

UBC Teaching and Learning Enhancement Fund

Final Report

Project Name: **On-line Homework System for Undergraduate Statistics Courses**

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Summary of Work Accomplished

Our project commenced in 2012 with the twin goals of (i) increasing the functionality of the on-line homework software WeBWorK to make it useful for statistical science problems and (ii) developing a large database of questions that can be used in WeBWorK for undergraduate education in statistics from introductory to upper level courses. To achieve (i), WeBWorK was enhanced with the capability to communicate with the powerful statistical software R, as functions within R permit a diverse range of questions to be posed that otherwise would not be possible in WeBWorK. For goal (ii), around 700 questions devised by faculty members have been coded in WeBWorK by graduate students and used by undergraduate students across some eleven UBC courses.

New questions have been coded in the past year for STAT 203 (largely based on existing questions from STAT 200), STAT 300, 305, 306, 344, 404, 443, and SPPH 400. In addition, some questions previously coded for STAT 200, 300, 302, and 305 have been revised in the light of instructor and student feedback.

Certain courses required questions for which the technical aspects were novel. Mike Marin, the instructor for SSPH 400, proposed the idea that students could use WeBWorK homeworks in a “case study” mode, whereby they would each see their own customized data across different WeBWorK homeworks within a course. Coding for this feature required modification of how WeBWorK can generate data sets, and this new functionality was soon added and tested with success. STAT 443, a course on time series, required students be able to access features from R packages that are not available in the standard installation of R. In addition, a feature permitting questions to access live data from external websites was also incorporated in questions. Both features were used in 2015 without problem on STAT 443.

It became obvious during the three-year project that once questions have been coded for a course, support is still required to assist instructors using WeBWorK, particularly when questions are being set for the first time. Hence we have allocated academic assistants to provide instructor support, enabling quick reactions to student queries and bug alerts. Ideally the support is provided by the academic assistant who originally coded the questions. Additionally, assistance has been provided to a faculty member, Prof Harry Joe, who has opted to code his own questions (for STAT 306 and 404) in Perl for use in WeBWorK.

A key element this year was further spreading the word about our so-called WeBWorKiR (WeBWorK integrating R) project. Andrew Leung (a graduate student in Statistics) and I ran a one-day workshop at the University of Toronto as part of the Statistical Society of Canada’s annual conference in May 2014. In July 2014, I presented on the project at the International Conference on Teaching Statistics (ICOTS) in Flagstaff, Arizona. I also participated via Skype at a “code camp” on WeBWorK at the University of Virginia in June 2014, contributing to revising the taxonomy that WeBWorK uses to tag statistics questions. Where feasible, we have incorporated questions we have tested into WeBWorK’s Open Problem Library, so that they are accessible to instructors across the world. All questions are submitted to UBC’s local problem library and therefore any UBC instructor can use them.

Work has been on-going to produce high-quality on-line materials for anyone who wishes to make use of the resources we have created. A wiki page built last year has tutorial materials, an authoring guide, and technical details about how to install the RServePerl code required to run our questions that call R. Following suggestions from colleagues, templates for various common styles of questions are now included on the wiki.

Various other technical upgrades and fixes were performed by Davor Cubranic. These included improving the nature of error messages produced by WeBWorK when interacting with R, increasing the functionality with R objects, and the handling of missing values. A detailed list of modifications is available at <https://github.com/cubranic/Statistics-R-IO/blob/master/Changes>. Davor also provided invaluable technical support for the academic assistants.

Evaluation of Project's Success

Student use and feedback have together formed the most important measures of the success of our project. At the time of writing, around 7000 UBC students have benefitted from our on-line homeworks since the project began. When all questions are coded for a course, there are between nine and twelve homework sets for students to attempt, resulting in near-weekly opportunities for students to attempt low-stakes formative assessment. Typically at least 90% of students on a course complete each on-line homework. This contrasts with our estimate of around 25% who would make a serious attempt at traditional, paper-based problems that were not for credit.

Feedback has been obtained from students via midterm surveys, for which students were awarded small amounts of credit to encourage their participation. Surveys on STAT 300 and 305 last year confirm evidence from seven earlier surveys: at least 80% of students on a course (and often over 90%) either agree or strongly agree that WeBWorK was very useful to their learning. The high response rates on these surveys make them close to a census of students on each course.

Feedback from faculty colleagues has been very positive. Everyone who has taught a course using WeBWorK considers it has been helpful to their students, and those who have taught the same course subsequently continued to use WeBWorK. The use of on-line homeworks appears to be perhaps the only active learning pedagogy for which no doubt about effectiveness exists in the department.

Our aim to have educators outside of UBC using the resources we have created seems to have been achieved. To our knowledge, instructors at UBC-O, The University of Calgary, Camosun College, The College of Idaho, and The University of Virginia are using questions created as part of our project. Quite likely the list of institutions benefitting from our work is much longer.