Affordable Learning Grant Report

Maureen T. Carroll
Department of Mathematics
Fall 2021

1 Summary of the Affordable Learning Grant project

In Fall 2021 I incorporated the open-source online homework system WeBWorK into my Math 142 Discrete Structures course. Supported by the Mathematical Association of America and the NSF, the WeBWorK problem library is nearly 50,000 strong and growing as more schools utilize this resource and contribute to the repository of problems. Using WeBWorK, students learn course concepts through practice and problem-solving as they complete online homework utilizing a randomization feature that allows for multiple attempts. Students receive immediate feedback as they submit answers, and a motivated learner has the ability to individualize the amount of help they receive as the system allows a student to practice as much as needed to develop the skills necessary for topic mastery. WeBWorK is an excellent teaching and learning tool available to mathematics instructors who have the time and resources to work with their IT department to set up a local server, master the homework system, and incorporate it into their course.

2 Specific tasks related to the implementation process

Implementing the homework system required completing the following tasks:

- work with IT to set up a local Scranton WeBWorK server
- learn how to administer the WeBWorK server (create and manage the homework system)
- browse the library of available problems to find those related to Math 142 topics
- learn to code in the PG (Problem Generation) language in order to:
    a. edit existing problems
    b. code my own problems (thus, contributing to the open problem library)
- set up assignments corresponding to the textbook
- import roster to register students on the WeBWorK system
- show students how to login to WeBWorK, navigate the system, and complete an assignment
- deploy assignments throughout the semester and manage student deadlines

3 Student assessment, engagement and outcomes

There were 24 WeBWorK homework problem sets assigned, roughly two sets for every week of the semester that was not an in-class testing week. Students were continually completing online homework problem sets. The overall average performance on these homework assignments was 85%. Of the 14 students, 8 completed every assignment. The average number of assignments not completed was 2.2, and the median was 1. These numbers indicate significant student involvement, though this is not unexpected as the online homework was worth 15% of their overall course grade.

In an effort to determine whether WeBWorK had a positive impact on in-class assessment, I compared performance on in-class quizzes with that of my pre-pandemic class from Fall 2019. The comparison proved difficult as six out of the eleven quizzes had different point totals. Of the remaining five quizzes, four had averages that were not statistically different (i.e., a p-value greater than 0.05). The fourth quiz, however, showed a statistically significant improvement in their overall

average score (with t = 2.15 and p = 0.02). This particular quiz, assessing mastery of introductory propositional logic and truth tables, may indicate that the added practice was beneficial for these particular topics. In general, it is too early to tell how effective WeBWorK will be in helping students understand the material. I plan to continue to employ the system for this course and will have a better sense of the added benefit after a longer period of time.

4 Student feedback

In order to assess student perception of WeBWorK, I added questions about the online homework system to the end-of-semester surveys. The response was overwhelmingly positive. Here is a list of the questions posed along with a summary of the responses.

1. *The cost of any online homework system is very important to me.*
2. *It is helpful that the WeBWorK homework system did not add to the cost of my textbook.*

For #1, all but one student agreed or strongly agreed. For #2, all strongly agreed. These answers clearly indicate the importance of affordable course resources to my students.

3. *I found the WeBWorK online assignments to be easy to navigate.*
4. *The WeBWorK assignments helped me understand the mathematics presented in class.*
5. *There should be a WeBWorK assignment for each section in the textbook.*

For #3, all but one agreed or strongly agreed. For #4, all strongly agreed. For #5, all but one agreed or strongly agreed. These answers indicate that my students see the online assignments as an aid to understanding the course concepts.

6. *In general, I found the WeBWorK homework problems to be difficult.*

For #6, only three students agreed or strongly agreed, suggesting that the problems were of an appropriate level of difficulty.

7. *On average, I would spend at most 2 hours per week completing the WeBWorK homework.*

For #7, all but two students agreed or strongly agreed. This suggests that the problems take a reasonable amount of time to complete.

5 General feedback and future plans

Student feedback and homework data indicate that this was a very successful project. Since most Affordable Learning Grants are awarded for the use of free online texts, I was honored to be chosen by the Weinberg Memorial Library for my non-traditional use of this grant, and I am grateful for their support of this project. As mentioned above, I will continue to use WeBWorK and to refine my online homework problems in my future discrete mathematics courses.