Year Surveys:** J. Benbasat, W. Goodey, T. Kion, J. Klenz, K. Nomme, R. Redfield, G. Spiegelman, K. Smith. **Evolution Concept Surveys:** G. Bradfield, C. Brauner, W. Goodey, M. Hawkes, D. Irwin, C. Leander, R. Redfield, E. Taylor, J. Whitton. **Ecological Attitude Survey:** G. Bradfield, W. Goodey, D. Irwin, T. Sinclair, R. Turkington, M. Vellend. **Upper Level Ecology Course Transformation:** D. Srivastava, G. Bradfield, J. Goheen, J. Shurin, R. Turkington, M. Vellend. **Invention Activities:** J. Benbasat, E. Gaynor, T. Kion, K. Smith, G. Spiegelman.

**Skylight Affiliate:** G. Birol

**Students:** Y. Himaras, S. Keerthisinghe, G. Ko, T. Liao, M. Moussari, J. Purcell, S. Tom-Yew

**Course Transformation**

| Course | Learning Goals | New Assessments | Improved methods |
|---|---|---|---|
| **BIOL 111: Cell and Organismal Biology** (Sept '07 - Sept '08)<br>Faculty: K. Nomme, J. Klenz<br>Skylight Liaison: G. Birol | • Course-level goals: completed<br>• Topic-level goals: completed | • Midterm student evaluations<br>• Focus groups<br>• Biology attitudinal survey<br>• Clicker questions | • Case studies<br>• Group activities<br>• Vista reading quizzes<br>• Peer tutor support<br>• Intentional alignment of topics with student work and assessment |
| **BIOL 112: Cell Biology** (Sept '07 start)<br>Faculty: George Spiegelman, Teaching Team<br>STLF: Jared Taylor | • Course-level goals: completed<br>• Topic-level goals: completed | • Midterm & end-of-term surveys<br>• Student interviews to assess problem solving abilities<br>• End-of-term assessment of learning and invention groups to assess transfer abilities<br>• Biology attitudinal survey | • Developed and refined 8 invention activities for student groups in voluntary extra sessions<br>• Developed and refined 8 learning group activities for student groups in voluntary extra sessions |
| **BIOL 121: Ecology, Genetics and Evolution** (Sept '07 – ongoing with TLEF support)<br>Faculty: C. Pollock, TeachingTeam, A. O'Neill<br>STLF: T.Kelly<br>Skylight Liaison: G. Birol<br>Graduate Students: S. Tom-Yew, M. Moussari | • Course-level goals: completed<br>• Topic-level goals: completed | • Mapping of multi-section course outcomes onto assessments<br>• Biology attitudinal survey | • Peer tutors<br>• Learning centre |
| **BIOL 201: Cell Biology II: Introduction to Biochemistry** (Jan '08 – Sept '08)<br>Faculty: W. Bingle, S. Chowrira, J. Richards<br>STLF: Jared Taylor | • Lecture level learning goals | • Chemistry concept pre-test<br>• Focus group interviews<br>• Focus group follow-up survey (entire class)<br>• Biology attitudinal survey | • Recommendations provided to faculty |
| **BIOL 204: Vertebrate Structure and Function**<br>(Jan '08- May '08)<br>Faculty: B. Milsom, A. O'Neill | • Course-level goals: completed<br>• Topic-level goals: completed | • Clicker questions<br>• Post test: Vista Reading/Content quizzes<br>• New study questions<br>• Midterm teaching evaluation | • Improvement of group activities and discussions in class<br>• Revised course content and lecture materials incorporating real life examples<br>• Enhanced problem solving approach including comparisons |
| **BIOL 302/303** Community and Ecosystem Biology & Population Biology **Transformation** to **BIOL 304/306** Fundamentals of Ecology and Advanced Ecology | • Course-level Learning Goals completed<br>• Topic Level Learning Goals: more than 50% completed | • Pre-assessment of selected learning goals for Biol 304 done in BIOL 302<br>• Collected feedback on 302/303 and transformation via survey (student interviews will conducted in April 09) | • Course learning goals for BIOL 304/306 are question based<br>• Clicker use in new courses<br>• Field labs with conceptual assessments instead of tutorials (labs will be tested in summer 2009) |

**Curriculum**

**Evidence Based Approach to Curriculum Design:**

- **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:** First year pre-post survey
- **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
- **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:**

- An organizational structure has been developed that will allow us to accomplish the goals of CWSEI-LS projects. This group consists of CWSEI-Life Sciences Group, Botany/Zoology Curriculum Working Group, Research Program Manager, Five Discipline Groups: Molecular Biology and Genetics, Cell Biology, Physiology, Ecology and Evolution and Diversity, and Course Committees.
- Curriculum working group has identified priority biology courses that will be transformed and/or developed. Summer plans are in place to further the work in course development.
- 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.

**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:** Gülnur Birol administered the Biology attitudinal survey in all sections of BIOL 111, 112, 121 classes this year. The survey validation has been completed. First set of data has been shared with faculty members. In the process of writing a paper in collaboration with the Colorado group.
- **Student Satisfaction Survey:** Harald Yurk and Gülnur Birol are investigating student satisfaction within the biology program. In April 09, 201 student responses were collected in fourteen forth year biology courses. We are in the process of analyzing the data. 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.
- **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. Results are being analyzed.

**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 are investigating how the teaching and assessment of learning outcomes map in a multi-section first year biology course.
- **Learning Centre - BIOL 121:** Stacey Tom-Yew, Maryam Massouri, Gülnur Birol and Carol Pollock are conducting a study on evaluating and optimization of the peer tutoring program in a first year undergraduate 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.

**Other**

- **CWSEI-LS Newsletter** published monthly to share best practices and results from various cwsei-ls projects.
- **BIOL 310:** Leticia Aviles and Harad Yurk conducted a study on the usefulness of group discussions in class through in-class observations and focus groups.
- **MICB 202:** 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.
- **PeerWise:** Rosie Redfield used PeerWise in her class.

## Chemistry Department

**Overview**

The Chemistry CWSEI program started in 2008 and has hired a Science Teaching and Learning Fellow, Jennifer Duis. The Chemistry CWSEI program is presently concentrating 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: Laurel Schafer (chair), Brian Cliff, Greg Dake, Neil Dryden, Sophia Nussbaum, John Sherman, and Jackie Stewart. In conjunction with these efforts, undergraduate laboratory revitalization for years 2 - 4 is ongoing in the department.

Skylight Affiliate Jackie Stewart 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 are working on the development of improved course support materials for CHEM 121 (tailored in-house textbook, homework sets, powerpoint notes for instructors, etc.) independently supported by TLEF and Skylight. 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 has just been secured to develop another interactive tutorial with Carnegie Mellon.

**People Involved**

**SEI Director:** Laurel Schafer

**STLF:** Jennifer Duis

**Faculty:** B. Cliff, G. Dake, N. Dryden, S. Nussbaum, L. Schafer, and J. Sherman

**Skylight Affiliate:** Jackie Stewart; **Students:** Mike Carlson, Yuri Samozvanov

**Course Transformation**

| Course | Learning Goals | New Assessments | Improved methods |
|---|---|---|---|
| **CHEM 123: Physical and Organic Chemistry (Lab component)**<br>(July '08 start)<br>Faculty: S. Nussbaum, L. Schafer<br>STLF: Jennifer Duis | • Course-level goals: current draft, inspired by Rice University's interdisciplinary science lab learning objectives, approved by Chemistry Lab Committee<br>• Experiment-level goals: (developed from existing course materials) 4 of 4.5 experiments complete and approved by Chemistry Lab Committee | • Chemistry background and demographics survey developed and given 2 Terms<br>• Attitudes survey (C-LASS CHEM) given 2 Terms<br>• Lab skills survey (written) developed & given 2 Terms<br>• Hands-on lab skills assessment<br>• Assessment of experiment specific learning goal achievement (surveys, observations, interviews) | • Will develop based on assessment results<br>o Present plans include incorporation of learning goals into the lab manual and alteration of lab assessments for better alignment with learning goals<br>• Present a proposal to the department for the increase in 1st year lab contact hours |

- **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 448:** Engaged 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 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 first round of modified TA training was implemented by Anka Lekhi and Sophia Nussbaum, with support from SHINE through VP Academic and the Chemistry Department. A proposal to support this training in the coming year has been submitted.

**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 American Chemical Society National Meeting, 92nd Canadian Chemistry Conference, Improving University Teaching 34th International Meeting.

## Mathematics Department

**Overview**

Starting in 2008, the UBC Mathematics Department is participating in the Carl Wieman Science Education Initiative (CWSEI) to improve undergraduate science education. Currently projects are concentrated in two areas:

The first area is computing and computer labs in Math 152, Math 257, Mech 221 (Math 256), Mech 222 (Math 253) and Math 307. These courses have all recently introduced computing as an intrinsic part of the course. The Math CWSEI will help in the creation of tutorials and lab materials, assist in integrating the computational component into the course material and developing testing methods, and assess the effectiveness of the computational component.

The second area is support for the workshops and the basic skills test in Math 180/184. The Math CWSEI will help to assess the effectiveness of the workshops and assist in the study of how well the basic skills test predicts success in the course.

**People Involved**

**SEI Director:** Richard Froese

**STLF:** Costanza Piccolo

**Faculty:** R. Anstee, R. Froese, P. Loewen, A. Peirce, B. Wetton

**TA's, Postdocs, and Lecturers:** J. Lo, K. Yurasovskaya, D. Karslidis, R. Schwarz, A. Lindsay, A. Raghoonundun, G. de Oliveira, W. Thompson

**Course Transformation**

| Course | Learning Goals | New Assessments | Improved methods |
|---|---|---|---|
| **MATH 180/184: Differential Calculus (Workshop component)** (Sept '08 start)<br>Faculty: Richard Anstee<br>STLF: Costanza Piccolo<br>TAs and Lecturers: D. Karslidis, R. Schwarz, K. Yurasovskaya | • Course-level goals: drafts complete<br>• Workshop goals: complete | • Student Surveys on Workshop activities<br>• Pre-Post Tests on problem-solving skills<br>• Statistical analysis to determine predictive features of the Basic Skill Test | • Workshops 1-12 completed: added workshop-level learning goals and list of required basic skills; created new workshop problems. |
| **MATH 152: Linear Systems (Computer Labs component)** (Sept '08 start)<br>Faculty: Brian Wetton<br>STLF: Costanza Piccolo<br>TA: A. Lindsay | • Topic-level goals: first draft completed | • pre- and post-tests on linear systems<br>• end-of-term student survey on computer labs | • Labs rewritten to tie in more closely with the course material |
| **Math 253 (Mech 222): Multivariable Calculus (Computer Labs component)** (Sept '08 start)<br>Faculty: Philip Loewen<br>STLF: Costanza Piccolo<br>TA: W. Thompson | • Course-level goals: first draft completed | | • All labs have been revised to tie in more closely with the course material |
| **Math 256 (Mech 221): Differential Equations (Computer Labs component)** (Sept '08 start)<br>Faculty: Brian Wetton<br>STLF: Costanza Piccolo<br>TA: W. Thompson | • Lab-specific learning goals have been started | • End of term Student Survey on computer labs | • Labs rewritten to tie in more closely with the course material |
| **Math 257/316: Partial Differential Equations (Computer Labs component)** (Sept '08 start)<br>Faculty: Anthony Peirce<br>STLF: Costanza Piccolo<br>TA: G. de Oliveira | • Topic-level goals: first draft started | | • 5 online tutorials completed: Basic EXCEL; Fourier series of a function; Fourier series for the 1D heat equation; solve differential equations numerically: the heat equation; differential equations numerically: the wave equation |
| **Math 307: Applied Linear Algebra (Computer Labs component)** (Sept '08 start)<br>Faculty: Richard Froese<br>STLF: Costanza Piccolo<br>TA: A. Raghoonundun | • Course-level goal: first draft completed<br>• Topic-level goals: first draft completed | • Student surveys<br>• Matlab quiz<br>• Special homework assignments with extensive use of Matlab | • Lecture Notes in process of being updated |

## Statistics Department

**Overview**

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

**People Involved**

**SEI Director:** Bruce Dunham

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

**Graduate Student:** Rebekah Mohr

**Course Transformation**

| Course | Learning Goals | New Assessments | Improved methods |
|---|---|---|---|
| **STAT 200: Elementary Statistics for Applications**<br>(2007 start)<br>Faculty: B. Dunham, E. Yu, N. Heckman | • Course-level goals: complete<br>• Topic-level goals: complete | • Compared the effectiveness of two different types of lab in helping students understand sampling distributions<br>• On-going study to assess what students retain from STAT 200 several months after they have completed the course | • Extensive use of clickers to stimulate class discussion<br>• More assigned homework<br>• Labs improved to focus on key concepts that learners typically find difficult |

- **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 443 – 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.