

Statistics

CWSEI Department Summary

This document summarizes the Statistics Department's activities 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:


Bruce Dunham (b.dunham@stat.ubc.ca) or Warren Code (warcodes@science.ubc.ca)


Contents

| | |
|---|----|
| Overview..... | 2 |
| People..... | 2 |
| Activities | 2 |
| Courses | 3 |
| Assessment Tools | 9 |
| Student Attitude Surveys | 9 |
| Concept Inventory for STAT 241/251 | 9 |
| WeBWork Online Homework Tool | 9 |
| Assessing the Difficulty Level of Examinations | 9 |
| Common Student Difficulties | 10 |
| Impact..... | 10 |
| Transformed course counts | 10 |
| Impact in terms of seats/registrations | 11 |
| Publications and Presentations | 11 |
| Related Department Links | 11 |

Overview

The Statistics CWSEI program started in 2007 and initially concentrated on the transformation of STAT 200, Elementary Statistics for Applications, an introductory course presently taken by around one thousand undergraduate students per year. In recent years our focus has expanded to enhance the teaching and assessment on STAT 241/251, Elementary Statistics (a calculus-based introduction for Applied Science and Computer Science students), STAT 300, Intermediate Statistics for Applications (a second course accessible to any student with a generic first course in Statistics), STAT 302, Introduction to Probability, STAT 305, Introduction to Statistical Inference, and STAT 443, Time Series and Forecasting. Our aim is to enhance the teaching and learning experience within our undergraduate courses through methods of proven effectiveness. There are eight faculty members and one STLF recently involved in the Statistics department's CWSEI project.

 [Poster \(CWSEI EOY 2014\): Recent Developments in the Transformation of Statistics Courses With Highlights on Study Skills Workshops and Lab TA Surveys](#)

 [Poster \(CWSEI EOY 2013\): An Overview of Transformations of Statistics Courses via CWSEI, with highlights on interactive engagement in STAT 300, STAT 302 and STAT 305](#)

 [Poster \(CWSEI EOY 2012\): Recent Developments in the Transformation of Statistics Courses with Highlights on Revisions to STAT 241/251 Labs](#)

People

CWSEI Department Director: Bruce Dunham

STLF: Gaitri Yapa

Faculty: A. Bouchard-Cote, B. Dunham, P. Gustafson, Y. Lim, N. Nolde, J. Petkau, W. Welch, L. Wu, E. Yu


Activities


Efforts in the Dept. of Statistics CWSEI project involve a transformation of [seven courses](#), including **STAT 200: *Elementary Statistics for Applications*** (an introductory course presently taken by around one thousand undergraduate students per year), **STAT 203: *Statistical Methods*** (an introductory course for non-science students), **STAT 241/251: *Elementary Statistics*** (a calculus-based introduction for Applied Science and Computer Science students), **STAT 300: *Intermediate Statistics for Applications*** (a second course accessible to any student with a generic first course in Statistics), **STAT 302: *Introduction to Probability***, **STAT 305: *Introduction to Statistical Inference***, and **STAT 443: *Time Series and Forecasting***. In addition, a number of changes have been implemented in **STAT 100: *Statistical Thinking*** and **STAT 335: *Statistics in Quality Assurance*** [read more...](#)

Personal Response Systems, or clickers, with concept-based questions probing understanding have been incorporated into the course lectures for the first time. The PRS has had an immediate impact, particularly in terms of student attendance and engagement. The instructors see the students learning

more in lectures due to the benefit of being able to provide instant feedback addressing any confusion that is evident. Instructors are learning how to focus teaching and assessment on the key ideas, and discovering the many ways in which students can misunderstand the concepts in the course. The instructors are very pleased with the changes they have made so far, and think the students are greatly benefiting.

We are developing and implementing online homework problems for the large enrolment courses. The on-line homework application WeBWork has been enhanced to integrate the statistical software R, and questions are being devised that make use of R's capacity to generate data, perform analyses, and create graphics. Presently WeBWork homeworks are being used in STAT 200, 203, 241/251, 300, 302, 305, 404, and 443.

 [Poster \(UBC Science Ed. Open House 2016\): Introductory Statistics Flexible Learning Project: Resources and Student Interactions with Web Visualizations](#)

 [Poster \(CWSEI EOY 2013\): An Overview of Transformations of Statistics Courses via CWSEI, with highlights on interactive engagement in STAT 300, STAT 302 and STAT 305](#)


 [Poster \(CWSEI EOY 2012\): Recent Developments in the Transformation of Statistics Courses with Highlights on Revisions to STAT 241/251 Labs](#)

 [Poster \(April 2009\): CWSEI Projects in the Department of Statistics](#)


 [Paper \(2009\): Statistics Clicks: Using Clickers in Introductory Statistics Courses, by Bruce Dunham](#)

Courses

Status as of May 2016:




| Course | Learning goals | New Assessments | Improved Methods |
|--|--|---|--|
| STAT 200: Elementary Statistics for Applications ('07 start) Faculty: Eugenia Yu, Yew-Wei Lim STLF: Gaitri Yapa  STAT 200 Learning Outcomes (learning goals) | Course-level goals: complete Topic-level goals: complete Ongoing discussion for improvement, with faculty who are/will be teaching for the first time. | Compared the effectiveness of two different lab activities in helping students understand sampling distributions. Comparison of student performances on exam and midterm questions following targeted interventions. On-line mid-course survey, for small amount of credit, elicits sizeable response | Developed and trialed worksheets/in-class activities for use in each class. Clicker questions used in every class. Lab activities improved to focus on key concepts that learners typically find difficult. Students work together in pre-assigned groups |

| | | | |
|---|--|--|---|
| | | <p>and useful data.</p> <p>Survey given during study skills workshop to gather data on student study habits.</p> <p>Following up on student test performances to evaluate the effectiveness of the study skills session.</p> | <p>within each lab.</p> <p>Pre-reading quizzes trialed to begin each lab session.</p> <p>TAs completed a feedback survey on their opinions about each lab session.</p> <p>Weekly on-line assignments in WeBWorK, eleven in total.</p> <p>Two-stage midterm and final examination trialed, in which students collaborated in their lab groups for part of the tests.</p> <p>Adopted more efficient method for grading written assignments to reduce turnaround time.</p> <p>Study skills sessions offered to help students study for the course more effectively and make links between the assessment tools and the learning goals.</p> |
| <p>STAT 203: Statistical Methods (2015-2016)</p> <p><u>Faculty:</u> Bruce Dunham</p> | <p>Course-level goals: complete</p> <p>Topic-level goals: complete</p> | | <p>All lecture and lab sessions use in-class activities on which students work in preselected groups. Class activities are supported by clicker questions.</p> |

| | | | |
|--|--|--|--|
| | | | <p>On-line homework assignments in WeBWork, with eleven sets of questions created.</p> <p>Two-stage midterm test and final exam adopted, in which students collaborate in their lab groups for part of each test.</p> |
| <p>STAT 241/251: Elementary Statistics (Sept '11 start)</p> <p>Faculty: Yew-Wei Lim STLF: Gaitri Yapa</p> <p> Poster (CWSEI EOY 2012): Recent Developments in the Transformation of Statistics Courses with Highlights on Revisions to STAT 241/251 Labs</p> | <p>Course-level goals: complete</p> <p>Topic-level goals: complete</p> | <p>Intervention used to address misconception identified on midterm exam question.</p> <p>On-line mid-course survey, for small amount of credit, elicits sizeable response & useful data, including data on study habits.</p> <p>Post-course interviews, also used to validate a new concept inventory, explore student retention.</p> <p>Following up on student test performances to evaluate the effectiveness of the study skills session.</p> | <p>Context rich problems included in assignments, midterm tests and examination.</p> <p>On-line homework assignments in WeBWork, ten sets of questions in total.</p> <p>New material incorporated to expand the number of labs.</p> <p>Students work together in pre-assigned groups within each lab.</p> <p>TAs completed a feedback survey on their opinions about each lab session.</p> <p>Study skills sessions offered to help students study for the course more effectively and make links between the assessment tools and the learning goals.</p> |

| | | | |
|---|--|---|---|
| <p>STAT 300: Intermediate Statistics for Applications (Sept '12 start)</p> <p><u>Faculty:</u> Bruce Dunham, Paul Gustafson, Lang Wu <u>STLF:</u> Gaitri Yapa</p> | <p>Course-level goals: complete</p> <p>Topic-level goals: complete</p> | <p>On-line mid-course survey, for small amount of credit, elicits sizeable response and useful data.</p> <p>Planning to investigate how students taking this course perform on STAT 305 and STAT 306 compared to peers who did not take STAT 300.</p> <p>Comparison of performances on a final examination question suggests learning gain due to WeBWork homework.</p> | <p>All lecture and lab sessions use in-class activities on which students work in preselected groups. Class activities are supported by clicker questions.</p> <p>Detailed course notes created, available via course website.</p> <p>New labs in Earth Science Building provide better environment for group-based activities.</p> <p>TAs completed an on-line feedback survey on their opinions about each lab session.</p> <p>Two-stage midterm test and final exam trialed, in which students collaborated in their lab groups for part of each test.</p> <p>On-line homework assignments in WeBWork, with ten sets of questions created.</p> <p>Twenty-four short “pencast” mini-lectures made available on-line.</p> <p>Course successfully transferred to another instructor from the original instructor via a co-teaching project.</p> |
|---|--|---|---|

| | | | |
|---|--|--|--|
| <p>STAT 302: Introduction to Probability (Sept '11 start)</p> <p><u>Faculty:</u> Alexandre Bouchard-Cote, Eugenia Yu <u>STLF:</u> Gaitri Yapa</p> | <p>Course-level goals: complete</p> <p>Topic-level goals: complete</p> | <p>Post-course knowledge retention interviews conducted, with eight student participants so far.</p> <p>On-line mid-course survey, for small amount of credit, elicits sizeable response & useful data.</p> <p>Effectiveness of an intervention – teaching on topic via in-class activity compared to traditional lecture – compared via student performance on final examination question over two terms.</p> | <p>Clicker questions developed and used for each lecture.</p> <p>Created and trialed ten in-class activities to target concepts where student misconceptions have been observed.</p> <p>Students work on activities in pre-selected groups each class.</p> <p>Weekly WeBWork on-line homework assignments created, twelve sets in total.</p> |
| <p>STAT 305: Introduction to Statistical Inference (Sept '12 start)</p> <p><u>Faculty:</u> John Petkau, William Welch <u>STLF:</u> Gaitri Yapa</p> | <p>Course-level goals: complete</p> <p>Topic-level goals: complete</p> | <p>Post-course knowledge retention interviews on-going.</p> <p>On-line mid-course survey, for small amount of credit, elicits sizeable response and useful data.</p> | <p>All lecture and lab sessions use in-class activities on which students work in preselected groups. Class activities are supported by clicker questions.</p> <p>New labs in Earth Science Building provide better environment for group-based activities.</p> <p>On-line homework assignments in WeBWork, with nine sets of questions developed.</p> <p>TAs completed an on-line feedback survey on their opinions about each lab session.</p> |

| | | | |
|---|--|---|---|
| <p>STAT 443: Time Series and Forecasting (Sept '09 start)</p> <p><u>Faculty:</u> Bruce Dunham, Natalia Nolde <u>STLF:</u> Gaitri Yapa</p> <p> STAT 443 Learning Outcomes (learning goals)</p> | <p>Course-level goals: complete</p> <p>Topic-level goals: complete</p> | <p>On-line mid-course survey planned, for small amount of credit.</p> | <p>All lecture and lab sessions use in-class activities on which students work in preselected groups. Class activities are supported by clicker questions.</p> <p>Regular lab sessions recently introduced.</p> <p>TAs complete an on-line feedback survey on their opinions about each lab session.</p> <p>On-line homework assignments in WeBWorK, with six sets of questions developed.</p> <p>Two-stage midterm test and final exam adopted, in which students collaborate in their lab groups for part of each test.</p> |
| <p> Poster (CWSEI EOY 2013): An Overview of Transformations of Statistics Courses via CWSEI, with highlights on interactive engagement in STAT 300, STAT 302 and STAT 305</p> <p> Poster (2009): CWSEI Projects in the Department of Statistics</p> <p>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. Nearly all of the faculty in the department have used clickers in their teaching.</p> <p>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:</p> | | | |

- (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 335 Learning Outcomes \(learning goals\)](#)

Assessment Tools

Student Attitude Surveys

We have developed a [Learning Attitudes Survey](#) for Statistics. Near the start and end of STAT 200, students are expected to complete this 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 and encoded in R (a freely available package for statistical computing), and a user guide has been 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.

Concept Inventory for STAT 241/251

Work is on-going with the validation of a proposed concept inventory for STAT 241/251. This course is a calculus-based introduction to probability and statistics, and although such courses are widely offered there is no other existing concept inventory. Any instructor wishing to trial this concept inventory should contact Dr. Bruce Dunham at b.dunham@stat.ubc.ca.

WeBWork Online Homework Tool

We are developing and implementing online homework problems for the large enrolment courses. The on-line homework application WeBWork has been enhanced to integrate the statistical software R, and questions are being devised that make use of R's capacity to generate data, perform analyses, and create graphics. Presently WeBWork homeworks are being used in STAT 200, 203, 241/251, 300, 302, 305, 404, and 443.

Assessing the Difficulty Level of Examinations

When a course is transformed, it appears inevitable that changes are reflected in assessment tools. Typically, for example, examination questions become more concept-oriented following a transformation of the methods of teaching and learning. This can make it difficult to evaluate the effectiveness of the changes in pedagogy. One promising approach to this issue involves attempting to calibrate the difficulty of an examination by equating the questions on the test to levels of Bloom's taxonomy. In this way an examination may be scored for difficulty, and compared with other examinations on the same course. Since student performances on assessments are readily accessible, we are developing a way of "Blooming" our examinations to help investigate how students perform in relation to objective measures of the difficulty level of the examinations. It is hoped this may be used to validate the effectiveness of course transformations in Statistics.

Common Student Difficulties

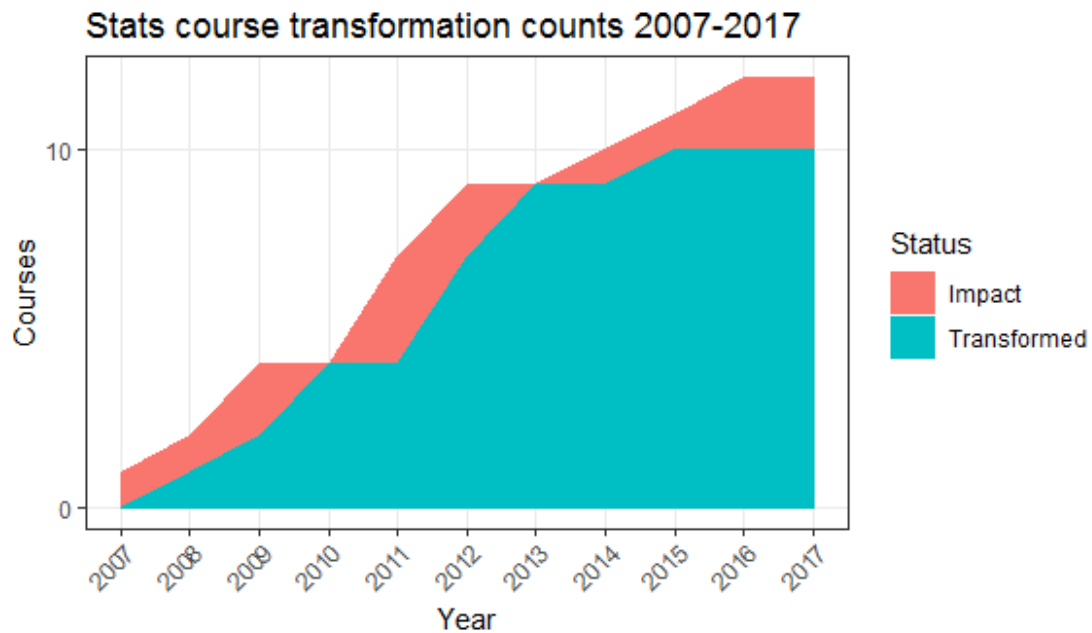
An objective of our project is the determination of specific areas of our undergraduate curriculum where students commonly have problems and misconceptions. This information will inform ways in which student thinking can be channelled into more “expert—like” patterns. Ideally, common and persistent misconceptions can be categorized and teaching methods devised directly to address these difficulties. Work is on-going on this goal via

- a review of student work, including particular questions on past exams,
- observing students working together in groups during “workshops” offered,
- discussions with previous instructors and TAs,
- student contributions to on-line forum, and
- conducting structured interviews with past STAT 200 students.

Impact

Transformed course counts

As of Spring 2018, we had 12 courses with CWSEI and/or Skylight influence (with 2 courses having only had the addition of WeBWork being included in this count):





Impact in terms of seats/registrations

We can look at this in terms of the **16 undergraduate STAT 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 | 1941 | 2163 | 2070 | 2357 | 2687 | 2907 |
| OnlyWebwork | NA | 59 | 35 | 147 | 172 | 203 |
| Other/None | 400 | 378 | 313 | 268 | 340 | 355 |

| EFFECT | Prop. | | | | | |
|-------------|------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| | Seats.2012 | Prop.Seats.2013 | Prop.Seats.2014 | Prop.Seats.2015 | Prop.Seats.2016 | Prop.Seats.2017 |
| Transformed | 82.9% | 83.2% | 85.6% | 85.0% | 84.0% | 83.9% |
| OnlyWebwork | NA | 2.3% | 1.4% | 5.3% | 5.4% | 5.9% |
| Other/None | 17.1% | 14.5% | 12.9% | 9.7% | 10.6% | 10.2% |

Publications and Presentations

| | | |
|-------|---|---|
| Paper | <p>Calibrating the Difficulty of an Assessment Tool: The Blooming of a Statistics Examination Bruce Dunham, Gaitri Yapa, and Eugenia Yu (Statistics, UBC)</p> <p>Journal of Statistics Education Volume 23, Number 3 (2015) www.amstat.org/publications/jse/v23n3/dunham.pdf</p> |  |
| Paper | <p>Statistics Clicks: Using Clickers in Introductory Statistics Courses Bruce Dunham (Statistics, UBC)</p> <p>Prepared for a panel discussion at the 34th International Conference on Improving University Teaching (IUT) at Simon Fraser University (2009).</p> |  |

Related Department Links

Statistics Department home: <https://www.stat.ubc.ca/>