Spring 2018

Calculus for Business and Economics

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Samuel Cartwright, Bhavana Burell, Patcharin Marion, and Jianmin Zhu

Calculus for Business and Economics
Grants Collection

Affordable Learning Georgia Grants Collections are intended to provide faculty with the frameworks to quickly implement or revise the same materials as a Textbook Transformation Grants team, along with the aims and lessons learned from project teams during the implementation process.

Each collection contains the following materials:

- Linked Syllabus
  - The syllabus should provide the framework for both direct implementation of the grant team’s selected and created materials and the adaptation/ transformation of these materials.
- Initial Proposal
  - The initial proposal describes the grant project’s aims in detail.
- Final Report
  - The final report describes the outcomes of the project and any lessons learned.

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Initial Proposal
**Application Details**

**Manage Application: ALG Textbook Transformation Grants**

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<td>Monday, August 1, 2016</td>
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<td>Submitter Title</td>
<td>Associate Professor</td>
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<tr>
<td>Submitter Email Address</td>
<td><a href="mailto:cartwris@fvsu.edu">cartwris@fvsu.edu</a></td>
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<tr>
<td>Submitter Phone Number</td>
<td>(478) 825 6997</td>
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<tr>
<td>Submitter Campus Role</td>
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<tr>
<td>Primary Appointment Title</td>
<td>Associate Professor of Mathematics</td>
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<td>Institution Name(s)</td>
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<tr>
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<td>Monday, August 1, 2016</td>
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**Team Members (Name, Title, Department, Institutions if different, and email address for each):**

Dr. Patcharin T. Marion, Associate Professor of Mathematics, Department of Mathematics and Computer Science, Fort Valley State University, tragoonsirisakp@fvsu.edu

Ms. Bhavana Burell, Lecturer of Mathematics and Computer Science, Department of Mathematics and Computer Science, Fort Valley State University, burellb@fvsu.edu

Dr. Jianmin Zhu, Professor of Mathematics, Department of Mathematics and Computer Science, Fort Valley State University, zhuj@fvsu.edu

Dr. Samuel Cartwright, Associate Professor of Mathematics, Department of Mathematics and Computer Science, Fort Valley State University, cartwris@fvsu.edu
**Sponsor, (Name, Title, Department, Institution):**

Dr. Dawit Aberra, Ph.D., Department Chair, The Department of Mathematics and Computer Science, Fort Valley State University

**Proposal Title:** 246

**Course Names, Course Numbers and Semesters Offered:**

- Calculus I (MATH 1154) Fall and Spring
- Calculus II (MATH 2164) Fall and Spring
- Calculus for Business and Economics (MATH 1150) Fall and Spring
- Differential Equations (MATH 3233) Fall

**Final Semester of Instruction:** Fall 2017

**Average Number of Students per Course Section:** 30

**Number of Course Sections Affected by Implementation in Academic Year:** 9

**Total Number of Students Affected by Implementation in Academic Year:** 270

**List the original course materials for students (including title, whether optional or required, & cost for each item):**


**Proposal Category:** No-or-Low-Cost to Students Learning Materials
Creation and Hosting Platforms Used ("n/a" if none):

The Department of Mathematics and Computer Science Webpage
BrightSpace

Project Goals:

The primary goal of this project is to provide and maintain high quality effective no-cost learning materials to students enrolled in differential equations, calculus for business and economics as well as calculus I and calculus II in both electronic and printable format. The purpose is to explore whether the free resources will effect the performance and attitudes of these students in attaining their academic goals. Quantitative data will be compared between two groups-- the experimental group that will be provided with the free resources and the control group which had to purchase the materials. Qualitative data will be collected in the form of interviews to compare the results of both groups. This project is anticipated to impact both STEM majors enrolled in early entry level courses and differential equations, along with business majors enrolled in calculus for business and economics. We expect that the cost savings will have a positive impact on student progression and retention for a large student population at this institution.

Statement of Transformation:

The transformation from high cost materials to no-cost materials will take place over the course of several months leading to and continuing through Spring 2018. Replacing the initial materials for our students enrolled in calculus courses and differential equation courses will be a team effort. Our team will find and adapt free materials as well as create online materials to place on departmental webpage and on BrightSpace to ensure that students have access to these high quality materials.
The **stake-holders** (differential equations, calculus for business and economics, calculus I and calculus II students) come from a student population that is 88% reliant on financial aid with many not receiving a book-voucher to make the book purchase. Even with the book-voucher, students have complained in the past that it was not enough to pay for more than half their books. The **impact of this transformation on stakeholders** will be immediate.

At more affluent academic institutions, students are expected to obtain their course syllabus and start reading the first few chapters prior to the first day of class. By comparison the students that cannot afford their books are discouraged and left behind before they even start the academic semester. At the same time for the instructors this can create a sensitive issue in the teaching process which is now delayed and as a result puts a heavier burden on the later part of the semester to complete the required substantive materials for their courses. The no-cost resources will allow instant access to materials that will have taken days or weeks well into the academic semester because of the lack of finances. This transformation in turn also allows students the foundation for their pathway to success.

The **transformative impact on the course, program, department, institution** will be positive. The location and creation of materials will be selected based on course curriculum and easy student-access to resources. The program will allow students' access to course materials at the beginning of the semester. Through our team's experience, the department would benefit in the short term and long term. That is, more students will have access to course materials from day-one and would make the course more affordable otherwise because of lack of funds. In the long term, the gained experience of putting together materials will inspire and enhance faculty's ability to extending their creativity in that regard to locating and developing free materials for other departmental courses. Through the departmental website and the help of marketing and communications, the students will be informed of the awareness and accessibility of these free resources.

**Transformation Action Plan:**

All Mathematics faculty members are able to teach calculus for business and economics as well as both calculus I and calculus II courses; however, Dr. Marion and Dr. Cartwright have taught it for a number of years. Each team member will be active in the development and implementation of both printed and online materials needed for availability and accessibility.

Dr. Marion and Dr. Zhu, during spring 2017, will lead in the identification, review and the selection process for the open Calculus (as well as calculus for business and economics) and Differential Equations textbooks. They will also investigate any copyright issues as far as the availability of open source materials are concerned. Dr. Marion is the Calculus I and Calculus II Coordinator and Dr. Zhu is the chair of Mathematics Curriculum Committee. Dr. Marion and Dr. Zhu will find resources and bring them before the Mathematics Curriculum Committee for examination and review prior to making the selection. This will ensure that all content is vetted. Through their past experience and expertise, Dr. Marion will redesign the syllabus to be in
alignment with the calculus textbook and Dr. Zhu will redesign the syllabus to be in alignment with the Differential Equations textbook. During Spring 2017, Ms. Burell will lead the identification, review and selection process for the Calculus for Business and Economics textbooks.

Ms. Burrell, during spring 2017, will organize BrightSpace training on campus, for the team for the Summer 2017 construction of the online resources in BrightSpace. Ms. Burell redesign the syllabus to be aligned with the Calculus for Business and Economics textbook. Ms. Burell is also a Mathematics Curriculum member and will work along with Dr. Marion and Dr. Zhu in the textbook selection and review process.

Dr. Cartwright, during spring 2017, will get Institution Review Board for Human Subjects Research (IRB) approval to conduct the research examining the effectiveness of this project in meeting its goal. Dr. Cartwright will write all reports for all work completed for this project. As a member of the Mathematics Curriculum Committee he will work along with Dr. Zhu, Dr. Marion, Ms. Burell and the other committee members in the book selection process.

Summer 2017, we will work as a team in constructing all resources to be used in both respective calculus courses. That is, actively creating materials in BrightSpace: materials and activities for global use will be linked to our departmental website.
Quantitative & Qualitative Measures: Quantitative measures such as students' grades, pre-test and post-tests will be compared to find whether the no-cost resources were effective in the performance of students. Surveys will also be given to students at the beginning and at the end of each semester to analyze information of each student's response such as age, student classification, previous mathematical background, study habits, use of resources etc. Qualitative measures such as interviews and class discussions will also be analyzed. The following are a set of specific questions for the students:

1. Did the no-cost resources on Brightspace contribute to their understanding of the course materials?
2. Was it easy to understand the online materials presented? Did it help with their understanding of these courses?
3. Did they use any other supplemental materials other than the resources provided?
4. Did they use the Openstax textbook frequently?
5. Do they prefer the Openstax textbook compared to the traditional textbook?

The following are a set of specific questions for the faculty teaching the course:

1. Did the pre-selected online assignments meet the needs of these courses?
2. Were they able to easily create the homework assignments and lectures according to their needs as well as the needs of students?
3. How does the quality of the Openstax textbook compare to the traditional textbooks for these courses?

Timeline:

January 2017 to March 2017

Open calculus I and II textbooks, Calculus for Business and Economics and Differential Equation books will be reviewed and vetted for selection. Training for D2L will be scheduled. Human Subjects Research form will be submitted for approval to examine the effectiveness of this project.

April 2017 to May 2017

Calculus I, Calculus II, Calculus for Business and Economics and Differential Equations course syllabi will be redesigned and adapted to the free textbook selected during the Spring 2017 semester.
June 2017 to July 2017

BrightSpace training and consulting will take place. After BrightSpace training as a team, and with the help of consultants, the project team will post assignments for students and have all materials aligned and ready by the end of July.

August 2017---------December 2017

Calculus I, Calculus II, Calculus for Business and Economics and Differential Equations will be piloted using the materials that were constructed and any adjustments to these materials will take place if needed to ensure that all materials for the courses are ready by Spring 2018.

January 2018 to May 2018

Calculus I, calculus II and Differential Equations will be completely ready and integrated.

Budget:

Team Members

Each of the four team members, namely Dr. Patcharin T. Marion, Ms. Bhavana Burell, Dr. Jianmin Zhu and Dr. Samuel Cartwright will be compensated as follows. Upon successful completion of the course construction in Summer 2017, a stipend of $5000 will be paid to each team member in accordance with the applicable university policies and procedures. On an ongoing basis it is understood that the monitoring and the updating of the materials will be done throughout the duration of this grant period.

Adjunct Professor

An Adjunct professor will be compensated ($2000) to cover one of the classes for one of the faculty team members during Fall Semester 2017 and Spring Semester 2018 so that the no-cost to students resource materials are maintained and project reports are created in a timely manner.

BrightSpace Support Consultant

A BrightSpace support specialist or a professor with expertise using BrightSpace will be compensated to work as a part of our support staff. He/she will provide support technical assistance to the Project Team. This will ensure that all the materials and resources will be in place and ready.

Traveling and Lodging for Training

Team members will set aside $800 to be used for travel expenses to attend the grant kick-off
Sustainability Plan:

Business Calculus, Calculus I and Calculus II courses are offered each semester throughout the year and Differential Equations is offered once a year. The department's full adoption of these transformed courses will ensure that they are reviewed annually for improvement and sustainability for students and faculty. Furthermore, future funding will be sought to enhance and improve other Mathematics courses such as Statistics and Quantitative Reasoning in order to increase the use of no-cost-to-student resources to ensure the stability and longevity of these benefits to our students' in the future.

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July 7, 2016

Affordable Learning Textbook Transformation Grant
Review Committee

Dear Committee Members:

On behalf of the Department of Mathematics and Computer Science, I am pleased to support the proposal of “No Cost to Student Resources for Differential Equations, Business Calculus, Calculus 1 and II”

The Department of Mathematics and Computer Science at Fort Valley State University offers programs of study leading to the Bachelor of Science degrees, with majors in Mathematics and Computer Science. Additionally, the department offers minor concentrations in these same areas, in Applied Statistics and in Nuclear Science and Engineering. In collaboration with the school of Education, the department also offers courses leading to graduate and undergraduate degrees in Education with concentration in Mathematics. The department also participates in several 3+2 dual degree programs, in conjunction with FVSU’s Cooperative Development Energy Program (CDEP). Through CDEP dual degree program, students obtain a B.S. degree in Mathematics from FVSU and a second B.S. degree in engineering, geosciences or health physics, from Georgia Tech (GT), the University of Nevada Las Vegas (UNLV), Penn State University (PSU), the University of Texas-Austin (UT-Austin), the University of Texas Pan American (UTPA), and the University of Arkansas (UARK).

Our Mathematics program, which is ranked top in the nation for producing African-American math graduates by Diverse Magazine (2015, 2014 and 2011), is well prepared to adopt the transformed courses.

We have the technology and laboratories required to facilitate student support for the on-line, free text resources. Dr. Cartwright and his team have all the qualifications and experience needed to meet the goals and objectives in the proposal. Their years of experience and expertise in the pedagogy and technology required for differential equations, calculus series courses and will ensure the success of the proposed transformation. I am excited about the potential financial savings this project would offer our students. Calculus I and Calculus II courses are offered each semester throughout the year and differential equations is offered every year. The department will review and assess these transformed courses annually and will seek funds as required to insure sustainability and improvement.

Sincerely yours,

Dawit Aberra, Ph. D., Chair
Department of Mathematics and Computer Science
1.8 REFERENCES & ATTACHMENTS

References


Attachments

1. Letter of Support
Fort Valley State University  
College of Arts and Sciences  
Department of Mathematics & Computer Science  
Fall Semester, 2017

MATH 1150-01: Calculus for Business and Economics (4 Credit Hours.)

Instructor: Dr. Samuel Cartwright  
Email Address: cartwr@fvsu.edu  
Meeting times: Class- 8:00—9:40 TTR  
Office Hours: MW 8:00-10:00am & MTWTR 11:00-12:00pm & F 8:00-10:00am


Course Description:
Students use the basic concepts of limits, continuity, differentiation, integration, maximization, minimization, and partial derivatives to model and solve real-world problems from the world of business and economics, the social sciences and life sciences. With the aid of a graphing calculator (TI-83 or equivalent) regression techniques and other data analytic measures are used to enhance students' understanding of mathematical ideas in algebraic, numerical and graphical modalities. Properties and uses of a library of elementary functions are explored.

Prerequisite: Passing MATH 1111, or MATH 1113 with a grade of C or above

Departmental Major Area Learning Outcomes:
This course addresses the following major area learning outcomes in mathematics:

I. Students will apply the concept of function together with the traditional computational techniques to solve real world problems (Course Learning Outcome II, Objectives 1 – 10)

V. Students will use graphing calculators and computers to perform numerical and symbolic computations, visualize data and mathematical objects, and solve mathematics problems. (Course Learning Outcome IV, Objectives 9, 10)

Course Learning Outcomes:

I. Students will describe and interpret real-world data sets using algebraic and geometric relationships

Objectives:
1. Translate real-world problem situations into mathematical models.
2. Use algebraic and geometric models to solve “Break-Even analysis” type problems.
3. Determine equations that model price-supply/demand.
4. Use graphical means to determine the equilibrium point, quantity and/or price.
5. Determine the rate of change of two linearly related variables
6. Determine the ratio (average rate of change) of non-linearly related variables
7. Use regression analysis to analyze numerical data and determine the line of “best fit.”
8. Use regression models to interpolate between points in a data set and/or extrapolate points outside the data set.
II. Students will use the properties and characteristics of the collection of Elementary Functions to model and solve real-life problems

Objectives:
1. Apply the concepts of elementary functions (their graphs and concepts of transformations) to mathematical models.
2. Determine maximum and minimum values using the properties and characteristics of quadratic functions.
3. Use exponential or logarithmic functions to model growth and decay (compute interest, salaries, etc.)

III. Students will apply techniques of limits and derivatives to solve real-world problems.

Objectives:
1. Use algebraic and graphical means to analyze and evaluate limits.
2. Use infinite limits and limits at infinity to describe the behavior of functions.
3. Determine whether a function is continuous.
4. Use the properties of continuity to solve inequalities and interpret problem situations.
5. Distinguish the average rate of change from instantaneous rate of change.
6. Use the four-step method to find the derivative of a function.
7. Determine if a function, f, is differentiable at \( x = a \).
8. For a given differentiable function, determine the differential of x, dx.
9. Use the concepts of derivatives to determine marginal cost, average cost and the marginal average cost.
10. Using the properties, find the derivative of explicit and implicit functions.
11. Solve problems involving related rates, relative rate of change and percentage rate of change.

IV. Students will explore graphical properties using the first and second derivatives.

Objectives:
1. Find the absolute maximum and minimum values of a function.
2. Use l'Hopital's Rule for different indeterminate forms.
3. Use graphing strategies to analyze rational and logarithmic functions.
4. Model average cost.
5. Use the four-step approach to solving optimization problems.

V. Students will find the anti-derivative and solve problems involving indefinite integrals.

1. Define the anti-derivative.
2. Find the indefinite integral of basic functions.
3. Perform integration by substitution.
4. Construct a slope field for a given differential equation.
5. Examine solutions of first-order differential equations used to model the limited or logistic growth sales and corporations.
**Proposed Class Schedule:**

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| 2 - 4 | **Unit 1:** Limits (and Introduction)  
Exam 1 TBA |
| 5 - 7 | **Unit 2:** The Derivative  
Exam 2 TBA |
| 8 - 11 | **Unit 3:** Rates and Extrema  
Exam 3 TBA |
| 14 - 16 | **Unit 4:** Limits and Antiderivatives  
Test 4 TBA  
**Comprehensive Final Exam TBA** |

**Grading Policies:**

There will be assessments throughout the semester: homework, quizzes, semester exams and a comprehensive final. The final grade will be tabulated by weighted mean. These five categories that will constitute the course grade breakdown is listed below.

**Grade Breakdown:**

- A: 90-100
- B: 80-89
- C: 70-79
- D: 65-69
- F: 64 and below

- Homework Average 20%
- Quiz Average 20%
- Exam Average 40%
- Final 20%

**Periodic Homework:**

There will be periodic homework given throughout the semester. Homework will account for 20% of the final grade. Due homework will be collected at the beginning of class, graded and then returned during the next class meeting.

**Quizzes:**

There will be a series of pop-quizzes given during the semester. These quizzes will account for 20% of the final grade. Pop-quizzes will be given towards the end of class or at the beginning of class. Students are required to review notes from previous prior to coming to class.

**Semester Exams:**

There will be five semester exams given during the semester. These exams do include the midterm exam but not final exam. Each exam will be announced at least one week before its administration to allow students time to review and prepare.

**Final Exam:**

The final exam will be given on the last day of class. The final exam will account for 20% of the final grade. The final exam will be announced at least one week before its administration to allow students time to review and prepare.

**Attendance:**

Attendance will be taken daily. In accordance with the FVSU Policy on attendance, your grade will be adversely affected by excessive unexcused absences. A point will be deducted from your overall class average for **each unexcused absence** in excess of the number of absences allowed according to the class policy. Also, tardiness will increase the number of unexcused absences; be advised that each three tardy arrivals will equate to one unexcused absence. A person is considered tardy
if he/she enters the class after the roll has been called. You are expected to remain in class during the entire class period.

_FVSU’s current policies and practices regarding plagiarism and academic dishonesty: Student Academic Dishonesty._ Expulsion or suspension from the University or any lesser sanction may be imposed for the commission of offenses involving cheating or defraud on examinations. Examples of such offenses include giving assistance not authorized by the instructor in the preparation of an essay, laboratory report, examination or other assignment included in an academic course; taking or attempting to take, steal, or otherwise procure in an unauthorized manner, any material pertaining to the conduct of a class, including but not limited to examinations, laboratory experiments, and roll books; and plagiarizing.

_Plagiarism._ The appropriation of someone else’s ideas, passages arguments, interpretation of events or factual information, in either hard copy or electronically, demonstrates a lack of integrity and is unacceptable at Fort Valley State University. Other examples of plagiarism include submitting someone else’s work/assignment as one’s own, submitting purchased papers as one’s own, and submitting papers from the Internet as one’s own. Students who are guilty of plagiarism are subject to disciplinary action. Acts of plagiarism must be reported to the Department Head, Dean, and Vice President for Academic Affairs and the Vice President for Student Affairs for appropriate action.

**DISABILITY**

FVSU is committed to the full inclusion of individuals with disabilities. To that end, the policies and procedures of FVSU ensure that a person with a documented disability is not, on the basis of that disability, denied full and equal access to academic programs, nor excluded from participation in co-curricular activities, or otherwise subjected to discrimination in such programs and activities. The policies for individuals with disabilities at FVSU are designed to ensure full compliance with all pertinent federal and state legislation, specifically to include Section 504 of the Rehabilitation Act of 1973 and the Americans with Disabilities Act (ADA) of 1990. If a student requires disability accommodations, he/she must register with the Office of Disability Services. To register online please visit: [http://www.fvsu.edu/disability-services/](http://www.fvsu.edu/disability-services/). You may also call (478) 822-1072, or visit the Royal C. Peabody Bldg. Room 125.

**IN Voluntary Withdrawal Policy**

If after the mid-semester period, the instructor verifies that a student has accumulated the following number of unexcused absences from the class, the student is subject to involuntary withdrawal from the class and will receive a final course grade of “WF.”

- The student is absent 20 or more days for a class (including labs) that meet 4 days per week.
- The student is absent 15 or more days for a class that meets 3 days per week.
- The student is absent 10 or more days for a class meets 2 days per week.
- The student is absent 6 or more days for a class meets 1 day per week.

_Telephone Usage:_ Refrain from bringing your cell phone to class. The use of head phones and cellular phones is not permitted in class – no text messaging, taking of photos of exams, or responding to calls during class time will be allowed.
Wearing of Hats/Scarfes in Class: Men and women are asked to remove all hats, “doo rags”, scarves and hoods upon entering class. Repeated requests to remove such head gear, your cap, “do rag” hat or scarf will result in dismissal from class.

Administrative Withdrawals from Class (WF):
Students who fail to attend class for an extended period of time may be administratively withdrawn from class. A “WF” is recorded on the student’s transcript in this case. The policy for administratively withdrawing a student from this course is as follows:
- Unexcused absence for 6 consecutive class hours OR
- Unexcused absence for a total number of 8 class hours.

Note: For this course (a 3 CR course that meets twice a week), we define one day absence = 1.5 class hours absence.

Disclaimer: The above schedule and procedures are subject to change in the event of extenuating circumstances.
Unit 1: Limits

Lesson 1: A Preview of Calculus
- Reading
- Exercises

Lesson 2: The Limit of a Function
- Reading
- Exercises

Lesson 3: The Limit Laws
- Reading
- Exercises

Lesson 4: Continuity
- Reading
- Exercises

Unit 2: Derivatives

Lesson 1: The Derivative of a Function
- Reading
- Exercises

Lesson 2: The Derivative of a Constant
- Reading
- Exercises

Lesson 3: The Derivative of a Sum
- Reading
- Exercises

Lesson 4: The Product Rule
- Reading
- Exercises

Lesson 5: The Quotient Rule
- Reading
- Exercises

Lesson 6: The Chain Rule
- Reading
- Exercises
Final Report
Date: 12/13/17

Grant Number: 246

Institution Name(s): Fort Valley State University

Team Members: There are 4 team members:

1. Professor Bhavana Burell, Mathematics and Computer Science Lecturer, Department of Mathematics and Computer Science, burellb@fvsu.edu
2. Dr. Samuel Cartwright, Associate Professor of Mathematics, Department of Mathematics and Computer Science, cartwis@fvsu.edu
3. Dr. Patcharin Marion, Associate Professor of Mathematics, Department of Mathematics and Computer Science, tragoosirisakp@fvsu.edu
4. Dr. Jianmin Zhu, Professor of Mathematics, Department of Mathematics and Computer Science, zhuj@fvsu.edu

Project Lead: Dr. Samuel Cartwright

Course Name(s) and Course Numbers:

Calculus I (MATH 1154)
Calculus II (MATH 2164)
Calculus for Business and Economics (MATH 1150)
Differential Equations (MATH 3223)

Semester Project Began: Spring 2017

Semester(s) of Implementation: Fall 2017

Average Number of Students Per Course Section:

Calculus I (MATH 1154) – 35 Students
Calculus II (MATH 2164) — 13 Students
Calculus for Business and Economics (MATH 1150) – 32 Students
Differential Equations (MATH 3223) – 6 Students

Number of Course Sections Affected by Implementation: 4 Courses
Total Number of Students Affected by Implementation: 86 Students
1. Narrative

A. Describe the key outcomes, whether positive, negative, or interesting, of your project.

Include:

Transformation Summary
The learning experience was a positive one in that we were able to find and create materials for Calculus I, Calculus II, Calculus for Business and Economics, and Differential Equations so that students in these courses did not have to pay for any course materials needed.

Uploading quizzes using the software Respondus was a challenge. This is because images seem to be scattered on a couple of quizzes that were uploaded.

Finding videos online that were aligned with course content was sometimes challenging because we had to be sure examples followed the content covered. For example, for the Calculus for Business and Economics course, examples of derivatives for trigonometry in the openstax textbook were not needed because there was no trigonometry in the course content and many videos had many examples with the trigonometry content.

- Transformative impacts on your instruction

The location and creation of materials was in Brightspace which allowed all students to easily access the resources. The materials were readily available at the beginning of the semester. This increased the number of students having access to the materials from day-one to 100%. Faculty gained experience of putting together materials with the help of an Online Instructional Professional.

Transformative Impacts
Students were able to save a total of $23, 320.00 (see Table 1A).

Table 1A

<table>
<thead>
<tr>
<th>Course</th>
<th>Number of Students Enrolled</th>
<th>Cost of Textbook</th>
<th>Students’ Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 1154</td>
<td>35</td>
<td>$306.25</td>
<td>$10,718.75</td>
</tr>
<tr>
<td>MATH 2164</td>
<td>13</td>
<td>$306.25</td>
<td>$3,981.25</td>
</tr>
<tr>
<td>MATH 1150</td>
<td>32</td>
<td>$225.50</td>
<td>$7,216.00</td>
</tr>
<tr>
<td>D-MATH 3223</td>
<td>6</td>
<td>$234.00</td>
<td>$1,404.00</td>
</tr>
<tr>
<td>Total Savings</td>
<td></td>
<td></td>
<td>$23,320.00</td>
</tr>
</tbody>
</table>

Table 1B gives the breakdown of the students served by the project. It also gives a breakdown on students with experience using Brightspace before entering the project courses. At least 48% or more of the student who participated in this project used Brightspace. Passing grades consists of A, B, and C. Non-passing grades consist of D, F, WF, and F. For Calculus I 21 of the 25 students expected to pass the course. For Calculus II 7 of the 8 students expected to pass. For
Differential Equations students did not answer that question. For Calculus for Business and Economics 24 of the 25 students expected to pass the course.

Table 1B

<table>
<thead>
<tr>
<th>Data Questions</th>
<th>Calculus I</th>
<th>Calculus II</th>
<th>Differential Eq.</th>
<th>Business Calculus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>16 Male</td>
<td>9 Female</td>
<td>4 Male 2 Female</td>
<td>8 Male 16 Female</td>
</tr>
<tr>
<td>Students enrolled in the course</td>
<td>25</td>
<td>8</td>
<td>6</td>
<td>25</td>
</tr>
<tr>
<td>Expected Grade out of the course</td>
<td>8 – A; 2 – B; 11 – C; 3 – D; 1 – F.</td>
<td>1-A; 2-B; 4-C; 1-D.</td>
<td>9-A; 9-B; 6-C; 0-D; 1-F.</td>
<td></td>
</tr>
<tr>
<td>Students who have taken a Math course in D2L before.</td>
<td>56%</td>
<td>63%</td>
<td>67%</td>
<td>48%</td>
</tr>
</tbody>
</table>

Lessons Learned

When creating questions using Brightspace, all instructors used only multiple choice questions because of time constrains. In future, after having gained experience using Brightspace and knowledge to create the course content, post open ended questions will be used to edit and update the course materials.

For Calculus for Business and Economics the search for more reasonable textbook will have to continue. The textbook selected was for a general calculus course and many examples using trigonometry dominated the textbook. Updating the course with an applied calculus textbook or one that caters to business will be in the works.

2. Quotes

Below are three quotes from students on the videos and its content.

Student 1
The course lecture videos are somewhat assisting and I do refer to them often, however I try to refrain from the videos that have actual instructor view. I am most comfortable watching the videos that have the black background along with using colored text for highlighting, these videos to more are most demonstrative, easy to view, and appealing to hear.
Student 2
No the video did not help understand the topic being discussed. I may need extra help trying to understand the problems being discussed.
Yes. I would watch the video again to try to get a better understanding of the lesson. The quality of the video in terms of the sound, visual, and content was very clear to my understanding.

Student 3
Yes. I am a visual learner and being that close and going step by step with the tutor helped me understand a bit easier. Also being able to pause and rewind made things a lot easier.
Yes. [I would watch the video again]
Everything [the video] was clear on my end, in all aspects.

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?

The overall student opinion was mixed. Table 1C gives a breakdown of student’s opinions about the materials.

There were positive opinions on: students downloading and printing a hard copy. For example, 50% or more of the students downloaded their respective textbook: that is 60% of Calculus I students, 50% of Calculus II students, 67% of Calculus for Business and Economics students and 68% of Differential Equations students.

With the exception of Differential Equations, most students were positive or excited about using the online materials. That is, 76% of Calculus I students, 100% of Calculus II students, 76% of Calculus for Business and Economics students and 40% of Differential Equations students.

With the exception of Differential Equations students were able to complete their homework before it was due. That is, 92% of Calculus I students, 100% of Calculus II students, 92% of Calculus for Business and Economics students and 40% of Differential Equations students.

The response on the need for needing more resources for course success was somewhat neutral. Even though more than 56% of students did not need any additional resources for their class. With the exception of Differential Equations who had no need: the other courses showed that 40 to 44% needed more resources. That is, 60% of Calculus I students, 63% of Calculus II students, 56% of Calculus for Business and Economics students and 100% of Differential Equations students.
<table>
<thead>
<tr>
<th>Survey Questions</th>
<th>Calculus I</th>
<th>Calculus II</th>
<th>Differential Eq.</th>
<th>Business Calculus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Download and View eTextbook</td>
<td>60%</td>
<td>50%</td>
<td>67%</td>
<td>68%</td>
</tr>
<tr>
<td>Referenced the textbook 7 or more times per week</td>
<td>15%</td>
<td>25%</td>
<td>67%</td>
<td>20%</td>
</tr>
<tr>
<td>Referenced the textbook for new materials</td>
<td>36%</td>
<td>88%</td>
<td>50%</td>
<td>32%</td>
</tr>
<tr>
<td>Logged 9 or more times per week into D2L</td>
<td>12%</td>
<td>40%</td>
<td>50%</td>
<td>20%</td>
</tr>
<tr>
<td>Spent 3 or more hours on homework in D2L</td>
<td>64%</td>
<td>88%</td>
<td>50%</td>
<td>40%</td>
</tr>
<tr>
<td>Current online Homework accessed in D2L</td>
<td>80%</td>
<td>100%</td>
<td>83%</td>
<td>64%</td>
</tr>
<tr>
<td>Students completed homework before it was due</td>
<td>92%</td>
<td>100%</td>
<td>40%</td>
<td>92%</td>
</tr>
<tr>
<td>Students were certain correct answers were entered in the first try in D2L.</td>
<td>32%</td>
<td>35%</td>
<td>50%</td>
<td>48%</td>
</tr>
<tr>
<td>Students looked for any mistakes in their work when D2L told them their answer was incorrect</td>
<td>40%</td>
<td>50%</td>
<td>13%</td>
<td>40%</td>
</tr>
<tr>
<td>Students worked alone on their homework in D2L</td>
<td>40%</td>
<td>100%</td>
<td>75%</td>
<td>80%</td>
</tr>
<tr>
<td>Students excited about using free resources</td>
<td>76%</td>
<td>100%</td>
<td>40%</td>
<td>76%</td>
</tr>
<tr>
<td>Students who did not need any additional resources for their classes</td>
<td>60%</td>
<td>63%</td>
<td>100%</td>
<td>56%</td>
</tr>
</tbody>
</table>
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?

Table 2 shows student performance in Calculus I for Spring 2017 and Fall 2017. The initial impact on student performance is positive. There was an increase of 14% passing.

Table 2.

<table>
<thead>
<tr>
<th>Calculus I (MATH 1154)</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Semester</td>
<td>Number of A, B, Cs</td>
<td>Number of D, F, W,</td>
<td>% passing</td>
</tr>
<tr>
<td>Spring 2017</td>
<td>9</td>
<td>30</td>
<td>23</td>
</tr>
<tr>
<td>Fall 2017</td>
<td>13</td>
<td>22</td>
<td>37</td>
</tr>
</tbody>
</table>

Table 3 shows student performance in Calculus II for Fall 2016 and Fall 2017. The initial impact on student performance is positive. There was an increase of 11% passing.

Table 3.

<table>
<thead>
<tr>
<th>Calculus II (MATH 2164)</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Semester</td>
<td>Number of A, B, Cs</td>
<td>Number of D, F, W,</td>
<td>% passing</td>
</tr>
<tr>
<td>Fall 2016</td>
<td>3</td>
<td>8</td>
<td>27</td>
</tr>
<tr>
<td>Fall 2017</td>
<td>5</td>
<td>8</td>
<td>38</td>
</tr>
</tbody>
</table>

Table 4 shows student performance in Calculus for Business and Economics for Fall 2016 and Fall 2017. The initial impact on student performance is negative. There was a decrease of 18% passing.

Table 4.

<table>
<thead>
<tr>
<th>Calculus for Business and Economics (MATH 1150)</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Semester</td>
<td>Number of A, B, Cs</td>
<td>Number of D, F, W,</td>
<td>% passing</td>
</tr>
<tr>
<td>Fall 2016</td>
<td>23</td>
<td>11</td>
<td>68</td>
</tr>
<tr>
<td>Fall 2017</td>
<td>16</td>
<td>16</td>
<td>50</td>
</tr>
</tbody>
</table>

Table 5 shows student performance in Calculus I for Fall 2016 and Fall 2017. The initial impact on student performance is neutral. Student performance remained unchanged.

Table 5.
### Differential Equations (MATH 3223)

<table>
<thead>
<tr>
<th>Semester</th>
<th>Number of A, B, Cs</th>
<th>Number of D, F, W, WF</th>
<th>% passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall 2016</td>
<td>6</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Fall 2017</td>
<td>6</td>
<td>0</td>
<td>100</td>
</tr>
</tbody>
</table>

### 3b. Narrative

For both Calculus I and Calculus II performance showed an improvement from using the traditional adopted textbook to using the free resources. That is a 14% and 11% respectively from Spring 2017 to Fall 2017. The impact of the materials on student performance for Differential Equations went unchanged. This is good news in that all students had success in passing the course during the Fall 2016 and Fall 2017 semester. Unfortunately, student in the Calculus for Business and Economics performance showed a negative impact. Comparing Fall 2016 with Fall 2017, we found a drop of 18% in passing.

For Calculus I, Calculus II and Differential Equations, the textbook and materials were all from traditional type textbooks. For Calculus for Business and Economics the textbook was a traditional textbook for calculus. Students enrolled in the Calculus for Business and Economics course had only the College Algebra as prerequisite. The additional content involving trigonometry could have created a negative factor in that students say mathematics they did not have the foundation for as they worked through problems. This may have caused a negative impact on student performance.

### 4. Sustainability Plan

The department's full adoption of these transformed courses has ensured that they will be reviewed annually for improvement and sustainability for students and faculty. Furthermore, with the exception of Differential Equations all of these courses are offered every semesters with the same instructors teaching the courses. Our teams’ commitment to that end enhances the assurance.

### 5. Future Plans

This project had positive influence on our thinking in terms of teaching and learning. The process of using D2L to create materials and organize materials for students to learn has provided a foundation to build on. That is, for creating more similar materials and well as taking what works and building upon for future use in the improvement of the course design.

This project experience, its impact on student performance, and the importance of these programs are things that we will share with other with vested interest. Paper, presentations and
publications are all in the works. The MAA Southeastern Regional Meeting at Clemson University is a target event for our first presentation on this project.

6. Description of Photograph

(left-right) Dr. Samuel Cartwright, Project Lead and Instructor of Calculus for Business and Economics as well as instructional designer, Dr. Patcharin Marion, Calculus Coordinator and Instructor of Calculus I and Calculus II as well as instructional designer, Professor Burell, Calculus I instructional designer and Calculus for Business Consultant, Dr. Jianmin Zhu, Instructor of Differential Equations as well as instructional designer.