Affordable Learning Georgia Textbook Transformation Grants

Final Report

Date: 12/17/15
Grant Number: 96

Institution Name(s): Albany State University

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Project Lead: Wanjun Hu

Course Name(s) and Course Numbers: MATH 1113 Pre-calculus

Semester Project Began: Summer 2015
Semester(s) of Implementation: Fall 2015

Average Number of Students Per Course Section: 30
Number of Course Sections Affected by Implementation: 2
Total Number of Students Affected by Implementation: 60

1. Narrative

The goal of our project is to evaluate free OpenStax textbook for Pre-calculus with a supplementary pamphlet of our own making. We start working on our pamphlet in Spring 2015. The pamphlet contains 16 selected topics. They are listed below:

1. Factoring
2. Linear Functions
3. Quadratic Functions
4. Polynomial Functions
5. Rational Functions
6. Exponential Functions
7. Logarithmic Functions
8. Measuring of Angles and Identifying Angles
9. Trigonometric Functions Using Unit Circle
10. Graphs of Cosine, Sine and Tangent Functions
11. Inverse Trigonometric Functions
12. Trigonometric Function Identities
13. Sum Formulas and Difference Formulas
14. Sum-to-Product Formulas and Product-to-Sum Formulas
15. Law of Cosine and Law of Sine
16. Solve Trigonometric Equations

The first five topics are basically a quick review of major contents in College Algebra. In our course design, the test 1 will cover those contents. Test 1 is also served as a quick preparation for students to get familiar with online tests in D2L settings. The rest of contents are divided into 6 groups. Each group of contents will have one test associated.

- Group 1: Exponential functions and equations, interest accumulations (assessed by Test 2)
- Group 2: Logarithmic functions, change of base (assessed by Test 3)
- Group 3: Measuring angles, identifying special angles on unit circles (assessed by test 4)
- Group 4: Graphs of cosine and sine functions (assessed by test 5)
- Group 5: Identities, inverse functions (assessed by test 6)
- Group 6: Sum formulas and related formulas, law of cosine and sine, trigonometric equations (assessed by test 7)

A website http://www.asurams.edu/pre-calculus is available for students’ reference. Students can also access the same contents within the D2L environment where they will also take online tests.

Our project will compare students’ performance in the same semester, instead of two consecutive semesters. The reason for that is because of the coordinate of course lecture contents and test schedules. For a comparison, we schedule two sections of pre-calculus, i.e., section 2 and section 7. Section 2 was taught using this newly designed course and section 7 was taught in traditional way using traditional hard copy of textbook. Both sections will follow pretty much the same schedule, same syllabus, and same D2L content design. There is slightly difference however regarding the policy for making up tests. Students in section 7 were allowed to make up tests, while students in section 2 were not. Another difference is extra credits. Students in section 2 were allowed to receive extra credits for attending supplementary instructions and taking (online) surveys, while students in section 7 did not have them.
Students’ performance is evaluated by 7 tests, one final exam and attendance. Each test is counted 10%. Final exam is counted 20% and attendance is counted 10%. Disregarding other difference, the histograms of final score calculated using the actual weight assignment are provided in the charts below.

Using Students’ T statistical test (see results below), we have 95% confidence level to claim that we cannot rule out the fact that the average scores for these two different course designs are any different. The calculation is done in Excel using Data Analysis add-ins.

<table>
<thead>
<tr>
<th>t-Test: Two-Sample Assuming Unequal Variances (alpha=0.05)</th>
<th>Section 2</th>
<th>Section 7</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mean</strong></td>
<td>73.15323</td>
<td>75.58621</td>
</tr>
<tr>
<td><strong>Variance</strong></td>
<td>188.713</td>
<td>124.9199</td>
</tr>
<tr>
<td><strong>Observations</strong></td>
<td>31</td>
<td>29</td>
</tr>
<tr>
<td><strong>Hypothesized Mean Difference</strong></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td><strong>Degree of freedom</strong></td>
<td>57</td>
<td></td>
</tr>
<tr>
<td><strong>t Stat</strong></td>
<td>-0.75461</td>
<td></td>
</tr>
<tr>
<td><strong>P(T&lt;=t) one-tail</strong></td>
<td>0.226794</td>
<td></td>
</tr>
<tr>
<td><strong>t Critical one-tail</strong></td>
<td>1.672029</td>
<td></td>
</tr>
<tr>
<td><strong>P(T&lt;=t) two-tail</strong></td>
<td>0.453588</td>
<td></td>
</tr>
<tr>
<td><strong>t Critical two-tail</strong></td>
<td>2.002465</td>
<td></td>
</tr>
</tbody>
</table>
As a conclusion, we are 95% confident that the new design of this pre-calculus class does not show significantly difference to traditional pre-calculus classes. It proves that our original project goal has been achieved, i.e., using OpenStax free textbook and a self-made pamphlet is sufficient to replace traditional expensive commercial textbook for this Pre-calculus class in community colleges.

Overall, our project went very well. We almost finished the pamphlet before summer term and tried to implement in summer 2015. However, due to low enrollment of one section of Pre-calculus, we postponed the implementation to fall 2015. With the section of a good enrollment, we adopted the materials, and course design in D2L. Students like that new design very much. From students’ feedback and our own experience to use the free textbook, we update the topics to covered and provide sample tests so that students can prepare themselves well.

When implementing the project in fall 2015, we coordinate almost the same schedule of lecture contents and tests. The tests are given every other weekend. Both sections have tests in D2L. Students like the online tests because of the flexibility. It is also good for us, since we can have more time on lectures.

Developing the pamphlet and grouping course contents for tests bring about an unexpected impact to our instructions. We realize new ways to present knowledge to students, so that learning of several topics can be chained to each other. It also impacts students’ performance. From the histograms of calculated final score, one can see that there is higher pass rate, i.e., 67% and 79%. The reason for the 79% pass rate is because of allowing students to make-up in Section 7. In our survey given to section 2 where new design is adopted, students in general demonstrate a satisfactory opinion toward the new design of this free textbook math class.

Due to time limit, we are not able to perfect the pamphlet. In the future, we will improve it and try to get it published. Another thing we think can be improved is the sample tests for each topic. We intend to use them as a study guide for students to prepare for real tests. There so many different types of questions. We hope we can have more time to make them more complete.

2. Quotes

In our survey given to students in Section 2 where the new design was adopted, we asked students to provide suggestions for “how to improve this new concept of free online textbook with pamphlet”, students responded very positively. Here are some quotes:

“this concept is the best i’ve seen thus far and i’m extremely thankful to professor Hu.”
“I think that all classes should provide them. I do believe that there should be more interactive things in the online textbook.”

“The online text book was so helpful and saved students a lot of money. Thank you”

3. Quantitative and Qualitative Measures

3a. Overall Measurements

Student Opinion of Materials

Was the overall student opinion about the materials used in the course positive, neutral, or negative?

Total number of students affected in this project: ___60_______

- Positive: ___83.87____ % of ___31____ number of respondents
- Neutral: ___5____ % of ___31____ number of respondents
- Negative: ___0____ % of ___31____ number of respondents
Student Learning Outcomes and Grades

Was the overall comparative impact on student performance in terms of learning outcomes and grades in the semester(s) of implementation over previous semesters positive, neutral, or negative?

*Student outcomes should be described in detail in Section 3b.*

Choose One:
- ___ Positive: Higher performance outcomes measured over previous semester(s)
- _x_ Neutral: Same performance outcomes over previous semester(s)
- ___ Negative: Lower performance outcomes over previous semester(s)

Student Drop/Fail/Withdraw (DFW) Rates

Was the overall comparative impact on Drop/Fail/Withdraw (DFW) rates in the semester(s) of implementation over previous semesters positive, neutral, or negative?

**Drop/Fail/Withdraw Rate:**

___33____% of students, out of a total ___31____ students affected, dropped/failed/withdrew from the course in the final semester of implementation.

Choose One:
- ___ Positive: This is a lower percentage of students with D/F/W than previous semester(s)
- _x_ Neutral: This is the same percentage of students with D/F/W than previous semester(s)
- ___ Negative: This is a higher percentage of students with D/F/W than previous semester(s)

3b. Narrative

Our data include DFW analysis, test scores, final exam, students’ attendance and survey.

DFW Analysis

- There is one student withdrawn from each section.
- The DFW rate for section 2 is 23%, and the DFW rate for section 7 is 10%.
- The average GPA for section 2 is 2.84, and the average GPA for section 7 is 2.59

Test score analysis
We will consider students’ score for each test and exam as a sample for each of these two categories: (1) students’ performance in the newly designed class, and (2) students’ performance in traditional class. Both samples have size more than 10 and roughly follow a normal distribution. Both samples satisfy the random requirements. Hence we can use the Student’s T test to test the hypothesis that students’ performance in the two categories have no difference.

The calculation was done in Excel using the Data Analysis add-in. The confidence level is 95%, or alpha=0.05. Here are the summary of the statistical analysis.

- **Test 1, conclusion: no difference**
  The mean score for section 2 is 15.8 out of 20 questions, and the mean score for section 7 is 15.3 out of 20. The variance is 2.46 for section 2 and 6.9 for section 7. Using Students’ T statistical test, the t-value = 0.96 and both one-tail or two-tail probabilities are greater than 0.05. Hence, we cannot deny that students’ performance in two categories are pretty much the same.

- **Test 2, conclusion: no difference**
  The mean score for section 2 is 15.2 out of 20 and the mean score for section 7 is 15.6 out of 20. The variance is 5.13 for section 2 and 4.99 for section 7. The t-value=-0.59 and both one-tail and two-tail probabilities are greater than 0.05. Hence, we cannot deny that students in two categories are pretty much the same.

- **Test 3, conclusion: no difference**
  The mean score for section 2 is 13.9 out of 20 and the mean score for section 7 is 14.5 out of 20. The variance for section 2 is 10.66 and 3.6 for section 7. The t-value is -0.83 and both one-tail and two-tail probabilities are greater than 0.05. Hence, we cannot deny that students in two categories are pretty much the same.

- **Test 4, conclusion: no difference**
  The mean score for section 2 is 17.4 out of 20 and the mean score for section 7 is 17 out of 20. The variance for section 2 is 0.87 and 20 for section 7. The t-value is 0.85 and both one-tail and two-tail probabilities are greater than 0.05. Hence, we cannot deny that students in two categories are pretty much the same.

- **Test 5, conclusion: section 2 is slightly better**
  The mean score for section 2 is 16.2 out of 20 and the mean score for section 7 is 13.4. The variance for section 2 is 4.3 and 28.7 for section 7. The t-value is 2.49 and both one-tail and two-tail probabilities are less than 0.05. Hence, we will reject the null hypothesis that students’ performances in two categories are the same.

- **Test 6, conclusion: no difference**
  The mean score for section 2 is 18.2 out of 20 and the mean score for section 7 is 17.8. The variance for section 2 is 2.22 and 1.95 for section 7. The t-value is 0.94 and both one-tail and two-tail probabilities are greater than 0.05. Hence, we cannot deny that students in two categories are pretty much the same.
• **Test 7, conclusion: section 2 is slightly better**
  The mean score for section 2 is 18.3 out of 20 and the mean score for section 7 is 15.2. The variance for section 2 is 3.03 and 13.56 for section 7. The t-value is 3.87 and both one-tail and two-tail probabilities are less than 0.05. Hence, we will reject the null hypothesis that students’ performances in two categories are the same.

• **Final exam, conclusion: section 2 is slightly better**
  The mean score for section 2 is 18.3 out of 20 and the mean score for section 7 is 15.7. The variance for section 2 is 2.93 and 3.95 for section 7. The t-value is 5.45 and both one-tail and two-tail probabilities are less than 0.05. Hence, we will reject the null hypothesis that students’ performances in two categories are the same.

• **Attendance, conclusion: section 7 is slightly better**
  The mean score for section 2 is 7.04 out of 10 and the mean score for section 7 is 8.9 out of 10. The variance for section 2 is 7.11 and 6.09 for section 7. The t-value is -2.675 and both one-tail and two-tail probabilities are less than 0.05. Hence, we reject the null hypothesis that students' performances in two categories are the same.

• **Final score calculated using assigned weight, conclusion: no difference**
  The mean score for section 2 is 73.15 out of 100 and the mean score for section 7 is 75.59 out of 100. The variance for section 2 is 188.71 and 124.92 for section 7. The t-value is -0.75 and both one-tail and two-tail probabilities are greater than 0.05. Hence, we cannot deny that students in two categories are pretty much the same.

• **Substitute test, conclusion: section 2 is slightly better**
  The mean score for section 2 is 18.897 out of 20 and the mean score for section 7 is 15.06 out of 20. The variance for section 2 is 2.45 and 3.68 for section 7. The t-value is 6.992 and both one-tail and two-tail probabilities are less than 0.05. Hence, we reject the null hypothesis that students’ performances in two categories are the same.

**Survey result analysis**

We have 8 questions on the survey. The last two allow students to provide comments.

• **Question 1: Did you have textbook for previous College Algebra class?**
  Result and analysis: 74% students said that they purchased textbook for College Algebra. 25% said no.

• **Question 2: Do you know that there are free textbook chapters provided online?**
  Result and analysis: 97% said yes. Only 3% (one student) said no.

• **Question 3: Do you know that there is an pamphlet for this course provided online?**
  Result and analysis: 90% said yes. Only 10% (three students) said no.

• **Question 4: How often do you read the online free textbook chapters?**
• Result and analysis: 13% said “always”, 42% said “frequently”. 42% said “sometime”. Only 3% (one student) said “seldom”.

• Question 5 How do you rate the free textbook chapters and the pamphlet?
  • Result and analysis: 48% said “very helpful”. 35.5% said “helpful”. 16% said “somewhat helpful”. No one said “not helpful”.

• Question 6 In the future, will you refer this class with free textbook chapters and pamphlet to other students?
  • Result and analysis: 67.7% said “strongly recommend”. 29% said “recommend”. Only 3% (one student) said “no opinion”. No one select “not recommend”.

4. Sustainability Plan

  We have setup a website for our project. It is located at [http://www.asurams.edu/pre-calculus](http://www.asurams.edu/pre-calculus). On that main page, there is a table that contains links to the pamphlet, the free OpenStax textbook chapters, and sample tests for the topics. All of them are freely available without any restrictions. The website is hosted at the Albany State University’s website. It is maintained by the IT department at Albany State University.

  In the future, the department will continue the support to recommend the online free resources to all sections.

5. Future Plans

  The free textbook initiative has gained some popularity recently. During our implementation, faculties in our department were encouraged. Some of them have succeeded in Round 4 funding. From our experience and the departmental consensus, we believed this free textbook concept is especially useful for community college such as Albany State University, where some students usually have full time jobs, and many students are not well prepared.

  Our unique design of this free textbook with pamphlet has its own merit. We have registered for one conference (poster) presentation. We may also have future presentations to share our experience with the society.

6. Description of Photograph

  Left: Dr. Li Feng, Team member and instructor for section 7

  Right: Dr. Wanjun Hu, team lead and instructor for section 2