Summer 2017

College Algebra, Trigonometry, and Precalculus (Clayton)

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Grants Collection
Clayton State University

UNIVERSITY SYSTEM
OF GEORGIA

Chaogui Zhang, Scott Bailey, Billie May,
Jelinda Spotorno, Kara Mullen

College Algebra, Trigonometry, and Precalculus

Affordable Learning Georgia

Georgia's Virtual Library
GALILEO
An Initiative of the University System of Georgia

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.

Initial Proposal

Application Form

Personal

Details

***Submitter First Name:**	Chaogui
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***Submitter Title:**	Chair and Associate Professor
***Submitter Email Address:**	ChaoguiZhang@clayton.edu
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***Submitter Campus Role:**	Proposal Investigator (Primary or additional)
***Applicant First Name:**	Chaogui
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***Applicant Email Address:**	ChaoguiZhang@clayton.edu
***Applicant Phone Number:**	(678)466-4435
***Primary Appointment Title:**	Chair and Associate Professor
***Institution Name(s):**	Clayton State University

Application Details

***Team Members (Name, Title, Department, Institutions if different, and email address for each. Include the applicant in this list.):**

Project Lead: Chaogui Zhang, Associate Professor and Department Chair, Department of Mathematics, ChaoguiZhang@clayton.edu.

Billie May, Lecturer, Department of Mathematics, BillieMay@clayton.edu.

Jelinda Spotorno, Senior Lecturer, Department of Mathematics, JelindaSpotorno@clayton.edu.

Aaron Rafter, Department of Mathematics, AaronRafter@clayton.edu

Kara Mullen, Head of Electronic Resources and Services, Clayton State University Library, KaraMullen@clayton.edu.

***Sponsor, (Name, Title, Department, Institution):**

Lila Roberts, Dean, College of Information and Mathematical Sciences, Clayton State University

***Proposal Title:**	213

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

College Algebra, MATH 1111, Trigonometry and Analytic Geometry, MATH 1112, Precalculus, MATH 1113, Spring 2016, Summer 2016, Fall 2016, Spring 2017

***Final Semester of Instruction (This is your final semester of the project):**	Spring 2017
***Average Number of Students per Course Section:**	28
***Number of Course Sections Affected by Implementation in Academic Year:**	30
***Total Number of Students Affected by Implementation in Academic Year:**	844
***List the original course materials for students (including title, whether optional or required, & cost for each item):**	Algebra and Trigonometry, with MyMathLab and e-book access, 5th edition, by Judith A. Beecher, Judith A. Penna, and Marvin L. Bittinger, $189.99 at campus bookstore, required.
***Proposal Categories:**	OpenStax Textbooks
***Requested Amount of Funding:**	$27,900
***Original per Student Cost:**	$189.99
***Post-Proposal Projected Student Cost:**	$0
***Projected Per Student Savings:**	$189.99
***Plan for Hosting Materials:**	D2L

***Project Goals:**

It is our goal to transition to a free, open access mathematics textbook and to design no-cost supplementary materials. We plan to use WeBWorK, a free, online homework management system created by the Mathematical Association of America, and to create supplemental materials such as course PowerPoint presentations for Math 1111, Math 1112, and Math 1113. In doing so, we predict that we will

* save each student enrolled in these courses about $190,

* provide high-quality learning materials to these students on day-one, and
* improve learning outcomes in these courses.

The students at Clayton State University are significantly burdened by the rising costs of textbooks, tuition, and fees. Clayton State University students who applied for financial aid during the 2014-2015 academic year had a median income that is less than $24,000. For fall 2014, over 90% of our first-year students received federal and/or state financial aid. Many Clayton State University students elect not to purchase required mathematics textbooks even though they know that doing so will likely affect their test scores and ultimately their final course grades. Even when students have sufficient financial aid to purchase all of their required textbooks, they typically are not able do so at the beginning of the semester because their financial aid awards are not disbursed in a timely manner.

The primary goal of this project is to reduce the cost of course materials for students enrolled in Math 1111 (College Algebra), Math 1112 (Trigonometry and Analytic Geometry), and Math 1113 (Precalculus). The current required textbook for these courses is Algebra and Trigonometry, with MyMathLab, 5th edition, by Judith A. Beecher, Judith A. Penna, and Marvin L. Bittinger, which costs $189.99 at the campus bookstore. Students typically follow one of two tracks: (1) Math 1111 and Math 1112 or (2) Math 1113. The 30 sections of Math 1111 and Math 1113 served nearly 850 students in the 2015 calendar year (spring, summer, and fall) at Clayton State University. Math 1112 students use the same textbook that is used in Math 1111, so there are typically no additional costs for Math 1112 students who completed Math 1111 at Clayton State. If we were to include Math 1112 students, there would be an additional 14 sections serving about 350 students. The total savings for Clayton State University students taking Math 1111 or Math 1113 is over $160,000 per year. With increasing enrollments in Math 1111, Math 1112, and Math 1113 each year, the projected savings will continue to increase, as well.

***Statement of Transformation:**

By transitioning to a free, open access textbook and a free, online homework management system, supplemented by high-quality, no-cost course materials, each of the Math 1111, Math 1112, and Math 1113 courses will be transformed from the “way we’ve always done it,” big-publisher driven course model to a more cost-effective and sustainable model appropriate for the students we serve.

The main stakeholders in this transformation are the students themselves. Almost every student in a STEM major is required to take either (1) Math 1111 and Math 1112 or (2) Math 1113 as a prerequisite for Calculus I. Some Non-STEM majors also take Math 1111 to fulfill their degree requirements. Students in these courses will have access to a free, open access textbook supplemented by no-cost learning materials, which we predict will improve learning outcomes since students will not be delaying or foregoing the purchase of a textbook. We will transition to a free homework management system developed by the Mathematical Association of America called WeBWorK. We believe that this transformation of Math 1111, Math 1112, and Math 1113 at Clayton State University will have the added benefit of encouraging other mathematics professors in the department to consider implementing a similar model in other mathematics courses.

Starting in fall 2015, Clayton State University (indeed, all universities in the USG) will be required to bear the difference in the cost of a textbook and the allotment provided by the Georgia Student Finance Commission (GSFC) for dual-enrolled (DE) students under the Move on When Ready (MOWR) program. That is, together, Clayton State University and the GSFC are paying for the expensive, big-publisher textbooks currently used in these courses for every student participating in MOWR. In addition, because no funds are provided for access to the MyMathLab online homework management system that we currently use in Math 1111, 1112, and 1113, the DE students must bear the cost of that product, which is currently $116. That is, even though Clayton State University and the GSFC are providing free textbooks to the students (by absorbing the costs themselves), access to the required MyMathLab homework system remains a burden for the DE student to bear. We anticipate that the number of dual enrollment students will continue to increase at Clayton State University, with continually increasing percentages taking Math 1111, Math 1112, or Math 1113, so these savings would compound over the next few years. Thus, Clayton State University and the State of Georgia are also stakeholders in this transformation.

The project benefits Math 1111, Math 1112, and Math 1113 students primarily, but also benefits the instructors of these courses. Indeed, we will provide
* a review of three OpenStax mathematics textbooks,
* homework assignments via WeBWorK that contain exercises tailored for each course,
* high-quality supplementary materials to support each course and the textbook, and
* an online learning environment via D2L and LibGuides for each course.

***Transformation Action Plan:**

The proposed transformation would affect 25 faculty members (19 full time and 6 adjuncts) in the Department of Mathematics at Clayton State University. These faculty members teach the 44 sections (and increasing) of Math 1111, Math 1112, and Math 1113. There will be four stages of implementation and review.

Stage One: Spring 2016. Chaogui Zhang, Billie May, Jelinda Spotorno, and Aaron Rafter will review three free OpenStax textbooks, College Algebra, Algebra and Trigonometry, and Precalculus, using the criteria developed by Affordable Learning Georgia. The content of these textbooks will be reviewed with respect to the course learning objectives for Math 1111, Math 1112, and Math 1113. Areas where textbook supplementation is required will be identified. Master syllabi for each course will be created. PowerPoint presentations related to the material covered in each course will be developed. WeBWorK homework assignments will be created for each course. Kara Mullen will aid in creating online learning environments using D2L and LibGuides. Two team members will attend the kick-off meeting in early February.

Stage Two: Summer 2016. Initial implementation of the transformed Math 1111, Math 1112, and Math 1113 courses will commence. May, Spotorno, Zhang, and/or Rafter will pilot courses to determine the efficacy of the new textbook and supplemental materials. Data will be collected from the students to ascertain whether or not they are, for example, reading the new textbook, reviewing the supplementary materials, and completing the homework assignments in a timely manner. Feedback will be requested to determine if the students have suggestions for improvements to the courses. Best-practices will be discussed and any necessary course redesign will occur.

Stage Three: Fall 2016. Full implementation of the transformed Math 1111, Math 1112, and Math 1113 courses will commence. Using the results of information collected during summer 2016 as well as their personal experiences concerning the initial implementation and pilot courses, May, Spotorno, Zhang, and/or Rafter will provide a half-day training workshop on best-practices for the mathematics faculty members and adjuncts during Faculty Planning Week. For example, the team members will lead discussions on using the new textbook, incorporating supplemental materials, and using WeBWorK in the transformed learning environment. Faculty members and/or adjuncts will teach all sections of Math 1111, Math 1112, and Math 1113 using the transformation principles and best-practices that have been developed. Data will be collected from the students to determine whether or not they are, for example, reading the textbook, reviewing the supplementary materials, and completing the homework assignments in a timely manner. Feedback will be requested to determine if the students have suggestions for improvements to the courses. Faculty members teaching these courses will be surveyed to determine how the transformation has impacted their teaching styles and to determine whether there were any positive changes in student-teacher interaction.

Stage Four: Spring 2017. Full implementation of the transformed Math 1111, Math 1112, and Math 1113 courses will continue. Faculty members and/or adjuncts will teach all sections of Math 1111, Math 1112, and Math 1113 using the transformation principles and best-practices that have been developed. Data will be collected from the students to determine whether or not they are, for example, reading the textbook, reviewing the supplementary materials, and completing the homework assignments in a timely manner. Feedback will be requested to determine if the students have suggestions for improvements to the courses. Faculty members teaching these courses will be surveyed to determine how the transformation has impacted their teaching styles and to determine whether there were any positive changes in student-teacher interaction. May, Spotorno, Zhang, and Rafter will review all data collected and prepare a report outlining the transformation of the Math 1111, Math 1112, and Math 1113 courses, with emphasis on the impact to the students in terms of the overall learning environment and increased understanding of mathematics.

Billie May is a Lecturer who has 34 years of teaching experience at the college level. She has taught each of Math 1111, Math 1112, and Math 1113 numerous times. She is currently serving as the Course Coordinator for Math 1111.

Jelinda Spotorno is a Senior Lecturer who has 21 years of experience teaching at the college level, as well as four years teaching K-12. She has taught each of Math 1111, Math 1112, and Math 1113 many times, including sections of Math 1113 at the Peachtree City-Fayette County instructional site, which serves a high number of dual enrollment students.

Chaogui Zhang is an Associate Professor with over 13 years of experience teaching college-level mathematics courses. He is in his first year as Department Chair of the Department of Mathematics at Clayton State University, but comes to Clayton State from Marywood University, where he served as Department Chair for four years. While at Marywood, he received an internal grant that allowed him to introduce WeBWorK and maintain the WeBWorK server.

Kara Mullen is the Head of Electronic Resources and Services in the Clayton State University library. She has been at Clayton State for five years and specializes in Electronic Resources Management and Electronic Services.

May, Spotorno, Zhang, and Rafter will be assisting each other during the textbook review process and with the creation of supplemental materials and WeBWorK homework assignments. May, Spotorno, Zhang, and Rafter will focus on the supplemental materials for Math 1111, Math 1112, and Math 1113, respectively. Zhang will focus on WeBWorK implementation and statistical analysis. Mullen will oversee the production of LibGuides and manage the online D2L master courses. All resources will be shared with our colleagues, both at Clayton State University and throughout the USG. Upon request, we will export D2L master courses and WeBWorK homework assignments to all faculty members who might be interested in using these resources.

***Quantitative & Qualitative Measures:**	Qualtrics surveys will be conducted in spring 2016 (current textbook), in summer and fall 2016, and in spring 2017 (new textbook and supplemental materials) to measure access to, use of, and attitudes toward the learning materials using Likert scale questions. Drop, fail, and withdraw rates and overall course grades will also be compared. A standardized final examination will be given before and during the transformation to determine how the new course materials, implementation of the transformation, and structure of the courses are affecting student learning. In particular, appropriate central tendencies and variabilities will be calculated. These statistics can then be used to estimate population parameters for the mathematics student population as a whole. In addition, student survey questions will address overall course satisfaction, with attention to determining students' willingness or reluctance to (1) complete homework in a timely manner, (2) read the textbook and supplemental materials, (3) attend class, and (4) participate in classroom discussions. Faculty members and adjuncts will be surveyed after the fall 2016 and spring 2017 terms. Although there are many factors that may be addressed in this survey, two important points are to determine (1) how the transformation has affected their teaching styles and (2) whether or not they have noticed an improvement in student-teacher interaction as a result of the transformation.

***Timeline:**

We provide this timeline as a brief version of the more robust Transformation Action Plan given in Section 1.3, with the intent of providing smaller milestones and deliverables.

Spring 2016: Attend kick-off meeting at beginning of February. Review OpenStax textbooks by end of February. Develop online learning environment in D2L by end of March. Develop supplemental learning materials and LibGuides by end of April. Conduct pre-transformation surveys during first week of May. Create WeBWorK homework assignments by end of May.

Summer 2016: Develop and teach pilot courses during June and July. Conduct initial transformation surveys during last week of classes (mid-July).

Early August 2016: Train faculty members and adjuncts concerning transformation principles and best-practices during Faculty Planning Week. Prepare initial progress report.

Fall 2016: Enact full implementation of the transformed Math 1111, Math 1112, and Math 11113 courses August to December. Conduct transformation surveys in first week of December. Prepare intermediate progress report by end of December.

Spring 2017: Continue teaching transformed courses January to May. Prepare final project report by end of May.

***Budget:**

Billie May, contract overload: $5,000

Aaron Rafter, contract overload: $5,000

Jelinda Spotorno, contract overload: $5,000

Chaogui Zhang, contract overload: $5,000

Kara Mullen, contract overload: $5,000

Training Workshop ($100 x 21 faculty/adjuncts): $2,100

Travel to Kick-off Meeting: $800

TOTAL $27,900

***Sustainability Plan:**

We view this transformation as a long-term commitment to student success and we anticipate that the results of the transformation will ultimately have a positive impact on students taking Math 111, Math 1112, or Math 1113. To ensure that the transformation has a lasting effect, the faculty members in the Department of Mathematics will form an assessment committee to determine how well each of these courses is improving student achievement and preparing them for future math courses. Supplemental materials, LibGuides, and the D2L master

courses will be updated as necessary to facilitate student achievement and understanding of learning objectives. We do not anticipate that any updates will require a significant amount of time to complete, so the transformed Math 1111, Math 1112, and Math 1113 course should be relatively easy to sustain once the implementation structure is in place.

Add Other Email Addresses for Notifications

Enter recipient(s) email address(es):	BillieMay@clayton.edu, JelindaSpotorno@clayton.edu, ChaoguiZhang@clayton.edu, KaraMullen@clayton.edu

CLAYTON STATE UNIVERSITY
College of Information and Mathematical Sciences

December 1, 2015

Dr. Christopher Raridan
Associate Professor of Mathematics
Department of Mathematics
College of Information and Mathematical Sciences
2000 Clayton State Boulevard
Morrow, Georgia 30260

Reference: Support for the Affordable Learning Georgia Textbook Transformation Grant Proposal

Dear Dr. Raridan:

I am pleased to support you and your team's proposal to transform College Algebra, Trigonometry, and Precalculus at Clayton State University. By offering an open-source textbook option from OpenStax and providing no-cost supplemental materials, including free access to the open source homework management system WeBWorK, as part of the Affordable Learning Georgia Textbook Transformation Grant, this proposal, if funded, will provide to the students substantial savings while at the same time offering them high-quality learning materials. The burden of rising tuition costs, along with with the ever-increasing costs of textbooks, is seen by reformers of education as a prohibitive expense for many students who would attend college. You and your team's proposal to eliminate the cost of learning materials for College Algebra (Math 1111), Trigonometry and Analytic Geometry (Math 1112), and Precalculus (Math 1113) would save the Clayton State students who take these courses over $150,000 per year, which is significant by any standards.

The department-wide plan that is outlined in the proposal is both feasible and sustainable. The surveys for students that you intend to use should provide sufficient data to determine what, if any, improvements would be necessary to allow the students to grow intellectually and to achieve their academic goals. Similarly, the faculty surveys will allow your team to understand how the learning materials can be updated as needed to meet our university's strategic plan to "create an outstanding educational experience that stimulates intellectual curiosity, critical thinking, and innovation."

The students and the Department of Mathematics will surely benefit as a result of this proposal being funded. The partnership created by working with both students and faculty to create a robust learning environment represents a vital collaboration that will serve our students in the best way possible. Your development of a modern instructional model, as well as your ability to incorporate proven and innovative teaching and learning strategies, will influence both educators and students and prepare them to meet the challenges of a 21st century, global society. In summation, I am completely confident that you and your team are capable of implementing and effectively managing the transformation of College Algebra, Trigonometry, and Precalculus described in this proposal. I enthusiastically support your efforts and look forward to the great benefit for our students that will be gained through this project.

Sincerely,

Lila F Roberts

Dr. Lila F. Roberts
Dean of the College of Information and Mathematical Sciences

Syllabus

WebWorK assignments are posted on the server webwork.clayton.edu which requires username and password for access.

MATH 1111/1112/1113 Online Resources Available by Topics/ Sections (From OpenStax)

2.2 Linear Equations in One Variable
- Solving rational equations
- Equation of a line given two points
- Finding the equation of a line perpendicular to another line through a given point
- Finding the equation of a line parallel to another line through a given point

2.4 Complex Numbers
- Adding and Subtracting Complex Numbers
- Multiply Complex Numbers
- Multiplying Complex Conjugates
- Raising *i* to Powers

2.5 Quadratic Equations
- Solving Quadratic Equations by Factoring
- The Zero-Product Property
- Completing the Square
- Quadratic Formula with Two Rational Solutions
- Length of a leg of a right triangle

2.6 Other Types of Equations
- Rational Equation with no Solution
- Solving equations with rational exponents using reciprocal powers
- Solving radical equations part 1 of 2
- Solving radical equations part 2 of 2

2.7 Linear Inequalities and Absolute Value Inequalities
- Interval notation
- How to solve linear inequalities
- How to solve an inequality
- Absolute value equations
- Compound inequalities
- Absolute value inequalities

3.1 Functions and Function Notation
- Determine if a Relation is a Function
- Vertical Line Test
- Introduction to Functions
- Vertical Line Test on Graph
- One-to-one Functions
- Graphs as One-to-one Functions

3.2 Domain and Range
- Domain and Range of Square Root Functions
- Determining Domain and Range
- Find Domain and Range Given the Graph
- Find Domain and Range Given a Table

- Find Domain and Range Given Points on a Coordinate Plane

3.3 Rates of Change and Behavior of Graphs
- Average Rate of Change

3.4 Composition of Functions
- Composite Functions
- Composite Function Notation Application
- Composite Functions Using Graphs
- Decompose Functions
- Composite Function Values

3.5 Tranformation of Functions
- Function Transformations

3.6 Absolute Value Functions
- Graphing Absolute Value Functions
- Graphing Absolute Value Functions 2

3.7 Inverse Functions
- Inverse Functions
- One-to-one Functions
- Inverse Function Values Using Graph
- Restricting the Domain and Finding the Inverse

4.1 Linear Functions
- Linear Functions
- Finding Input of Function from the Output and Graph
- Graphing Functions using Tables

4.2 Modeling with Linear Functions
- Interpreting a Linear Function

5.1 Quadratic Functions
- Graphing Quadratic Functions in General Form
- Graphing Quadratic Functions in Standard Form
- Quadratic Function Review
- Characteristics of a Quadratic Function

5.2 Power Functions and Polynomial Functions
- Find Key Information about a Given Polynomial Function
- End Behavior of a Polynomial Function
- Turning Points and x- x-intercepts of Polynomial Functions
- Least Possible Degree of a Polynomial Function

5.3 Graphs of Polynomial Functions
- Intermediate Value Theorem

5.4 Dividing Polynomials
- Dividing a Trinomial by a Binomial Using Long Division
- Dividing a Polynomial by a Binomial Using Long Division

- Ex 2: Dividing a Polynomial by a Binomial Using Synthetic Division
- Ex 4: Dividing a Polynomial by a Binomial Using Synthetic Division

5.5 Zeros of Polynomial Functions
- Real Zeros, Factors, and Graphs of Polynomial Functions
- Complex Factorization Theorem
- Find the Zeros of a Polynomial Function
- Find the Zeros of a Polynomial Function 2
- Find the Zeros of a Polynomial Function 3

5.6 Rational Functions
- Graphing Rational Functions
- Find the Equation of a Rational Function
- Determining Vertical and Horizontal Asymptotes
- Find the Intercepts, Asymptotes, and Hole of a Rational Function

5.7 Inverses and Radical Functions
- Graphing the Basic Square Root Function
- Find the Inverse of a Square Root Function
- Find the Inverse of a Rational Function
- Find the Inverse of a Rational Function and an Inverse Function Value

6.1 Exponential Functions
- Exponential Growth Function
- Compound Interest

6.2 Graphs of Exponential Functions
- Graph Exponential Functions

6.3 Logarithmic Functions
- Introduction to Logarithms

6.4 Graphs of Logarithmic Functions
- Graph an Exponential Function and Logarithmic Function
- Match Graphs with Exponential and Logarithmic Functions
- Find the Domain of Logarithmic Functions

6.5 Logarithmic Properties
- The Properties of Logarithms
- Expand Logarithmic Expressions
- Evaluate a Natural Logarithmic Expression

6.6 Exponential and Logarithmic Equations
- Solving Logarithmic Equations
- Solving Exponential Equations with Logarithms

6.7 Exponential and Logarithmic Models
- Logarithm Application – pH
- Exponential Model – Age Using Half-Life
- Newton's Law of Cooling
- Exponential Growth Given Doubling Time

- Exponential Growth – Find Initial Amount Given Doubling Time

7.1 Angles
- Angles in Standard Position
- Angle of Rotation
- Coterminal Angles
- Determining Coterminal Angles
- Positive and Negative Coterminal Angles
- Radian Measure
- Coterminal Angles in Radians
- Arc Length and Area of a Sector

7.2 Right Angle Trigonometry
- Finding Trig Functions on Calculator
- Finding Trig Functions Using a Right Triangle
- Relate Trig Functions to Sides of a Right Triangle
- Determine Six Trig Functions from a Triangle
- Determine Length of Right Triangle Side

7.3 Unit Circle
- Trigonometric Functions Using the Unit Circle
- Sine and Cosine from the Unit
- Sine and Cosine from the Unit Circle and Multiples of Pi Divided by Six
- Sine and Cosine from the Unit Circle and Multiples of Pi Divided by Four
- Trigonometric Functions Using Reference Angles

7.4 The Other Trigonometric Functions
- Determing Trig Function Values
- More Examples of Determining Trig Functions
- Pythagorean Identities
- Trig Functions on a Calculator

8.1 Graphs of the Sine and Cosine Functions
- Amplitude and Period of Sine and Cosine
- Translations of Sine and Cosine
- Graphing Sine and Cosine Transformations
- Graphing the Sine Function

8.2 Graphs of the Other Trigonometric Functions
- Graphing the Tangent
- Graphing Cosecant and Secant
- Graphing the Cotangent

8.3 Inverse Trigonometric Functions
- Evaluate Expressions Involving Inverse Trigonometric Functions

9.1 Solving Trigonometric Equations with Identities
- Fundamental Trigonometric Identities
- Verifying Trigonometric Identities

9.2 Sum and Difference Identities
- Sum and Difference Identities for Cosine
- Sum and Difference Identities for Sine
- Sum and Difference Identities for Tangent

9.3 Double-Angle, Half-Angle, and Reduction Formulas
- Double-Angle Identities
- Half-Angle Identities

9.4 Sum-to-Product and Product-to-Sum Formulas
- Sum to Product Identities
- Sum to Product and Product to Sum Identities

9.5 Solving Trigonometric Equations
- Solving Trigonometric Equations I
- Solving Trigonometric Equations II
- Solving Trigonometric Equations III
- Solving Trigonometric Equations IV
- Solving Trigonometric Equations V
- Solving Trigonometric Equations VI

10.1 Law of Sines
- Law of Sines: The Basics
- Law of Sines: The Ambiguous Case

10.2 Law of Cosines
- Law of Cosines
- Law of Cosines: Applications
- Law of Cosines: Applications 2

10.3 Polar Coordinates
- Introduction to Polar Coordinates
- Comparing Polar and Rectangular Coordinates

10.4 Polar Coordinates: Graphs
- Graphing Polar Equations Part 1
- Graphing Polar Equations Part 2
- Animation: The Graphs of Polar Equations
- Graphing Polar Equations on the TI-84

10.5 Polar Form of Complex Numbers
- The Product and Quotient of Complex Numbers in Trigonometric Form
- De Moivre's Theorem

10.6 Parametric Equations
- Introduction to Parametric Equations
- Converting Parametric Equations to Rectangular Form

10.7 Parametric Equations: Graphs
- Graphing Parametric Equations on the TI-84

10.8 Vectors

- Introduction to Vectors
- Vector Operations
- The Unit Vector

11.1 Systems of Linear Equations: Two Variables

- Solving Systems of Equations Using Substitution
- Solving Systems of Equations Using Elimination
- Applications of Systems of Equations

11.2 Systems of Linear Equations: Three Variables

- Ex 1: System of Three Equations with Three Unknowns Using Elimination
- Ex. 2: System of Three Equations with Three Unknowns Using Elimination

11.3 Systems of Nonlinear Equations and Inequalities: Two Variables

- Solve a System of Nonlinear Equations Using Substitution
- Solve a System of Nonlinear Equations Using Elimination

11.5 Matrices and Matrix Operations

- Dimensions of a Matrix
- Matrix Addition and Subtraction
- Matrix Operations
- Matrix Multiplication

11.6 Solving Systems with Gaussian Elimination

- Solve a System of Two Equations Using an Augmented Matrix
- Solve a System of Three Equations Using an Augmented Matrix
- Augmented Matrices on the Calculator

12.1 The Ellipse

- Conic Sections: The Ellipse
- Graph an Ellipse with Center at the Origin
- Graph an Ellipse with Center Not at the Origin

12.2 The Hyperbola

- Conic Sections: The Hyperbola Part 1 of 2
- Conic Sections: The Hyperbola Part 2 of 2
- Graph a Hyperbola with Center at Origin
- Graph a Hyperbola with Center not at Origin

12.3 The Parabola

- Conic Sections: The Parabola Part 1 of 2
- Conic Sections: The Parabola Part 2 of 2
- Parabola with Vertical Axis
- Parabola with Horizontal Axis

Final Report

Affordable Learning Georgia Textbook Transformation Grants

Final Report

Date: 5/26/2017

Grant Number: 213

Institution Name(s): Clayton State University

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

Scott Baily, Associate Professor, Department of Mathematics,
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Chaogui Zhang, Chair and Associate Professor, Department of Mathematics,
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Project Lead: Chaogui Zhang

Course Name(s) and Course Numbers:

MATH 1111 – College Algebra

MATH 1112 – Trigonometry and Analytic Geometry

MATH 1113 – Precalculus

Semester Project Began: Summer 2016

Semester(s) of Implementation: Spring 2017

Average Number of Students Per Course Section: 24

Number of Course Sections Affected by Implementation: 20

Total Number of Students Affected by Implementation: 474

1. Narrative

The primary goal of this project is to reduce the cost of course materials for students enrolled in MATH 1111/1112/1113 at Clayton State University, and therefore improve student access to course materials, and hopefully student learning outcomes. We began with two pilot testing sections in Summer 2016 in MATH 1111, and then expanded the project to all sections of MATH 1111, MATH 1112, and MATH 1113 in the fall, while continuously improving the available material to students. Spring 2017 was the office "implementation" semester, with all content available from the beginning of the semester. An OpenStax textbook was chosen and used together with the open source WebWorK system. We had some challenges with student perception of the new course materials, especially for MATH 1112 students, in the early part of the Fall 2016 semester. We believe that we did achieve our goals, and students are generally satisfied, after overcoming some initial transitional issues.

It had a very significant impact on our campus in many ways. The cost reduction was so significant to students that our campus bookstore revenue saw a large decrease contributable to our project. The Mathematics faculty attended WebWorK training sessions to prepare for the transition from MyMathLab to WebWorK, and many faculty who were not comfortable with WebWorK previously now are embracing the new platform. We believe faculty awareness of both student affordability and open source educational resources increased significantly.

One key lesson we learned is that careful evaluation and revision of open source material for local use is very important. We discovered that some WebWorK problems in the "Open Problem Library" still need quality checks. Some of these issues caused confusion among students and occasionally faculty as well. We revised and will continue to revise problems available in the library, and aim to provide online homework assignments and material with the highest possible quality we can achieve.

2. Quotes

- "It was a course that did not require you to buy the text book because it was online, which a lot of students greatly appreciated."
- "One highlight in this course was that students didn't have to purchase anything for this course."
- "No mymathlab, that was awesome. The textbook was free. The quiz and homework grades helped me understand what my weak points are. The study guides were a huge asset to doing well on tests. I liked how easy it was to make discussion posts because getting points for them was very convenient (either making a post in D2 L or visiting the CAS). Webwork is good too, although it does have some flaws, entering in answers was not as finicky as [mymathlab], so

that saved a lot of time because multiple answer formats are allowed (unless specified otherwise)."

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: 474

- Positive: 59.5% of 79 respondents
- Neutral: 21.5% of 79 respondents
- Negative: 19.0% of 79 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)
- _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:

38.6% of students, out of a total 474 students affected, dropped/failed/withdrew from the course in the final semester of implementation.

Choose One:

- _x_ 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

Included in the supporting data are the student survey results on their opinions regarding the course materials adopted. Surveys were conducted both before the adoption of open source material (Spring 2016) and after (Fall 2016 and Spring 2017). Although it is self-evident that the new materials should be more affordable (free for digital access, and low cost for printed textbook), we nonetheless included questions in the survey to gauge student perception and reaction to the change. In the pre-transformation survey result, nearly half (48%) of the respondents chose "strongly disagree" or "disagree" on the statement that "I was able to afford the textbook and/or MyMathLab access code", while the post-transformation survey results had only 19.8% (Fall 2016) and 15% (Spring 2017) of the respondents with such responses. The mean values of the overall affordability statement (1 - strongly disagree to 5 – strongly agree) on the survey increased from 2.63 (Spring 2016) to 3.52 (Fall 2016) and 3.61 (Spring 2017) with almost identical standard deviations. We believe we did achieve our primary goal for reducing cost of course material to students.

On the utilization of the homework systems, the pre- and post-transformation responses are similar for the many items, but MyMathLab scored more positively (3.38) than WebWorK (2.91 and 2.94) in the overall satisfaction, partly due to the transitional issues for many students who had difficulties switching from a familiar system to a new one. The second semester of WebWorK did see a slight improvement, but we still have a lot of work to do to improve the quality of the WebWorK assignments.

On the other hand, the overall satisfaction with the quality of the chosen OpenStax textbook (3.12 in Fall 2016 and 3.5 in Spring 2017) is higher than the previous Pearson product (2.79 in Spring 2016).

One other point worth noting is on the question of student engagement with the instructor. When asked about the frequency of a student contacting the instructor either by email or during office hours regarding either MyMathLab or WebWorK homework questions, the "Rarely or Never" responses dropped from 70% (Spring 2016) to 40% (Fall 2016) and 51% (Spring 2017). It is most likely the "Email Instructor" feature in WebWorK that helped in this area. We would like to further improve student

engagement and this is a promising sign. We hope that students will be better equipped to take advantage of the tools available in WebWorK as we increase student awareness of the functionalities and features of WebWorK.

On student performance, we included the summary grade distributions of the affected courses in Spring 2016 (pre-transformation), and Fall 2016/Spring 2017 (post-transformation). The student grades overall changed slightly if we compare the average GPA in all three courses between Spring 2016 (1.88) and Fall 2016 (1.91)/Spring 2017 (1.81). For individual courses, MATH 1111 saw improvements in both Fall 2016 (1.99) and Spring 2017 (1.74) from Spring 2016 (1.69), while MATH 1112 had a significant decline in student performance (from an average GPA of 2.12 in Spring 2016 to 1.09 in Fall 2016 and 1.81 in Spring 2017). The alarmingly large drop in Fall 2016 may be attributed to the unusually high rate of withdraw in that semester in MATH 1112 (all of the average GPAs include withdraws). MATH 1113 had a significant improvement in GPA in the Fall 2016 semester (2.73), but a more modest one (2.23) in Spring 2017, over Spring 2016 (1.76). In summary, other than MATH 1112 (discussed in more detail below), the other courses had improved performance as measured by average GPAs.

The DFW rates tell a similar story. The overall DFW rate for all three courses dropped slightly from 40% (Spring 2016) to 39.3% (Fall 2016) and 38.6% (Spring 2017). However, for individual courses, MATH 1111 DFW rate improved much more significantly (from 44.3% to 36.5%/36.4%), while MATH 1112 had an alarming spike in DFW in Fall 2016 (65.4%), from 35% in Spring 2016. It came down to a closer to normal 42.4% in Spring 2017. MATH 1113 also had improved DFW rate (from 35.3% to 16.3% and 31.4%). We should caution the reader that the enrollment in MATH 1113 is much lower and therefore the rates are not as reliable as an indicator of the effectiveness of teaching and/or quality of course material. Variations in student abilities in MATH 1113 may have a more direct impact on the performances.

One co-factor that may have influenced the outcomes, especially in MATH 1112, is the changing implementation of the co-requisite model at Clayton State University in College Algebra (MATH 1111), the pre-requisite course of MATH 1112. Testing of the co-requisite model was started in Fall 2014, with large scale implementation done in Spring 2015 for the first time. In AY 2015-2016, different strategies were being tested to improve student performance. Although we can't say for certain, it is possible that the first group of MATH 1112 students affected by the ALG textbook transformation may have had insufficient preparation, even though they have passed College Algebra.

Another co-factor that may have influenced the outcomes is the fact that all MATH 1112 students in Fall 2016 (and some MATH 1112 students in Spring 2017) went through their pre-requisite MATH 1111 course using MyMathLab, and therefore had an expectation (a very reasonable one) of continuing to use that system. They may be shocked to learn in the first week of class that they had to deal with a new homework system, which may

have caused anxiety among some students, even though those who never experienced MyMathLab found WebWorK to be a user friendly system.

4. Sustainability Plan

We plan to continue the use of the OpenStax textbook for these courses, and continue to improve the student experience in using WebWorK. The University provides the infrastructure support for the homework system, and we have local WebWorK expertise to maintain and update the system.

5. Future Plans

The project also inspired the department to adopt OpenStax material and WebWorK for our Intro to Statistics course (MATH 1231), which has over a dozen sections each semester, affecting about 350 students in Spring 2017. This also generated significant savings for our students.

We don't have any plan to publish or present at this point, although we are open to sharing our experience with others in the mathematics learning community, both in and out of USG.

6. Description of Photograph

Dr. Chaogui Zhang (left) and Dr. Scott Bailey (right).