

Affordable Learning Georgia Textbook Transformation Grants

Final Report

Date: 12/15/2015

Grant Number: 72

Institution Name(s): Valdosta State University

Team Members (Name, Title, Department, Institutions if different, and email address for each):

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- **Dr. Sudhir Goel, Professor, Department of Mathematics and Computer Science, sgoel@valdosta.edu**

Project Lead: Ault

Course Name(s) and Course Numbers: MATH-2261 – Analytic Geometry & Calculus I

Semester Project Began: Summer 2015

Semester(s) of Implementation: Fall 2015

Average Number of Students Per Course Section: 26.5

Number of Course Sections Affected by Implementation: 2

Total Number of Students Affected by Implementation: 53

1. Narrative

Our goal was to develop and implement a no-cost option for Calculus (specifically, MATH-2261, Analytic Geometry & Calculus I). Traditionally, Calculus students are expected to purchase a textbook that costs over \$150, and get access to an online homework system which alone costs about \$90. While certain bundle deals exist to combine the two resources into one discounted purchase, the materials are nevertheless quite expensive. In my experience teaching Calculus at VSU (since Fall 2012), I have heard from many students who said they had to wait until the 2nd or 3rd week, or even later, before they could afford to purchase the required materials. Meanwhile, the lecture is based entirely upon the textbook and homework system, so student who did not have those materials were at a distinct disadvantage right from the start.

Of course you get what you pay for, as they say. The expensive book and homework system are quite effective at communicating the mathematical concepts to students. Any

replacement materials had to meet stringent quality measures in order to benefit the students. Furthermore, the chosen materials had to be flexible enough to permit a wide range of instructors' teaching styles. To that end, our grant proposal consisted of the following: finding a high-quality no-cost textbook covering at least the departmental course objectives for MATH-2261 and containing enough textbook exercises so that instructors could choose not to use an online homework system if desired; implementing a no-cost online homework system to go with the textbook; developing or locating additional no-cost resources to help our students succeed in Calculus.

After reviewing many possible free textbooks a short-list of three possibilities emerged. A careful reading of each textbook led towards the final choice of APEX Calculus, by Gregory Hartman et al. The textbook was found to have an adequate number of varied exercises at the end of each section. Sections are arranged in roughly the same order as in our current traditional textbook, Thomas Calculus, although APEX lacks a preliminary chapter on algebra, trigonometry, and pre-calculus concepts. This deficiency was addressed by providing supplementary materials.

For an online homework system, the clear choice was WeBWork, which is maintained by the Mathematical Association of America (MAA). Numerous institutions across the country have been using WeBWork for years to great success, including at The Ohio State University, where Dr. Ault gained valuable experience as an Assistant WeBWork administrator while pursuing his graduate degree. There are already free problem libraries available, and we initially thought that these libraries could be sufficient for building homework sets corresponding to the sections of APEX Calculus, however we eventually decided to create a new problem library specific to APEX. Ault created on a library of 365 problems, modeled from the end-of-section problems in the text. We worked closely with VSU's IT department to set up a WeBWork server on campus, which can be accessed at: <https://webwork01.valdosta.edu/webwork2>.

Finally, we had planned to write workbooks to help students with pre-calculus material. Dr. Goel has completed the content for an Algebra workbook and a Trigonometry workbook, but these two items still need editing and formatting before we can use them in the course. We simply ran out of time.

The no-cost materials were implemented in two pilot courses in Fall 2015. Dr. Ault taught one using WeBWork exclusively for homework, and Dr. Goel taught another using the textbook problems exclusively. Aside from using the no-cost materials, there was not a huge impact on the way either of us taught the course – and this was the desired outcome. In order to eventually make a smooth transition to no-cost across all sections of Calculus, it is important that instructors do not have to re-learn how to teach the subject. A textbook change is traumatic enough, usually necessitating writing a new set of lecture notes, quizzes, tests, etc., so our aim for the no-cost material is that it should be no more work than a textbook change.

On the other hand, we are pleased to report a positive change in student perceptions about the course, along with no appreciable negative impact on grades, DFW rates, or preparedness for Calculus II (as measured by meeting course objectives for Calculus I). Our data below substantiates this claim.

There are not very many things we would do differently, except to give ourselves more time and a less ambitious writing schedule for the supplementary materials. Now that we understand the number of hours required to write WeBWork problems and supplementary workbooks, we can budget our time better for those items in the future.

2. Quotes

Student reactions were somewhat mixed between appreciating the fact that the materials were free to complaining that the problems were too hard or something was lacking or hard to use in the homework program compared to other programs. These are issues that could be addressed by changing the homework problems and putting in links to worked-out examples.

- “The fact that the book + homework program are free is amazing. The fact that they are free does not subtract from the overall class experience because the lectures in class cover everything. Two complaints that I do have though are the text book not having a direct link in WeBWork and the lack of examples in WeBWork.”
- “The free materials were much better to use. I was more willing to go on the textbook or WeBWork and play around with the system.”
- “Sometimes I miss having an actual textbook in front of me, but do not miss the cost of the textbook.”
- “Some of the WeBWork problems are too difficult; however once I figure them out I have learned something new.”
- “In my opinion WeBWork would be better if there were examples given underneath each problem like of MyMathLab. Also I thought it was helpful how MyMathLab walked you through the answers that you got wrong.”

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: 53

- Positive: 65 % of 26 number of respondents
- Neutral: 27 % of 26 number of respondents

- Negative: 8 % of 26 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?

Choose One:

- Positive: Higher performance outcomes measured over previous semester(s)
- 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:

41.5 % of students, out of a total 53 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)
- 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

As stated in our grant proposal, the primary metric we were striving for is that students do *no worse* in the no-cost course than in the current traditional course. In terms of retention, DFW rate, course perceptions, meeting course objectives, and preparedness for subsequent math courses, we believe we have succeeded. Thus, the indication of “Neutral” in the questions above concerning grades, objectives, and DFW rates meets our own expectations for the project. While the data show an improvement in DFW rates and course medians, the delta values are not large enough to claim statistical significance. What follows is a more detailed assessment of the measures.

- I. DFW rates. There seemed to be a large difference (-11%) in DFW rates when comparing to the same course taught using traditional materials (same instructor and semester).

While this is quite encouraging (less students DFW in the no-cost course), other co-factors cannot be ruled out.

- II. Median course scores. We found no significant change.
- III. Student success in learning objectives (measured by specific questions on the final exam, which was administered to one no-cost and one traditional section). We found no significant change.
- IV. Survey data. The majority of students had positive opinions of all the free materials (see accompanying spreadsheet).

There are sometimes wide differences in overall student performance from one section to the next, even if taught in the same semester by the same instructor. For this reason, we are cautious when attempting to conclude anything definite about the significance of our data. The best conclusion we can reach is that the no-cost option is no worse than traditional methods, and so there is little reason not to consider adopting no-cost for all sections going forward.

4. Sustainability Plan

In the short term, 5 more sections of no-cost Calculus will be offered in Spring 2016. Based on the data available, the MATH-2261 committee will vote on transitioning all sections of Calculus I to no-cost starting in Fall 2016. Dr. Ault will take on the role of WeBWorK Administrator and help to coordinate other aspects of no-cost Calculus as well. A common departmental final exam is currently being developed. Further updates to no-cost materials will be handled by instructors as needed.

5. Future Plans

- This project has given us a greater perspective on what open-access resources actually exist already. We were pleasantly surprised to have found such a high-quality free textbook relatively quickly. Dr. Ault plans to use his experiences on this grant to continue developing no-cost materials for the other courses in the Calculus sequence, 2262 and 2263, hopefully with the support of another ALG grant or other funding source.
- Dr. Ault has submitted a proposal to present at the USG Teaching and Learning Conference (April 13-14, 2016). Additionally, we plan to present a Teaching Colloquium here in the VSU Math Department.

6. Description of Photograph

- Dr. Shaun Ault, team lead, subject matter expert, question bank author and instructor of record for MATH-2261-D; Dr. Sudhir Goel (*not pictured due to health issues*), subject matter expert, workbook author and instructor of record for MATH-2261-E.