

# Life Sciences (Departments of Botany, Microbiology & Immunology, Zoology)

## CWSEI Department Summary

This document summarizes the activities of the “Life Sciences” departments as part of the Carl Wieman Science Education Initiative over the years 2007-2018. In this initial version, it replaces a series of web pages that were updated over the lifetime of the CWSEI. It may be updated in future with more detail on impact.

For questions, please contact:

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## Overview

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 2011 with four new STLFs starting in late 2011 and early 2012. The new funding allows STLFs to work with all second year core courses in the newly designed and implemented Biology Program at UBC. Two additional STLFs were hired in 2013, in conjunction with the Flexible Learning Initiative project for two first-year core courses, and one more was hired in January 2015. We are currently implementing interactive activities and peer discussion in core courses in the Biology program from first to third year. The types of activities we are implementing include clicker questions with peer discussion, worksheets, case studies, learning activities, and invention activities. We have also assisted with the implementation of learning goals and pre-reading assignments in most of these core courses. 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. On a larger scale, we are currently carrying out a department-wide characterization of the impact of various classroom practices (COPUS observations) on student learning (concept inventory data).

## People

**CWSEI Dept. Director:** Patricia Schulte, George Spiegelman (emeritus)

**STLFs:** Jaclyn Dee, Natalie Schimpf, Tammy Rodela, Megan Barker, Lisa McDonnell, Martha Mullally, Malin Hansen, Laura Weir, Amanda Banet, Bridgette Clarkston, Tamara Kelly, Jared Taylor, Harald Yurk

**Faculty (instructors teaching targeted courses):** K. Smith, G. Spiegelman, G. Bradfield, W. Goodey, R. Turkington, M. O'Connor, E. Hammill, P. Kalas, S. Chowrira, P. Schulte, J. Klenz, G. Haughn, D. Altshuler, D. Moerman, C. Berezowsky, A. O'Neill, W. Tetzlaff, S. Ellis, S. Graham, M. Berbee, G. Bole, J. Whitton, D. Srivastava, P. Tortell. M. Hawkes, C. Douglas, E. Hinze, M. Graves, J. Brodie, R. Young

**Faculty (others involved in working groups, committees, or ad-hoc support):** G. Bole, C. Pollack, A. O'Neal, K. Nomme, B. Couch

**Skylight Affiliate:** Gulnur Birol (emeritus)

**Students and Postdocs:** T. Deane, E. Jeffrey, R. Oh, M. Tseng, N. Wang, P. van Stolk

## Activities

**Curriculum:** We are gathering a variety of data to inform our curriculum design, and an organizational structure has been developed. [Read more on curriculum planning...](#)

**Course Transformation:** Major efforts are underway in Biology courses at all undergraduate levels. [Read more on course transformation...](#)

**Assessment and Evaluation:** A range of assessment is being implemented, including conceptual understanding and attitudes about learning biology. [Read more on assessment...](#)

**Research:** Numerous biology education research projects are being pursued, including a study of the effects of jargon on conceptual understanding, and a study to investigate how students solve problems in genetics. [Read more on research...](#)

Broader departmental involvement is being fostered via the LS-CWSEI Blog. [Read the Blog...](#)

## Curriculum


### Organizational Planning

- **Curriculum Mapping Project:** Life Sciences STLFs B. Clarkson, M. Banet, L. Weir, and L. McDonnell undertook a curriculum mapping project of the biology program. Information about nearly all biology courses was collected and has been used to map the overlap (and gaps) in the coverage of course-level and program-level learning goals and skills.
- Biology Program curriculum working group 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.

### Evidence Based Approach to Curriculum Design

We are gathering a variety of data to inform our curriculum design:

- **Concept Inventories:** Jared Taylor and Liz Imrie with help from George Spiegelman developed gene regulation concept inventory in BIOL 112 which has been validated and deployed in some large classroom settings. A smaller version of the inventory has been used in Biology 112 as a pre-test, and the full inventory as a post-test. Additionally, the inventory was 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. Ad hoc concept inventories have been developed and implemented in BIOL 260.
- **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.

 [Poster \(April 2009\): Student Satisfaction and Skill Development Study — Harald Yurk & Gülnur Birol](#)

- **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.

**Report on Chemistry content in Biology courses at UBC:**



[Chemistry Content in UBC Biology Courses: Cell Biology and Genetics Program](#) 



- **Natural Selection Conceptual Understanding:** Harald Yurk assessed 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.


## Courses

Status as of May 2016:

Course	Learning goals	New Assessments	Improved Methods
<b>BIOL 111: Cell and Organismal Biology</b> (Sept '07 - Sept '08)  <u>Faculty:</u> Kathy Nomme, Jennifer Klenz	Course-level goals: complete  Topic-level goals: complete	Midterm student evaluations  Focus groups  Biology attitudinal survey	Case studies  Clicker questions, group activities  Vista reading quizzes

<p>Skylight Liaison: G. Birol</p> <p> <a href="#">Poster (2008): Impact of a Non-majors First Year Biology Course on Students' Attitudes Towards Biological Sciences</a></p>		<p>Clicker questions</p>	<p>Peer tutor support</p> <p>Intentional alignment of topics with student work and assessment</p>
<p><b>BIOL 112: Cell Biology</b> (Sept '07 start)</p> <p>Faculty: K. Smith, S. Chowrira, C. Douglas, E. Hinze, M. Graves; previous: E. Gaynor, T. Kion, G. Spiegelman</p> <p>STLF: Jared Taylor ('07-'11); Megan Barker ('13-'14)</p> <p> <a href="#">Poster (CWSEI EOY 2010): Invention Activities in Biology 112: changing the way first year biology students approach problem solving</a></p> <p><a href="#">Materials for Invention Activities in Cell Biology (11 MB zip file)</a></p>	<p>Course-level goals: complete</p> <p>Topic-level goals: complete</p>	<p>End-of-term surveys</p> <p>Student interviews to assess problem solving abilities</p> <p>End-of-term assessment of learning and invention groups to assess transfer abilities</p> <p>Biology attitudinal survey</p> <p>Concept inventory</p> <p>Student perspectives and faculty perspectives on the value of active learning course components</p> <p>Course management: TA workload</p> <p>Classroom practices captured (COPUS data)</p>	<p>Developed and refined a series of invention/ investigation activities for in class once per week. As of 2014, two of these have been maintained in the course.</p> <p>Just-in-Time Teaching incorporated with pre-class readings.</p> <p>In-class writing assignments</p> <p>Clicker questions with peer discussion</p> <p>End of week problems</p> <p>PeerWise used in all sections</p> <p>PeerWise workshops were implemented in an attempt to give the students some guidance in writing better multiple choice questions.</p> <p>Targeted pre-reading assignments; weekly pre-reading quizzes</p>
<p><b>BIOL 121: Ecology, Genetics and</b></p>	<p>Course-level goals: complete</p>	<p>Mapping of multi-section course outcomes onto</p>	<p>Peer tutors</p>



<p><b>Evolution</b> (Sept '07 start)</p> <p><u>Faculty</u>: C. Pollock, G. Bole, P. Kalas, B. Couch, A. O'Neill</p> <p><u>Skylight Liaison</u>: G. Birol</p> <p><u>STLF</u>: Martha Mullally ('13), Lisa McDonnell ('15)</p> <p> <a href="#">Poster (CWSEI EOY 2009): Evaluation of the peer tutor program for a first year biology course (BIOL 121)</a></p> <p> <a href="#">Poster (CWSEI EOY 2009): Development of a Methodology to Investigate Consistency in Assessment of Learning Outcomes for Biology 121</a></p>	<p>Topic-level goals: complete (revised and extended for the ecology unit in '11)</p>	<p>assessments</p> <p>Biology attitudinal survey</p> <p>Meiosis concept inventory (in preparation)</p>	<p>Learning centre</p> <p>PeerWise used in some sections.</p> <p>Writing project with Rosie Redfield ('08/'09)</p> <p>Clickers implemented in most sections.</p> <p>Testing of conceptual inventory in community and population ecology ('10).</p> <p>Used the community and population ecology concept inventory to evaluate the effectiveness of in-class activities (Kalas '11).</p> <p>Two-stage review activity used in multiple sections.</p>
<p><b>BIOL 140: Laboratory Investigations in Life Sciences</b> (Sept 2014 start)</p> <p><u>Faculty</u>: K. Nomme, C. Sun, M. Moussavi, L. Norman, B. Germano, P. Kalas</p> <p><u>STLF</u>: Natalie Schimpf</p>	<p>Overall course goals to be re-examined, existing objectives revised</p>	<p>Documentation of TA hours</p> <p>TA focus group interviews</p> <p>Observations of lab classes</p> <p>Collecting student reports of time spent on activities outside of class</p> <p>Past student survey conducted</p> <p>Course-specific evaluation</p>	<p>Refocused assessments and tasks to support prioritized skills/knowledge</p> <p>Standardised outside of lab format</p> <p>Clarified requirements and introduced grading rubrics for assignments, incorporated into class activities</p> <p>Increasing research</p>



<p> <a href="#">Talk (UBC Science Ed Open House 2016): Biology 140 Renewal; Responding to Student Feedback</a></p>		<p>administered to students</p> <p>Student experience focus groups</p> <p>Concept Inventories: BEDCI, SRBCI, 'SCENDI' ('Scenario Diagnostic Inventory' - in-house developed set of pre-post questions</p> <p>InterCLASS data collected</p>	<p>authenticity – explicit links to authentic and local research (feature videos, scenario and Beaty Biodiversity Museum activities)</p> <p>Guidance and scaffolding of writing process (repeated practice of scientific explanation) and experimental design</p> <p>TLEF: Development of digital instructional resources</p> <ul style="list-style-type: none"> <li>- 'Draw-my-life' narrated animation</li> <li>- Researcher profile videos</li> <li>- Interactive tutorials (branching decision tree)</li> </ul> <p>Additional resources – posters and QR code links to background organism and factor information.</p>
<p><b>BIOL 200: Fundamentals of Cell Biology</b> (2013 start)</p> <p><u>Faculty:</u> R. Young, N. Abraham, N. Pante, L. Kunst, L. Chen, M. Graves</p> <p><u>STLF:</u> Megan Barker</p>	<p>Course-level goals: complete</p> <p>Topic-level goals: complete</p> <p>Writing-specific goals: complete</p>	<p>Concept inventory developed and deployed across the course</p> <p>Student writing project (press release) developed</p> <p>Targeted modification of writing assessments on midterm and final exam</p> <p>Classroom practices data (COPUS observations)</p> <p>Tutorial observations: protocol developed &amp; feedback given to TAs</p>	<p>Writing assignments scaffolded through semester (2013)</p> <p>Clicker questions with peer discussion (section-dependent)</p> <p>Pre-reading assignments and pre-quizzes developed and deployed</p> <p>Two-stage review activities built and used</p> <p>Worksheets developed and piloted</p>

		TA tracking timesheets were setup and deployed	
<p><b>BIOL 201: Cell Biology II: Introduction to Biochemistry</b> (2008; 2013-)</p> <p><u>Faculty:</u> Sunita Chowrira, Jeffrey Richards, Reinhard Jetter; previous: Wade Bingle <u>STLF:</u> Jared Taylor ('08), Megan Barker (2013-)</p>	<p>Lecture-level goals: complete</p>	<p>Chemistry concept pre-test</p> <p>Focus group interviews</p> <p>Focus group follow-up survey (entire class)</p> <p>Biology attitudinal survey</p> <p>Tutorial observations (using COPUS protocol) and feedback</p>	<p>Recommendations provided to faculty in 2008 by Jared.</p> <p>More recent: Pre-reading assignments and quizzes developed by course coordinator (deployed 2015)</p> <p>Worksheets and clicker question development/support (section-dependent)</p> <p>Two-stage review (section-dependent)</p>
<p><b>BIOL 204: Vertebrate Structure and Function</b> (Jan '08 start)</p> <p><u>Faculty:</u> Bill Milsom, Angie O'Neill, Wolfram Tetzlaff <u>STLF:</u> Laura Weir</p>	<p>Course-level goals: complete</p> <p>Topic-level goals: complete</p>	<p>Clicker questions</p> <p>Post test: Vista Reading/Content quizzes</p> <p>In-class exam-style questions with posted rubrics and feedback</p>	<p>New study questions</p> <p>Midterm teaching evaluations</p> <p>Improvement of group activities and discussions in class</p> <p>Revised course content and lecture materials incorporating real life examples.</p> <p>Enhanced problem solving approach including comparisons.</p> <p>Introduced exam-style question practice into lecture time</p> <p>Collected data regarding approaches to teaching phylogenetics</p>




			Piloting Calibrated Peer Review for short essay questions
<p><b>BIOL 205: Comparative Invertebrate Zoology</b> (Jan '13 start)</p> <p><u>Faculty:</u> Angie O'Neill <u>STLF:</u> Laura Weir</p>	<p>Course-level goals: In process</p> <p>Topic level goals: In process</p>	<p>Clicker questions</p> <p>Pre-reading assignments for lecture and laboratory</p>	<p>Clicker questions with peer discussion</p> <p>Pre-reading assignments that cover both lecture and laboratory material</p> <p>Midterm teaching evaluations</p> <p>Collecting data regarding approaches to teaching phylogenetics</p>
<p><b>BIOL 209: Non-vascular Plants</b> (Sept '12 start)</p> <p><u>Faculty:</u> Mary Berbee, Michael Hawkes <u>STLF:</u> Laura Weir</p>	<p>Course-level goals: complete</p> <p>Topic-level goals: complete</p>	<p>Clicker questions</p> <p>Independent research projects</p>	<p>Clicker questions with peer discussion</p> <p>Alignment of exam questions and learning objectives</p> <p>Collecting data regarding approaches to teaching phylogenetics</p> <p>Use of worksheets in class</p>
<p><b>BIOL 210: Vascular Plants</b> (Jan '13 start)</p> <p><u>Faculty:</u> Shona Ellis, Sean Graham <u>STLF:</u> Laura Weir</p>	<p>Course-level goals: complete</p> <p>Topic level goals: complete</p>	<p>Clicker questions</p> <p>In-class worksheets</p>	<p>Clicker questions with peer discussion</p> <p>Alignment of exam questions and learning objectives</p> <p>Collecting data regarding approaches to teaching phylogenetics</p>

<p><b>BIOL 230: Fundamentals of Ecology</b> (formerly BIOL 304) (Sept '09 start)</p> <p><u>Faculty:</u> D. Srivastava, R. Turkington, W. Goodey, E. Hammill, J. Brodie</p> <p><u>STLF:</u> Malin Hansen</p> <p> <a href="#">Poster (CWSEI EOY 2011): Measuring Learning Gain in a Transformed Introductory Ecology Course</a></p> <p> <a href="#">Poster (CWSEI EOY 2012): Evaluating Interactive Activities by Measuring Student Learning Gain</a></p>	<p>Topic-level/ class specific goals: complete</p> <p>Learning goals have been linked to exam question, clicker questions and pre-reading questions</p>	<p>The CLASS pre and post biology attitude surveys have been used in all sections each term (2009-2013).</p> <p>A pre/post conceptual survey for community and population ecology has been developed and is used.</p> <p>Student interviews have been conducted to assess class activities and methods and to validate conceptual survey.</p> <p>Midterm survey has been developed and is used to assess class activities and methods.</p>	<p>Clicker questions with peer discussion</p> <p>Pre-reading assignments with multiple choice and open-ended question (with feedback) are issued each week</p> <p>Small group in-class discussions</p> <p>23 on-line article-based practice problems/case studies developed; some have been implemented as in-class activities</p> <p>Three mandatory field labs have been implemented</p> <p>Two tutorials have been designed and implemented (for summer courses only)</p> <p>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)</p> <p>Conceptual questions on population dynamics are used to compare the effectiveness of in-person tutorials and on-line tutorials ('12-'13)</p> <p>The effectiveness of using analogies when teaching ecology was evaluated using optional tutorials ('11)</p>
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			Two-stage group exams were used for two midterms (J. Brodie & M. Hansen '13)
<p><b>BIOL 234: Fundamentals of Genetics</b> (Jan '12 start)</p> <p>Faculty: J. Klenz, P. Kalas, D. Moerman, G. Haughn, C. Berezowsky STLF: Lisa McDonnell</p> <p> <a href="#">Poster (CWSEI EOY 2013): Comparing post-course retention of conceptual and procedural knowledge in genetics</a></p> <p> <a href="#">Poster (SABER 2014): Exploring ways to overcome misconceptions about genetic linkage and molecular markers</a></p> <p>Article (CourseSource 2015): Teaching Genetic Linkage and Recombination through Mapping with Molecular Markers</p>	<p>Topic level learning goals — complete; used to structure lectures, tutorials, assessments, and provided to students</p>	<p>Genetics Concept Inventory Test</p> <p>Student think-aloud interviews to assess problem solving in genetics</p> <p>Interviews conducted to assess course satisfaction</p> <p>Problem solving and conceptual understanding assessed with some handed-in homeworks</p> <p>Mid-term and end-of-term satisfaction surveys deployed to assess class activities and student attitudes</p> <p>Regularly collecting feedback from TAs about their experience and the challenges they observe students experiencing</p> <p>Classroom observations (COPUS) for instructor feedback</p>	<p>Clicker questions with peer discussion and in-class worksheets used (by most instructors)</p> <p>Targeted pre-reading assignments with quiz are used weekly</p> <p>Tutorials with an emphasis on group work and facilitation by TAs deployed weekly</p> <p>Improved support for TAs to provide students with a consistent experience across multiple tutorial sections</p> <p>Peer-discussion used in-class regularly</p> <p>Improved approach to teaching problem solving</p> <p>Two-stage review activity used</p>
<p><b>BIOL 234: Fundamentals of</b></p>	<p>Topic level learning goals — complete,</p>	<p>Genetics Concept Inventory Test</p>	<p>Tutorials with an emphasis on group work and</p>

<p><b>Genetics – online section</b> (Sept-Dec '14)</p> <p><u>Faculty:</u> Rosie Redfield <u>STLF:</u> Lisa McDonnell</p>	<p>used to structure lectures, tutorials, assessments, and provided to students</p>	<p>Mid-term and end-of-term satisfaction surveys deployed to assess class activities and student attitudes</p> <p>Common exam questions with non-online section</p> <p>Observations of tutorials to capture student difficulties</p>	<p>facilitation by TAs deployed weekly</p> <p>Two-stage review activity used</p>
<p><b>BIOL 260: Fundamentals of Physiology</b> (Jan '12 start)</p> <p><u>Faculty:</u> Patricia Schulte, Philippe Tortell <u>STLF:</u> Mandy Banet ('12-'13), Laura Weir ('14), Tammy Rodela ('15-continuing)</p>	<p>Course level learning goals: complete</p> <p>Lecture-level learning goals: complete</p> <p>Goals have been linked to exams, online activities, and iclicker questions</p>	<p>Mid-term teaching survey deployed for student feedback on in-class and out-of-class activities</p> <p>Mid-course and end-course surveys conducted to get specific detail on active learning aspects of the course</p> <p>Pre and post conceptual survey for physiology developed and implemented.</p> <p>New three-stage homework model with student reflection stage designed and deployed to provide students with timely feedback</p> <p>Classroom observations (COPUS) done to provide feedback to instructors</p> <p>Creation of a course package for transfer of course materials</p>	<p>Clicker questions with peer discussion</p> <p>Pre-reading assignments with an online quiz (including one open-ended JITT questions) are issued each week</p> <p>Practice exam questions provided as online and in-class activities to give students practice and feedback on what is expected from them when answering a short essay question</p> <p>Worksheets and problem sets in class with real-time instructor feedback</p> <p>Rearranged course schedule to include overview lectures introducing main physiology concepts for each in-course module</p> <p>Accompanying concept-based clicker questions and worksheets were designed and deployed to</p>

			complement the overview lectures for each module
<p><b>BIOL 306: Advanced Ecology</b> (2010–2013)</p> <p>Previously <b>BIOL 303: Population Biology</b></p> <p><u>Faculty:</u> Gary Bradfield, Wayne Goodey, Mary O'Connor</p> <p><u>STLF:</u> Malin Hansen</p>	<p>Topic-level/class specific goals: complete</p>	<p>The CLASS pre and post biology attitude surveys have been used in all sections each term ('10, '11 &amp; '12).</p> <p>A pre/post conceptual survey for advanced ecology has been developed and is used.</p> <p>A pre/post conceptual survey on competition models have been developed. Student interviews have been conducted to assess class activities and methods and to validate conceptual survey.</p> <p>Mid-term survey has been developed and is used to assess class activities and methods.</p>	<p>Clicker questions with peer discussion</p> <p>Pre-reading assignments with multiple choice and open-ended questions (with feedback) are issued each week</p> <p>Small group in-class discussions have been incorporated</p> <p>23 on-line article based practice problems have been developed. Some of them were implemented as in-class learning activities in '11 &amp; '12 (approx. one learning activity per week).</p> <p>The conceptual inventory on competition models is being used to evaluate an in-class learning activity</p> <p>Three mandatory field labs have been implemented</p> <p>Two tutorials have been designed and implemented (for summer courses only)</p>
<p><b>BIOL 310: Introduction to Animal Behaviour</b> (Jan '11 start)</p> <p><u>Faculty:</u> Wayne Goodey</p> <p><u>STLF:</u> Malin Hansen</p>	<p>Topic-level/class specific goals: complete</p> <p>Learning goals have been linked to exam questions, iClicker</p>	<p>The CLASS pre and post biology attitude surveys have been used in all sections each term ('11-'12).</p> <p>A pre/post conceptual/attitudinal survey has been developed by the</p>	<p>Clicker questions with peer discussion</p> <p>Pre-reading assignments with multiple choice questions (with feedback) are issued each week</p>

	questions and pre-reading questions.	instructor and is used.  Mid-term survey will be developed and used.	Small group in-class discussions have been 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.
<b>BIOL 325: Introduction to Biomechanics</b> (2014 start)  <u>Faculty:</u> Phil Matthews <u>STLF:</u> Natalie Schimpf	Finalising course learning goals	Pre and post diagnostic in first iteration (as part of department-wide COPUS)	Intention (for next iteration) to incorporate pre-class readings and quizzes, clicker questions, in-class activities and worksheets. Class participation to be included in final grade
<b>MICB 325: Microbial Genetics</b> (2011-2012)  <u>Faculty:</u> Tom Beatty <u>STLF:</u> Jared Taylor   <a href="#">Poster (CWSEI EOY 2012): Restructuring Microbiology 325: Microbial Genetics</a>	A complete set of learning goals has been established.	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 Just-in-time teaching format.
<b>BIOL 331: Developmental</b>	Course-level: in progress	Intention to observe lecture (COPUS) and labs to provide	<u>Course revision to include:</u> — Pre-readings and quizzes

<p><b>Biology</b> (Sept 2016 start)</p> <p><u>Faculty:</u> Vanessa Auld <u>STLF:</u> Tammy Rodela</p>	<p>Topic-level: in progress</p>	<p>feedback to instructors, release mid-course and end-course student attitudinal surveys</p>	<ul style="list-style-type: none"> <li>— Clicker questions</li> <li>— Weekly homework question (three-stage including student reflection)</li> <li>— Peer discussion</li> <li>— Activities focusing on primary literature in developmental biology</li> </ul>
<p><b>BIOL 335: Molecular Genetics</b> (Dec '14-'15)</p> <p><u>Faculty:</u> Craig Berezowsky, Yuelin Zhang, Don Moerman <u>STLF:</u> Lisa McDonnell</p>	<p>Iterative process to revise goals underway</p>	<p>Using concept inventory (pre- and post) to measure learning gains</p> <p>Observing tutorials to capture baseline information to inform change</p> <p>Observing lecture (COPUS) to provide instructor feedback</p> <p>Mid-course survey deployed</p>	<p>To be incorporated as part of course revision:</p> <ul style="list-style-type: none"> <li>— Peer instruction</li> <li>— Clickers</li> <li>— Group work to solve complex problems</li> </ul>
<p><b>BIOL 336: Fundamentals of Evolution</b> (Jan '12 start)</p> <p><u>Faculty:</u> Jeannette Whitton, Greg Bole <u>STLF:</u> Bridgette Clarkston ('12); Laura Weir ('13-'14)</p>	<p>Course-level: in progress</p> <p>Topic-level: complete</p>	<p>Mid-course and end-course student attitudinal surveys</p> <p>Clicker questions</p> <p>Speciation Concept Inventory (in validation stage)</p>	<p>Weekly targeted textbook pre-reading assignments and quizzes</p> <p>Assessment questions drawn from learning goals.</p> <p>Tutorials more connected to lecture section and converted from informal discussion to more structured group work with worksheets and discussion.</p> <p>Clicker questions with peer discussion; broader use of clicker questions (e.g., assess prior knowledge, make predictions, probe misconceptions)</p> <p>In-class practice exam</p>

			<p>questions and worksheets are used</p> <p>Two-stage review activity implemented</p>
<p><b>BIOL 361: Introduction to Physiology</b> (Sept '12 start)</p> <p><u>Faculty:</u> Doug Altshuler, Tammy Rodela, Agnes Lacombe <u>STLF:</u> Mandy Banet, Tammy Rodela</p>	<p>Lecture-level learning goals: Goals were provided to students.</p> <p>Goals have been linked to exams, iclicker questions, practice problems, and homework.</p>	<p>Pre-term assessment on topics covered in the course was given first day of class.</p> <p>End-of-term survey was conducted to get specific detail on active learning aspects of the course. Focus groups are used to provide feedback on class activities and methods.</p>	<p>Clicker questions with peer discussion</p> <p>Pre-reading assignments with an online quiz (including one open-ended JITT questions) are issued each week.</p> <p>Practice exam questions are provided as in-class activities to give students practice and feedback on what is expected from them when answering a short essay question.</p> <p>Developed and piloted worksheets and case studies</p> <p>Two-stage group exams were used</p>
<p><b>BIOL 362: Cellular Physiology</b> (Jan 2015 start)</p> <p><u>Faculty:</u> Robin Young <u>STLF:</u> Megan Barker</p>	<p>Learning goals already in place</p>	<p>Concept inventory</p> <p>Ongoing peer feedback as part of term project</p>	<p>Two-stage review</p> <p>Support with case studies, student writing and peer group feedback</p>
<p><b>BIOL 456: Comparative and Molecular Endocrinology</b> (Jan 2015 start)</p> <p><u>Faculty:</u> Tammy Rodela</p>	<p>Course-level and topic-level learning goals completed</p>	<p>Two-stage exam style exams</p> <p>Developing a course pack for transfer of course-related materials</p>	<p>In-class worksheets and case studies designed and deployed</p> <p>Practice exam questions provided as online and during in-class activities</p>



			<p>Student writing project (science journalism paper) developed</p> <p>Developed weekly pre-reading and assignments focusing on the scientific (primary) literature</p>
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CWSEI-LS consulting on courses and changes undertaken by individual faculty members:

**BIOC 203 and BIOC 302: Fundamentals of Biochemistry & General Biochemistry** (Faculty: Robert Maurus) – 2015: Megan Barker is consulting with the instructors of these courses, conducting tutorial observations and giving TA feedback using qualitative observations and COPUS data.

**MICB 300: Microbial Ecology** (Faculty: William 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.

**MICB 302: Immunology** (Faculty Pauline Johnson) – worked with Jared Taylor to create learning goals.

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

**BIOL 441: Fall 2014:** Megan Barker consulted with Geoff Wasteneys about the structure of the fourth-year course, and provided some support on the curriculum request documents.

**BIOL 463: Gene Regulation in Development** (Faculty: Pam Kalas) – Used two-stage review activity on the first day of class, deployed concept inventory.

## Assessment and Evaluation

Below are some broad assessment tools that are not course-specific. There were also numerous assessment tools being developed and implemented for specific courses.

### Concept Inventory

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. 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.

Ad hoc concept inventories have been developed and implemented in BIOL 260.

### Questions for Biology

CWSEI was involved in this collaborative effort to develop concept inventories for biology

 [Poster \(CWSEI EOY 2012\): Developing Concept Inventories for Biology](#)

### 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, and fourth year courses between 2009 and 2013. This is part of a longitudinal study where we investigate shifts in students' attitudes towards biology from first to fourth year. The survey was designed to gain a better understanding of first-year students' attitudes towards learning Biology. It is a tool to investigate how instruction in Biology fosters "expert thinking" in students.

### 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.

### Natural Selection Conceptual Understanding


Harald Yurk assessed 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.

### Focus Group Interviews

e.g. BIOL 111, BIOL 121, BIOL 201, 4th year students (2007-2009)

## CWSEI-Funded Research


**Use of Scientific literature across the Biology Program:** Life Sciences STLFs N. Schimpf, T. Rodela have undertaken a program-level project examining how scientific literature is used in Biology courses. Surveys were developed to collect perspectives from both a faculty and students.



**Characterizing Active Classrooms and Student Learning:** Laura Weir, Lisa McDonnell, Megan Barker, Natalie Schimpf, and Tammy Rodela conducted a department-wide study examining whether a relationship exists between levels of active learning in classrooms (characterized through COPUS observations) and student learning (pre-post test CI scores). Data collection and analysis is completed and a manuscript is in preparation.  [Poster: UBC Science Ed Open House 2016](#). Published in PLOS ONE in 2019.


**Three stage online homework model:** providing timely feedback to students in large enrollment courses: Tammy Rodela is measuring how a required homework assignment with a reflection stage helps students interact with course materials. Data collection is complete and analysis is underway.


**Effects of jargon on conceptual understanding:** Megan Barker and Lisa McDonnell conducted a pilot project to assess the effects of jargon on learning new concepts in first year biology. [Paper: McDonnell, L., Barker, M. K. and Wieman, C. \(2016\), Concepts first, jargon second improves student articulation of understanding. Biochem. Mol. Biol. Educ., 44: 12–19. doi:10.1002/bmb.20922.](#)

**Study skills workshops to improve student performance:** Laura Weir, in collaboration with Ashley Welsh, Sara Harris, Costanza Piccolo, Sandra Merchant, and Jackie Stewart, has been running workshops in BIOL 121 to help students understand how the course learning objectives can be linked to exam questions. Next steps toward improving the effectiveness of these workshops are underway.


**Pre-reading Study:** Mandy Banet collaborated with Cynthia Heiner (former STLF in Physics) to study the implementation of directed pre-readings in across disciplines.  [Paper \(2014\): Preparing students for class: How to get 80% of students reading the textbook before class.](#)

**Problem Solving in Genetics:** Lisa McDonnell conducted a study to investigate how students solve problems in genetics, and how to modify course activities to improve student ability at problem solving in genetics. Student interviews and tests continue to be collected to assess the effectiveness of changes to the way we teach problem solving. Posters (  [CWSEI EOY 2014](#);  [SABER 2014: Beyond the content: Improving student problem-solving in genetics](#) ). Manuscript prepared for submission.


**Retention of conceptual and procedural knowledge in genetics:** Lisa McDonnell is measuring the degree of retention of conceptual understanding and procedural knowledge (how to solve problems) in genetics. Students from summer, fall, and spring terms are recruited approximately 2.5 months after course completion to write a previously-written conceptual inventory and exam questions. Data collection and analysis is complete and a manuscript is in preparation.  [Poster \(CWSEI EOY 2013\): Comparing post-course retention of conceptual and procedural knowledge in genetics.](#)

**Two-stage Collaborative Test Study:** Bridgette Clarkston collaborated with Brett Gilley (STLF in EOAS) to study the effects of testing students in groups vs. individually on student learning.  [Their paper: Collaborative Testing: Evidence of Learning in a Controlled In-Class Study of Undergraduate Students](#) was published in the Journal of College Science Teaching (Vol. 43, No. 3, 2014).

**Constructing logical arguments:** Laura Weir is examining the effectiveness of repeated practice with feedback on the construction of logical arguments on open-ended essay type examinations.

**Biology Attitudinal Survey:** Gulnur Birol and Malin Hansen have completed a study that compares student attitudes in first and fourth year courses. The CLASS pre and post biology attitude surveys have been used in several first and fourth year courses between 2009-2013. This is part of a longitudinal study where we investigate shifts in students' attitudes towards biology from first to fourth year.  [Paper \(CBE-LSE 2014\): Longitudinal Study of Student Attitudes in a Biology Program.](#)

**Evidence-Based approach to teach genetic linkage and recombination:** Lesson and tutorial activities developed by Lisa McDonnell and Jennifer Klencz. Activities used and tested (via clicker questions and


post-test) in 200 level genetics class.  [Poster \(SABER 2014\): Exploring ways to overcome misconceptions about genetic linkage and molecular markers](#), article accepted for publication (CourseSource, <http://coursesource.org/>).


**Learning Activities/Case Studies:** Malin Hansen studied the effectiveness of in-class activities in BIOL 121 and BIOL 230 using a concept inventory in population and community ecology.

**Tutorial vs. in-class activities:** Malin Hansen compared student learning from using separate tutorials in addition to traditional lectures vs. in-class activities using a concept inventory in population ecology.

**Use of analogies to teach ecology:** Malin Hansen studied the effectiveness of using analogies when teaching ecology using optional tutorials in BIOL 230/304 in the fall of 2011.

**Invention Activities:** Jared Taylor, George Spiegelman and Karen Smith conducted a study of the effectiveness of invention activities in developing students' reasoning/problem solving skills and ability to transfer knowledge to novel situations.

 [Paper \(Winter 2010\): Using Invention to Change How Students Tackle Problems](#) — Jared L. Taylor, Karen M. Smith, Adrian P. van Stolk, and George Spiegelman (CBE—Life Sciences Education) [An Instructor's Guide and accompanying materials for Invention Activities in Cell Biology \(11 MB zip file\)](#) - prepared by Jared L. Taylor and George B. Spiegelman in Life Sciences.

**Learning Objectives:** Jared Taylor in collaboration with Beth Simon, former STLF in Computer Science, conducted a study of student and faculty perceptions of the usefulness of learning goals. Their paper on this work is published in the Journal of College Science Teaching (Nov/Dec 2009).  [What is the Value of Course-Specific Learning Goals?](#)

**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 fourth year biology courses.

**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).

**Characterising Active Classrooms and Student Learning:** Laura Weir, Lisa McDonnell, Megan Barker and Natalie Schimpf are conducting a department-wide study examining whether a relationship exists between levels of active learning in classrooms (characterized through COPUS observations) and student learning (pre-post test CI scores).


**Visual communication of classroom practices data:** a design study for instructors, researchers, and institutions. In conjunction with Jessica Dawson (STLF from Computer Science). An investigation of the potential uses for COPUS data among the diversity of end-users, and design of appropriate visuals to aid interpretation and impact.

## Collaboratively-funded Research


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.

 [Poster \(Oct. 2008\): Findings of the Impact of a Non-majors First Year Biology Course on Students' Attitudes Towards Biological Sciences](#) — Gülnur Birol, Kathy Nomme, Sandra Keerthisinghe, and Jennifer Klenz

**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.

 [Poster \(Oct. 2008\): How Do Cell Biology Students Learn Effectively?](#) — Gülnur Birol, Ellen Rosenberg, Joanne Nakonechny, and Lacey Samuels

**Questions for Biology:** CWSEI is involved in this collaborative effort to develop concept inventories for biology. People involved are Gülnur Birol, Greg Bole, Sunita Chowrira, Brett Couch, Thomas Deane, Malin Hansen, Elizabeth Imrie, Erica Jeffery, Pam Kalas, Jennifer Klenz, Kathy Nomme, Rosemary Oh-McGinnis, Angie O'Neill, Carol Pollock, Karen Smith, George Spiegelman, Jared Taylor, Michelle Tseng (all at University of British Columbia) and Joan Sharp (at Simon Fraser University).  [Poster \(CWSEI EOY 2012\): Developing Concept Inventories for Biology](#)

**Understanding the impact of jargon within first- and second-year biology to improve student learning:** Skylight Development Grant, with matching funds from Biology Dept. People involved are Lisa McDonnell, Megan Barker, Marcia Graves (with additional support from James Cooke and Pam Kalas).

## Newsletters

[LS-CWSEI Blog](#) 2014 - ongoing

[New Blog](#) with regular entries, such as:

- **Clarifying requirements and expectations in assessment**
- **Hack Your Classroom: Using student responses as clicker options, on the fly**
- **How to find out what really happens in your classroom**
- **Save class time with a more efficient review strategy: two-stage review activity**
- **and more!**

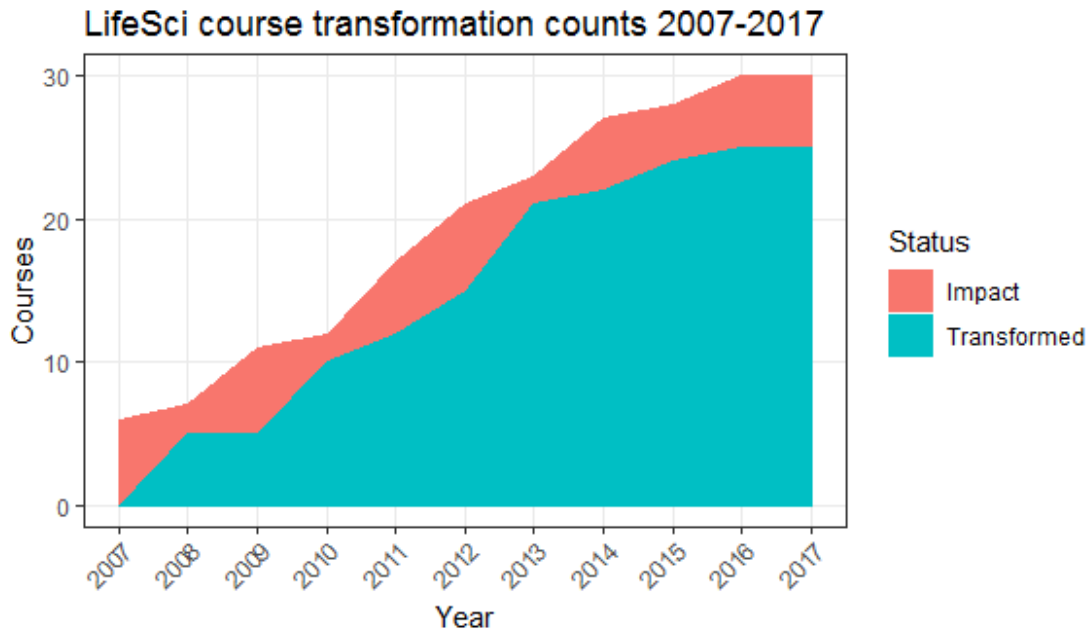
2008-2009 Newsletters

Available as a zip bundle download at: <https://cwsei.ubc.ca/outcomes/departments/lifesciences>

## Impact

## Transformed course counts

As of Spring 2018, we had 30 courses with CWSEI and/or Skylight influence:









## Impact summary

### Impact in terms of seats/registrations

We can look at this in terms of the **106 undergraduate BIOL, BIOC, or MICB courses offered in 2017** with LEC, LAB or DST as primary activity and excluding distance ed. sections. In terms of **seats/registrations** (with LEC, LAB or DST as primary activity; excludes distance ed. sections):




EFFECT	Seats.2012	Seats.2013	Seats.2014	Seats.2015	Seats.2016	Seats.2017
	Transformed	12113	12194	12005	12161	12143
Impact	18	758	647	873	924	880
Other/None	6362	6298	6149	5982	5979	5968
EFFECT	Prop.Seat s.2012	Prop.Seats. 2013	Prop.Seats. 2014	Prop.Seats. 2015	Prop.Seats. 2016	Prop.Seats. 2017
Transformed	65.5%	63.3%	63.9%	64.0%	63.8%	64.1%
Impact	0.1%	3.9%	3.4%	4.6%	4.9%	4.6%
Other/None	34.4%	32.7%	32.7%	31.5%	31.4%	31.3%

## Publications and Presentations

<p>Paper</p>	<p><b>Teaching Students How to Check Their Work While Solving Problems in Genetics</b>          Lisa McDonnell and Martha Mullally (Zoology, UBC)           Journal of College Science Teaching, Vol. 46(1), pp. 68-75 (2016)</p>	
<p>Paper</p>	<p><b>Concepts First, Jargon Second Improves Student Articulation of Understanding</b>          Lisa McDonnell, Megan Barker (Zoology, UBC), &amp; Carl Wieman           Biochemistry and Molecular Biology Education, Vol. 44(1), pp. 12-19 (2016)</p>	<p><a href="#">To view full text</a></p>
<p>Paper</p>	<p><b>An Improved Design for In-Class Review</b>          E. Jane Maxwell (Chemistry, UBC), Lisa McDonnell (Zoology, UBC), &amp; Carl Wieman           Journal of College Science Teaching, Vol. 44(5), pp. 48-52 (2015)</p>	
<p>Paper</p>	<p><b>Preparing students for class: How to get 80% of students reading the textbook before class</b>          Cynthia Heiner (Physics, UBC), Amanda Banet (Zoology &amp; Botany, UBC), &amp; Carl Wieman           American J. Physics, Vol. 82(10), pp. 989-996 (2014)</p>	
<p>Paper</p>	<p><b>Longitudinal Study of Student Attitudes in a Biology Program</b>          Malin Hansen &amp; Gülnur Birol (Life Sciences &amp; Skylight, UBC)           CBE—Life Sciences Education, Vol. 13, pp. 331–337 (2014)</p>	
<p>Paper</p>	<p><b>The Colorado Learning Attitudes about Science Survey (CLASS) for Use in Biology</b>          Kate Semsar (Integrative Physiology, CU), Jenny Knight &amp; Michelle Smith (Molecular, Cellular, &amp; Developmental Biology, CU), &amp; Gülnur Birol (Life Sciences &amp; Skylight, UBC)           CBE—Life Sciences Education, Vol. 10, pp. 268–278 (2011)</p>	
<p>Paper</p>	<p><b>Using Invention to Change How Students Tackle Problems*</b>          Jared L. Taylor, Karen M. Smith, Adrian P. van Stolk, and George Spiegelman (Life Sciences, UBC)</p>	

	<p>CBE—Life Sciences Education (Winter 2010)  *Selected for inclusion in the 2010 Highlights issue of the CBE Life Sciences Education</p>	
Paper	<p><b>A Report on the Implementation of the Blooming Biology Tool: Aligning Course Learning Outcomes with Assessments and Promoting Consistency in a Large Multi-Section First-Year Biology Course</b>  Angie O'Neill, Gülnur Birol, and Carol Pollock (Life Sciences, UBC)</p> <p>The Canadian Journal for the Scholarship of Teaching and Learning (2010)</p>	
Paper	<p><b>What is the Value of Course-Specific Learning Goals?</b>  Beth Simon (Computer Science, UCSD) and Jared Taylor (Life Sciences, UBC)</p> <p>Journal of College Science Teaching (November/December 2009)</p>	
Talk	<p><b>Concept first, jargon second: An assessment of the influence of technical vocabulary on conceptual learning</b>  Megan Barker &amp; Lisa McDonnell (LS-CWSEI, UBC), &amp; Carl Wieman (Stanford)</p> <p>Society for the Advancement of Biology Education Research (SABER)  National Meeting: Twin Cities, Minnesota (July 2014)</p>	
Poster	<p><b>Exploring ways to overcome misconceptions about genetic linkage and molecular markers</b>  Jennifer Klenz &amp; Lisa McDonnell (Botany &amp; LS-CWSEI, UBC)</p> <p>Society for the Advancement of Biology Education Research (SABER)  National Meeting: Twin Cities, Minnesota (July 2014)</p>	
Poster	<p><b>Beyond the content: Improving student problem-solving in genetics</b>  Lisa McDonnell &amp; Martha Mullally (LS-CWSEI, UBC)</p> <p>Society for the Advancement of Biology Education Research (SABER)  National Meeting: Twin Cities, Minnesota (July 2014)</p>	
Poster	<p><b>Profile of common genetics misconceptions in 1st to 4th year undergraduate biology students</b>  Pam Kalas &amp; Lisa McDonnell (Zoology, UBC)</p> <p>Society for the Advancement of Biology Education Research (SABER)  National Meeting: Minneapolis, Minnesota (July 2013)</p>	
Poster	<p><b>Exam over, knowledge gone? Retention of conceptual and procedural knowledge in genetics</b></p>	



	<p>Lisa McDonnell &amp; Pam Kalas (Zoology, UBC)</p> <p>The Western Conference on Science Education: London, Ontario (July 2013), and Society for the Advancement of Biology Education Research (SABER) National Meeting: Minneapolis, Minnesota (July 2013)</p>	
Poster	<p><b>Students' perspectives on pre-class reading assignments</b></p> <p>Cynthia Heiner (Physics and Astronomy, UBC) and Amanda Banet (Zoology, UBC)</p> <p>Foundations and Frontiers of Physics Education Research: Puget Sound (June 2012)</p>	
Poster	<p><b>Bio-Invention Activities for Small Group Learning</b></p> <p>Jared L. Taylor, Karen M. Smith, and George B. Spiegelman (Life Sciences, UBC)</p> <p>American Society for Microbiology, Conference for Undergraduate Educators, Fort Collins, Colorado (May 2009)</p>	
Poster	<p>Implementation of a First Year Biology Learning Group Pilot Study</p> <p>Karen M. Smith, Tamara L.J. Kelly, Gülnur Birol, and George B. Spiegelman (Life Sciences, UBC)</p> <p>ISSOTL 2008, Edmonton, Alberta (October 2008)</p>	

## Related Department Links

Botany Department Home: <http://www.botany.ubc.ca/>

Microbiology & Immunology Dept. home: <http://www.microbiology.ubc.ca/>

Zoology Dept. home: <http://www.zoology.ubc.ca/>

LS-CWSEI Blog: <http://ls-cwsei.biology.ubc.ca/>