FUND FOR INNOVATIVE TEACHING (FIT) REPORT

Project: Adoption of WebWork into Math courses
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Using the Fund for Innovative Teaching, The Department of Mathematics and Statistics initiated a switch from the current publisher-provided online homework system to an open source system called WebWork. WebWork (a product developed by Mathematical Association of America) is a widely adopted online homework system that is used by over 1000 institutions worldwide. Most locally, University of British Columbia and Kwantlin Polytechnic University uses it for all of their first-year mathematics courses.

WebWork is a fully developed resource with an extensive library of questions containing a large variety of problems. These problems have been designed and tested by faculty members all over the world and are suitable for various teaching styles. The system gives immediate feedback to students and can be used for homeworks, quizzes and diagnostics. It provides instructors with real-time data on student progress they can use to better tailor their lectures to students' needs. It requires no software beyond an ordinary web browser and instructor has full control over student access and registration eliminating potential third-party issues.

WebWork is an open access resource and is textbook independent, allowing instructor freedom in the use of class resources and creating their own. Using WebWork, instructors can draw on all of the available resources (not just publisher-created or self-made) to provide the students with the best available materials.

The adoption of the system into the Department involved:
- creating training documents and facilitating training sessions for faculty members,
- liaising with UFV IT and Mathematical Association of America (MAA) to set up course shells,
- hiring, training and supervising student coders writing up additional questions for the courses involved (Math 111, 118 and Math 125),
- setting up a sustainable method of paying for server rental costs,
- supporting faculty members using WebWork throughout the year.

Adoption of the system started in summer 2018 with setting up training course shells and facilitating faculty training sessions. Over the summer, I hired, trained and supervised 2 undergraduate students in the creation of over 100 questions for Math 125. Dr. Cynthia Loten has been instrumental in helping to find suitable questions, proofread the coded questions, find errors and ensure they are fixed.

The first full implementation of the system took place in Fall 2018. The original plan was to switch to WebWork only in mainstream calculus, but due to faculty interest and willingness, we also included precalculus and discrete math.

- In Fall 2018, the system was launched in all sections of Math 111, 110 and 125. This involved 6 instructors (Kseniya Garaschuk, Cynthia Loten, Ben Vanderlei, Rachel Toews, Joseph Yu, Tariq Narrudin), 11 course sections and 396 students enrolled in WebWork in total.
- In Winter 2019, the system was used in all sections of Math 110, 111, 112, 118 and 125. This involved 2 new instructors and 4 repeated ones (Kseniya Garaschuk, Cynthia Loten, Ben Vanderlei, Rachel Toews, Stan Manu, Vanessa Radzimski) and 13 course sections. There were 418 students enrolled in WebWork in total.

One of the bigger challenges in implementing the project was the set-up of course shells. The original plan was to pay for MAA servers for the first year and set up an internal server for hosting the system through UFV IT. While the initial meetings with IT were promising, in the end IT could not spare the people resources to set up the system for us. This was quite disappointing considering how minimal these resources have to be; UBC and KPU (which is a more appropriate comparison) run their own WebWork servers and were willing to work with our IT department to help with the set up. However, UFV IT decided they could not afford to partake in the project. This meant that we had to come up with a sustainable plan to pay for MAA servers going forward. We implemented a system of vouchers that are sold through the bookstore at a cost of $7 per voucher, which is enough for us to cover server costs (at ~$200 US per course section) and is still very cheap compared to nearly $100 that students used to pay for a publisher-provided online homework system. While this set up works, it has clear downsides: while using MAA servers, we cannot link WebWork to our registration system, so instructors have to manually upload class lists into courses. They also are now tasked with tracking WebWork vouchers purchased through the bookstore, tracking late registrants, manually archiving courses after they are over to ensure no developed material gets lost (server rentals have expiry dates). We hope that the conversation with IT about this project can happen again with a more successful outcome.

Implementing WebWork has allowed for easier implementation of Department-wide initiatives, such as the running of Calculus Readiness Test across all sections of Math 111. This diagnostic test allows students to self-assess their precalculus background and assess the gaps in their knowledge at the very start of the term.

This project has resurrect used textbooks market as students no longer have to buy a brand new bundle with textbook and online access code, but are able to buy previously owned textbooks. This is obvious from the clear dip in the number of new books UFV bookstore sold: 59 in Fall 2018 versus 151 in Fall 2017. The UFV bookstore is now able to buy back used copies of the books for upcoming semesters and we will track the numbers of used copies being sold in the future.

WebWork also served as the first step in larger movement towards using open access resources. In life sciences sections of Math 111 and in Math 118, we now use WebWork and open access textbook developed by a UBC professor, therefore both minimizing cost to students and using most modern and relevant materials. In fact, in life sciences calculus stream in particular, WebWork project was the first step in collaborating with UBC as we now use their library of locally created questions and contribute to it.

As many institutions are looking to switch to open access resources, to disseminate the information about the project, I presented on this project at the 2018 Canadian Mathematical Society Winter

meeting in Vancouver (December 2018) and at PIMS Education Circles at UBC (March 2019). I've now been approached by several departments for advice on WebWork implementation.

I have collected data on student participation and their performance in the online homework and plan to analyze it over the summer to study how well success on WebWork correlated with success in the course. Specifically, I'm interested in students' overall online homework scores and participation.

We have collected general student and instructor feedback on WebWork. We adjusted certain practices in the use of the system based on the comments. Specifically, faculty training documents have been made more precise and we now include "WebWork Introduction" assignment for students in all courses by default. When asked to comment on the cons of the system, I believe this quote from one of the instructors summarizes them well: "Given we charge the students $7 for this system and the used textbook market is viable again, any inconveniences I had were worth it."