Improving Student Success Rate

With Online Homework

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Abstract - The aim of this paper is to demonstrate how online homework improves student success rates in PreCalculus and Calculus I courses. WeBWorK, provided by the Mathematical Association of America, was adopted as the online homework system. In the spring of 2013, the system was implemented in two classes, one section of PreCalculus and one section of Calculus I. As a result, the pass rates of both sections with WeBWorK were well above other sections without WeBWorK (about 17% higher). This paper also shows how the WeBWorK system was used.

Keywords: Online grading, WeBWorK, pass rate.

1 Introduction

As one of the core areas in college, Math often becomes a hurdle for students. The pass rate in this subject shows that math courses can hinder students’ success in college endeavors. Currently, the pass rates in most sections of College Algebra, PreCalculus, and Calculus I at our institution are very low (around 60%). The cause of failure is partially due to the lack of interaction between teachers and students. With oversized classes (usually 30 or more students in a class), the instructor does not have enough time to grade homework. Some students do not work on suggested homework problems at all. Consequently, these students do poorly on the tests. They feel frustrated and lose their interest in the subject. An online homework system can help improve this situation. An online homework system will help make up for the lack of interaction between teachers and students. Students will likely do their homework online because many of them are used to and prefer a technological environment. If students complete their homework, they will come to class prepared and ready to participate in discussion. As a result, students will be motivated to learn and will be able to succeed in the course. The following two tables show the dramatic increases in pass rates with the WeBWorK system.

2 WeBWorK

WeBWorK is an open-source online homework system for math and science courses. It is supported by the Mathematical Association of America and the National Science Foundation and comes with a National Problem Library (NPL) of over 20,000 homework problems. Problems in the NPL target most lower division undergraduate math courses and some advanced courses. Supported courses include college algebra, discrete mathematics, probability and statistics, single and multivariable calculus, differential equations, linear algebra, and complex analysis. Over 300 colleges, universities, and high schools have successfully used WeBWorK. Unlike other commercial online homework softwares, WeBWorK is free to students. It is also easier to manage and popularize the system. WeBWorK provides the tools needed to assign and grade homework easily. Students can do their homework from anywhere and at any time as long as they can access the internet. The assignments do not have to be completed all at once. They can also be printed out and worked on by students. Students receive feedback immediately after they submit their answers. They can keep trying until they get the correct answer or reach a limit of tries set by the instructor. The instant feedback either gives immediate gratification for correct answers or drives students to work hard in trying again: in both scenarios the student is more engaged in the homework. After the due date, students can view the solutions to the problems. WeBWorK offers students a personalized, interactive learning environment, where they can learn at their own pace and measure their own progress. In addition, WeBWorK provides different sets of problems for different students. This feature allows students to work together, yet still figure out how to solve the problems independently. Thus the common problem of academic dishonesty is avoided while still allowing students to work together.

3 Implementation

In the spring of 2013, WeBWorK was adopted in one section of PreCalculus and one section of Calculus I offered at Southern Polytechnic State University. Students were assigned homework through WeBWorK once every two weeks. Each of the assignments consisted of 10-20 questions with multiple parts and a due date. They were given four or five tries for each problem, depending on the difficulty of the problem. Usually, they were given one week to work on each assignment. During the weeks in which there was no WeBWorK homework, traditional homework was assigned. The homework contributed to about 15% of the final course grade. Students still took the regular quizzes, tests, and a
comprehensive final exam for 85% of the course grade. Figure 1 shows a list of courses at SPSU supported by WeBWorK.

Figure 1: List of courses

Students click the course to enter the system with a username and password. Figure 2 shows the window for a student to enter his/her username and password.

Figure 2: Login page

As shown in Figure 3, once students log into the system, they are shown a list of assignments.

Figure 3: List of homework assignments

After students click the appropriate assignment, a collection of problems will be displayed for students to work on. Figure 4 shows what the problems look like.

Figure 4: Problem page

After students work on the problems, they enter their answers in the boxes provided for each part of the problem. Immediately, they can check whether the inputted answers are correct or not. They can keep trying until they reach the limit of four or five times.

4 Effects of WeBWorK

At the end of the spring of 2013, the pass rate in PreCalculus enhanced by WeBWorK was 17% higher than the pass rate in PreCalculus classes without WeBWorK. The percentage of A’s and B’s also increased by 27%. (See Table I).

The pass rate in the Calculus I class enhanced by WeBWorK was also 17% higher than the pass rate in Calculus I classes without WeBWorK. The percentage of A’s and B’s increased by 21%. (See Table II).

Compared with the sections in which WeBWorK was not used, the pass rate of those with WeBWorK was significantly higher, and the retention rate increased. Here are two tables that show the detailed effects:

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>F</th>
<th>Pass Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>With WW</td>
<td>26%</td>
<td>31%</td>
<td>14%</td>
<td>6%</td>
<td>11%</td>
<td>77%</td>
</tr>
<tr>
<td>Without WW</td>
<td>13%</td>
<td>17%</td>
<td>21%</td>
<td>9%</td>
<td>25%</td>
<td>60%</td>
</tr>
</tbody>
</table>
Table II: Comparison on pass rates in Calculus I.

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>F</th>
<th>Pass Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>With WW</td>
<td>30%</td>
<td>15%</td>
<td>20%</td>
<td>5%</td>
<td>10%</td>
<td>70%</td>
</tr>
<tr>
<td>Without WW</td>
<td>11%</td>
<td>13%</td>
<td>17%</td>
<td>12%</td>
<td>27%</td>
<td>53%</td>
</tr>
</tbody>
</table>

The tables show that WeBWorK improves students’ performances in these classes. It was found that more students were motivated to work on their homework with WeBWorK. They prefer working with computers because students in the digital age are used to learning via technology. They like the instant response to their answers, and the option to correct wrong answers without any penalty. In this manner, students learn through their mistakes and are able to understand the problem fully. A survey conducted at the end of the spring of 2013 reflected students’ positive feedback on the WeBWorK system. Here are four questions from the survey.

1. Between the traditional homework and the online homework from WeBWorK, do you like WeBWorK better?
2. Does WeBWorK help you learn in this course?
3. Do you agree that WeBWorK has more strengths than weaknesses?
4. Would you recommend others to use WeBWorK?

We summarized the responses in the following table III.

Table III: Survey result

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>85%</td>
<td>89%</td>
<td>73%</td>
<td>82%</td>
</tr>
<tr>
<td>No</td>
<td>15%</td>
<td>11%</td>
<td>27%</td>
<td>18%</td>
</tr>
</tbody>
</table>

6 Acknowledgements

We would like to thank Southern Polytechnic State University for providing us with a minigrant during the project. We also would like to thank Dr. Shangrong Deng for his help setting up the websites for the classes.

7 References


5 Conclusion and Future Work

The use of WeBWorK has significantly improved students’ success rates. Both the pass rate and the students’ response to survey questions support the positive effect of using WeBWorK. The results consistently showed a direct correlation between required use of WeBWorK for homework assignments and higher success rates.

We would like to further analyze the impact of using WeBWorK on subsequent courses. The pass rate of students taking Calculus II who came out of a redesigned Calculus I course with WeBWorK will be compared with the overall pass rate of all sections of Calculus II. Other plans for the future include using even more of the tools offered by WeBWorK (e.g., item analysis) to further increase student success rates.