

Fall 2016

Calculus II (University of North Georgia)

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Grants Collection

University of North Georgia



UNIVERSITY SYSTEM
OF GEORGIA



Minsu Kim, Hashim Saber, Bikash Das, Thomas Hartfield

Calculus II





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

**Affordable Learning Georgia Textbook Transformation Grants
Rounds Four and Five
For Implementations Beginning Spring Semester 2016
Running Through Spring Semester 2017**

Proposal Form and Narrative

Submitter Name	Minsu Kim
Submitter Title	Assistant Professor
Submitter Email	Minsu.kim@ung.edu
Submitter Phone Number	678-717-3546
Submitter Campus Role	<i>Proposal Investigator</i>
Applicant Name	<i>Minsu Kim</i>
Applicant Email	Minus.kim@ung.edu
Applicant Phone Number	678-717-3546
Primary Appointment Title	Assistant Professor
Institution Name(s)	University of North Georgia – Gainesville Campus
Team Members	<p>1. Minsu Kim, Assistant Professor of Mathematics; minus.kim@ung.edu</p> <p>2. Hashim Saber, Professor of Mathematics; hashim.saber@ung.edu</p> <p>3. Bikash Das, Assistant Professor of Mathematics; bikash.das@ung.edu</p> <p>4. Thomas Hartfield, Associate Professor of Mathematics; Thomas.Hartfield@ung.edu</p>

Sponsor, Title, Department, Institution	<i>Dr. John Cruthirds, Department Chair of Mathematics, University of North Georgia; john.cruthirds@ung.edu</i>				
Proposal Title	No-cost replacement of the high cost required materials for four mathematics courses (College Algebra, Pre-Calculus, Elementary Statistics, and Calculus II)				
Course Names, Course Numbers and Semesters Offered	<ol style="list-style-type: none"> 1. <i>College Algebra; Math 1111, offered every Fall, Spring, and Summer</i> 2. <i>Pre-Calculus; Math 1113, offered every Fall, Spring, and Summer</i> 3. <i>Elementary Statistics; Math 2400, offered every Fall, Spring, and Summer</i> 4. <i>Calculus II; Math 2460, offered every Fall, Spring, and Summer</i> 				
Final Semester of Instruction	Fall 2016				
Average Number of Students Per Course Section	30	Number of Course Sections Affected by Implementation in Academic Year	35	Total Number of Students Affected by Implementation in Academic Year	1050
Award Category (pick one)	<input checked="" type="checkbox"/> No-Cost-to-Students Learning Materials <input type="checkbox"/> OpenStax Textbooks <input type="checkbox"/> Specific Top 50 Lower Division Courses				
List the original course materials for students (including title, whether optional or required, & cost for each item)	Course	Course Materials			Optional /Required & cost[e-book: hard cover]
	College Algebra (Math 1111)	Julie Miller, College Algebra, McGraw Hill; 2014			Required \$133.35
		ConnectMath Homework software			Optional \$98.70
Pre-Calculus (Math 1113)	Stewart, Redlin & Watson, Algebra and Trigonometry, 3 rd Edition,			Required	

		Brooks/Cole;2012	\$206.80
		WebAssign Homework software	Optional \$92
	Elementary Statistics (Math 2400)	Fundamentals of Statistics by Michael Sullivan (Fourth Edition)	Required \$98
	Calculus II (Math 2460)	Calculus. Early Transcendental Functions 6th edition by Larson & Edwards (Publisher: Brooks/Cole)	Required \$299.70
		WebAssign Homework Software	Optional \$118
Original Per Student Cost	<ol style="list-style-type: none"> 1. College Algebra (Math 1111) – \$98.70 (with e-text) to \$133.35 (with hardcover) 2. Pre-Calculus (Math 1113) - \$92 (with e-text) to \$206.80 (with hardcover) 3. Elementary Statistics (Math 2400) - \$98 (with e-text) 4. Calculus II (Math 2460) - \$118 (with e-text) to \$299.70 (with hardcover) 		
Post-Proposal Projected Per Student Cost	\$0 (100% savings)		
Projected Per Student Savings	<ol style="list-style-type: none"> 1. From \$98.70 to \$133.35 for College Algebra (Math 1111) 2. From \$92 to 206.80 for Pre-Calculus (Math 1113) 3. \$98 for Elementary Statistics (Math 2400) 4. From \$118 to \$299.70 for Calculus II (Math 2460) 		
Plan for Hosting Materials	<input type="checkbox"/> OpenStax CNX <input checked="" type="checkbox"/> D2L <input type="checkbox"/> LibGuides <input checked="" type="checkbox"/> Other – Shared Class Files		
Requested Amount of Funding	\$21,200		

NARRATIVE

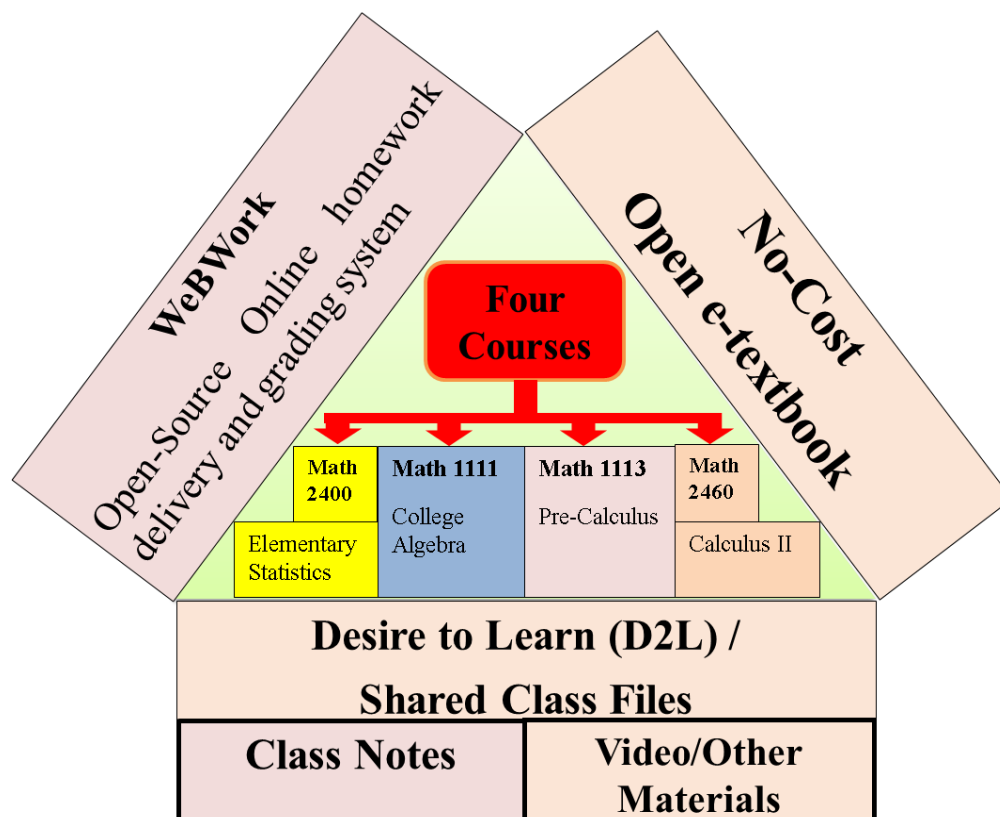
1.1 PROJECT GOALS

There are three goals that the project intend to achieve

1. To Replace high-cost required textbooks by high-quality and affordable instructional materials, through Open Education Resources, at zero cost to students.
2. To improve education quality and student's learning by providing easy access valuable textbooks and supplement materials with zero cost to students. These chosen open resources and constructed materials (short video lectures, notes, open textbooks materials and videos) will be mapped to the objectives and topics of each course to maintain syllabus consistency and provide better capacity to meet learning goals of each course. Materials will be accessed through D2L and shared class files.
3. To incorporating a free computerized homework and quiz delivery and grading system (WeBWork) into each course. Commercial software is usually costly and most students do not take the advantage of using the software because they can't afford buying them.

It is a fact that purchasing a high-cost required textbook is a burdensome to students and in particular to low-income and non-traditional students. Even students who receive financial aids sometimes have to wait until the second week of classes before the aid become available. This project will make all instructional materials available to all students in the four courses from day one of the semester with no cost. As a result, this project serves to increase retention and progression in the course and raise awareness to students regarding resources that available to them at no cost.

1.2 STATEMENT OF TRANSFORMATION



For the four courses, College Algebra, Pre-calculus, Elementary Statistics, and Calculus II, online texts from Affordable Learning Georgia open online texts will be adopted and will be linked to D2L or Shared Class Files. To improve teaching and learning, WeBWork, a free open-source online computerized homework-generating and grading system, will be used for homework and quizzes. Since video lectures help students develop conceptual understanding and motivation (Ruthven & Hennessy, 2002), we will link supplemental micro video lectures and practice exercises from Khan Academy or YouTube for the appropriate sections in D2L and Shared Class Files. In addition we plan to create additional short video lectures or videos for reviews using Camtasia Studio. Thus, students will access the aforementioned open resources on D2L or Shared Class Files with no cost to students.

The primary stakeholders are students. Utilizing the Affordable Learning Georgia Textbook Transformation Grant, students will have opportunities to learn using materials with the same educational recourses and similar instructional methods to commercial resources at no cost. In addition, students will be prepared for upper-level mathematics courses in an innovative educational environment at a minimum of expense.

The faculty members who teach these courses are also stakeholders. Mathematics faculty will have the opportunity to use innovative open resources with the same quality of

commercial texts and materials. Instructors have the opportunity to use their time more efficiently and better develop their pedagogical methods through this project. For example, instructional materials in D2L or Shared Class Files will serve as a guide providing no-cost-to-student learning materials. In addition, we will post and share our quizzes and homework assignments through WeBWorK. Each faculty member can utilize the same problem sets for their quizzes and homework on WeBWorK because WeBWorK changes the numerical values using the same question forms. Thus, this project will encourage faculty to align their instruction with sound pedagogical methods and innovative open educational recourses for College Algebra, Pre-Calculus, Elementary Statistics, and Calculus II because of the high quality of teaching materials, reduction in financial concerns for students, and easy access to our class websites on D2L and Shared Class Files.

This project will have immediate impact for approximately 1,050 students to reduce their cost of learning materials each academic year (see Table 1). In addition, a total savings in the year of implementation will be at least \$96,600.

Table 1. Cumulative saving cost of Spring, Summer, and Fall 2015				
Course	The number of sections from College Algebra, Pre-Calculus, Statistics, and Calculus II	The number of students	The minimum cost for a text (at least \$92): College Algebra \$98.70 (with e-text), Pre-Calculus \$92 (with e-text), Statistics \$98(with e-text), Calculus II \$118 (with e-text)	Total cost savings
Spring 2016	10	300	\$27,600 (\$92×300)	\$27,600
Summer 2016	Possible 10	300	\$27,600 (\$92×300)	\$27,600
Fall 2016	15	450	\$41,400 (\$92×450)	\$41,400
Total	35	1050		\$96,600

1.3 TRANSFORMATION ACTION PLAN

There are four components of the action plan for this project:

1. Review and development

Each team member will review all course materials and identify research in terms of adopting free educational open resources in order to find the most appropriate open texts. We will develop a syllabus for each course and replace a commercial textbook with a free open text from Affordable Learning Georgia and incorporate computerized homework by using WeBWorK.

2. Creation of open education rescors

We will create PDF lecture notes or Power Points. We will create homework assignments and quizzes for each section of each course on WeBWorK and make these assignments available to faculty who teach these courses. Mr. Thomas Hartfield and Dr. Kim will utilize their expertise to create additional video lectures using Camtasia Studio.

3. Integration

We will search for appropriate videos and interactive multimedia content. We will link short videos or interactive multimedia content to the PDF lecture notes or Power Points based on topics for the four courses.

4. Implement in College Algebra, Elementary Statistics, and Calculus II (sections taught by only grant members)

The open texts, online lecture notes with linked video and interactive multimedia, and WeBWorK for each course will be uploaded into D2L or Shared Class Files.

1.4 QUANTITATIVE AND QUALITATIVE MEASURES

- i) To evaluate this project, data will be collected from three different data sources: Drop, Fail, Withdraw (DFW) rate from Banner Web. This data will then be cross tabulated along with the preliminary assessment and Cumulative Final exam results.

Rubric							
Course	Total no. of stud. Registered	Preliminary assessment (median)	Withdraw %	Drop %	Cumulative Final exam (median)	Pass %	Fail % Individual Scores are less than 60%
College Algebra (Math 1111)							
Pre-Calculus (Math 1113)							
Calculus II (Math 2460)							
Elementary Statistics							

(Math 2400)							
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Data for the rubric will be collected from Spring 2016 for all the above mentioned courses which will be analyzed with a similar set of data from control courses taught in a traditional fashion using an actual text book and/or an online publishers' website. The linear correlation will be examined to study the interplay between "no cost" courses and "students' success/retention".

- ii) Technological Competency: The students' Internet skills, retrieving and managing information via technology will be evaluated at least three times during the semester period via online survey and assessments through D2L. Data like how often and how long a student is logged in to the online learning system WeBWorK or accessing OpenStax text books and how that corresponds to their successful completion of the course will be collected. For all these data the appropriate central tendencies and variabilities will be calculated. These statistics will be used as point estimates to estimate the population parameters for the entire UNG Mathematics student population. The final results will be closely administered and studied thoroughly to determine necessary improvements and easier accessibility of the course resources.
- iii) Students' feedback through survey: Students will be asked to participate in anonymous surveys about the overall effectiveness of the "no cost" courses at least twice during the semester. We plan to conduct an initial survey early in the term with a final survey near the end of the semester. A separate survey will be conducted to determine students' progress which will target the following areas: how regularly or reluctantly students are attaining lectures or attending classes; to what degree the major assignments are being completed; the degree of efficiency in completing major assignments; and the level of student participation in class work and/or discussions. Moreover, the principal investigators will conduct a self-assessment of the experience of adopting the **Affordable Learning Georgia** initiatives.

At the conclusion of the semester a general report based on the rubric will be created for peer evaluation and the following learning outcomes will be evaluated:

1. Students will be able to identify and relate to the course specific topic mastery requirements.
2. Students will be able to relate each of the course topics with at least one real life application problem and master it.
3. Students will be able to develop skills for **reading Mathematics course materials** and retain the information with ease.
4. Students will exhibit the characteristic of self-directed learners.

Finally, we will ask students if they encountered any difficulties using the materials accessible through the internet or their mobile devices so that the courses can be made easier to access from anywhere using a wide variety of devices such as tablets and smartphones.

1.5 TIMELINE

10/1/2015	Kick-off meeting to construct learning materials for the four courses (Math 1111; Math 1113; Math 2400; and Math 2460).
10/15/2015	Finalize reviewing and evaluating no-cost e-textbooks. Map the learning objectives (stated in UNG syllabi) of each of the four courses to the sections of the texts selected from the e-textbook. Modify each course syllabus to reflect the changes.
11/30/2015	Complete creation of learning materials to include class notes and short videos for each of the four courses based on the selected no-cost e-textbook.
12/15/2015	Complete creation of assignments in WeBWork for each of the four courses. [WeBWork is already installed in UNG-Gainesville server]
12/18/2015	Submit a semester status report to ALG
12/20/2015	Finalize the learning materials and upload all needed electronic materials to D2L and UNG WeBWork site to make sure that all four courses are ready for delivery in the Spring 2016 semester.
January 11, 2016-April 29, 2016	1/12/2016 Pre-test completed for the four courses
	Implementation: Piloting of course materials for the four classes – Spring 2016 semester.
	4/28/2016 Complete data collection and complete Post-test (the four courses)
May 2016	Review and modify the piloted materials
May 20, 2016	Submit a semester status report to ALG
Summer 2016	Implement possibly 10 sections for the four courses
August 12, 2016	Submit a semester status report to ALG
Fall 2016	Implement 15 sections for the four courses; conduct discussions with colleagues and the department Curriculum Committee to see if implementation on a larger scale is an appropriate departmental endeavor.
December 2016	Work on data analysis and evaluating course effectiveness
	Prepare final project report
December 23, 2016	Submit final project report

1.6 BUDGET

Dr. Hashim Saber	Faculty additional time spent for preparation instructional materials	\$5,000
Dr. Minsu Kim	Faculty additional time spent for preparation instructional materials	\$5,000
Dr. Bikash Das	Faculty additional time spent for preparation instructional materials	\$5,000
Mr. Thomas Hartfield	Faculty additional time spent for preparation instructional materials	\$5,000
Travel	Kick-off meeting or Conference	\$800
Supplementary material	Paper, ink cartridges, and copying cost. etc	\$400

1.7 SUSTAINABILITY PLAN

We anticipate good results and a positive impact on student success as a result of piloting the four courses during the first academic year (10 sections in Spring 2016, possibly 10 sections in Summer 2016, and 15 sections in Fall 2016). Materials (Open Textbook, class notes, and WeBWrok assignments) for the four redesigned courses will be available to math instructors who are interested in OER for future terms. The project team members will keep the original copy of the learning material and will maintain and update materials as needed. The D2L part of each course must be updated each semester which can be easily done with help from the UNG-IT department.

1.8 REFERENCES & ATTACHMENTS

Ruthven, K., & Hennessy, S. (2002). A practitioner model of the use of computer-based tools and resources to support mathematics teaching and learning. *Educational studies in mathematics*, 49(1), 47-88.

Syllabus

**University of North Georgia
College of Science and Mathematics
Mathematics Department
Mathematics 2460, Calculus II**

Semester: Spring 2016

Instructor: Dr. Bikash C Das

Office: Watkins 118

Office Phone: Mon: (678) 717-3679

E-Mail: bikash.das@ung.edu

Office Hours:

Mon: 11:00 am – 12:00 pm

Tue: 9:00 am -10:00 am, 12:00 pm – 3:00 pm

Wed: 11:00 am – 12:00 pm

Thu: 9:00 am -10:00 am, 12:00 pm – 3:00 pm

Fri: 11:00 am – 12:00 pm

Important Dates:

1. Course changes and late registration: Friday, January 15, 11:59 pm.
2. Mid-Semester Withdrawal without a 'WF' grade: Monday, March 7, 11:59 pm
3. Final Exam: Monday, May 2, 3:00 pm – 5:00 pm

Text and Other Materials:

- APEX Calculus

Library Resources:

- ✚ *Calculus. Early Transcendental Functions* 6th edition by Larson & Edwards (Publisher: Brooks/Cole), for **Gainesville, Oconee and Cumming campuses**.
- ✚ Supplementary Text: Student Solutions Manual (Optional)
- ✚ Calculator: *The calculator policy is left to the discretion of the instructor.*
- ✚ Apostol, *Calculus, Volume I*, Blaisdell, Waltham, MA, 1967.
- ✚ Dudley, *Readings for Calculus*, MAA, 1993.
- ✚ Dunham, *The Mathematical Universe: An Alphabetical Journey Through the Great Proofs, Problems, and Personalities*, Wiley & Sons, New York, 1994.

- ✚ Halmos, *Problems for Mathematicians, Young and Old*, MAA, Washington, D.C., 1991.
- ✚ Hight, *A Concept of Limits*, Prentice-Hall, Englewood Cliffs, N.J., 1966.
- ✚ Nolan, *Women in mathematics: scaling the heights*, MAA, 1997.
- ✚ Parker, *She Does Math!*, MAA, 1995.
- ✚ Sawyer, *What is Calculus About?*, Random House, 1961.
- ✚ Sterrett, *101 careers in mathematics*, MAA, 1996.
- ✚ *Women, Minorities and Persons with Disabilities in Science and Engineering*, National Science Foundation, 1999 (NS 1.49).
- ✚ Weaver, *Conquering calculus: the easy road to understanding mathematics*, Plenum, 1998.
- ✚ Young, *Excursions in calculus: an interplay of the continuous and the discrete*, MAA, 1992.
- ✚ Yount, *A to Z of women in science and math*, Facts on File, 1999.

Web-based Resources:

- Association for Women in Mathematics - <http://www.awm-math.org>
- The Math Forum – <http://www.mathforum.org>
- Waterloo Maple's Student Center - <http://www.maplesoft.com/academic/students/index.aspx>
- Texas Instruments - <http://education.ti.com/educationportal/>
- Key Curriculum Press <http://www.keypress.com>
- Eric Weisstein's World of Mathematics (Encyclopedia of Mathematics) - <http://mathworld.wolfram.com>
- Math Nerds -<http://www.mathnerds.com>
- SOS Mathematics <http://www.sosmath.com>
- Project Interactivate - <http://www.shodor.org/interactivate>
- Multicultural Pavilion – <http://www.edchange.org/multicultural>
- Women in Mathematics – <http://www.agnesscott.edu/lriddle/women/women.htm>
- Careers in mathematics - <http://www.ams.org/early-careers/>
- Calculus Applets- <http://www.calculusapplets.com>
- Related Rates Applets - http://www.usna.edu/MathDept/website/courses/calc_labs/index.html

Technology Resources:

Access to computer and web based learning software WeBWork. Follow instructor's separate email instructions for WeBWork.

Course Description:

A continuation of Calculus I. Topics include application of definite integrals, derivatives and integrals with inverse trigonometric functions, indeterminate forms and L'Hospital's rule, techniques of integration, polar coordinates, and infinite sequences and series.

Prerequisite:

Grade of C or above in MATH 1450 or approval of the department head.

Course Objectives:

After completion of the course the student will be able to:

- Find the area of planar region, the volume of a solid of revolution, and the length of a curve in the plane by means of definite integration.
- Determine the derivative of a function involving inverse trigonometric functions.
- Determine an antiderivative of a function by applying properties of inverse functions, including inverse trigonometric functions.
- Solve rate or optimization problems that involve inverse trigonometric functions.
- Select an appropriate method, l'Hospital's Rule or algebraic simplification, for evaluating indeterminate forms.
- Evaluate the limit of an indeterminate form by using L'Hospital's Rule or algebraic simplification.
- Find the antiderivative of a function by using a combination of the following techniques: trigonometric substitution, integration by parts, trigonometric identities, and partial fraction decomposition.
- Approximate areas by using the midpoint rule, trapezoidal rule, and Simpson's rule.
- Determine the convergence or divergence of an improper integral.
- Evaluate improper integrals that converge.
- Find the area of a region bounded by polar curves.
- Choose the representation, rectangular or polar, that facilitates the solution of a given problem in two dimensions.
- Determine the convergence or divergence of a sequence.
- Determine the convergence or divergence of infinite series by using each of the following: geometric series, the sequence of partial sums, the integral test, the direct comparison test, the limit comparison test, the alternating series test, the ratio test, and the root test.
- Determine whether a convergent alternating series is conditionally convergent or absolutely convergent.
- Approximate non-polynomial functions using power series.
- Determine when power series approximations are not valid.

Course Calendar:

M	W	M	W
01/11 Orientation and Review Basic Integration Techniques and Integration by Substitution	01/13 Lecture Fundamental Theorem of Calculus, Natural Logarithms	01/18 MLK DAY	01/20 Lecture on Integration by Substitution, Inverse Trigonometric Functions
01/25 Lecture on Numerical Integration	01/27 Lecture on Area of region bounded by curves	02/01 Lecture on Volume Disk Method	02/03 Lecture on Volume Shell method
02/08 Lecture on Arc length, Surface of Revolution and work done	02/10 Test 1	02/15 Lecture on Integration by parts	02/17 Lecture on Trigonometric Integrations
02/22 Lecture on Integration by Trigonometric substitutions	02/24 Lecture on Integration of Rational Functions	02/29 Lecture on Indeterminate form and L'Hopital Rule	03/02 Test 2
03/07 Lecture on Indefinite Integration	03/09 Lecture on Sequences, Series and Convergence	03/14 Spring Break	03/16 Spring Break
03/21 Lecture on Integral Test and P-Series	03/23 Lecture on Comparison Test and Alternating Series	03/28 Lecture on Alternating Series, Ratio Test and Root Tests	03/30 Test 3
04/04 Lecture on Taylor Polynomials and Approximations	04/06 Lecture on Power Series	04/11 Lecture on Representation of Functions by Power Series	04/13 Lecture on Taylor and Maclaurin Series
04/18 Lecture on Calculus of Parametric Equations	04/20 Test 4	04/25 Lecture on Calculus and Polar Coordinates and basic Polar curves	04/27 Final Review
		(M) 05/02 Final 3:00 pm -5:00 pm	

Methods of Instruction: The methods of instruction may include, but are not limited to lecture; problem-solving sessions with informal assessment by the student or instructor; discussion; group projects; timely feedback from test, quiz, or project results (formative assessment); question and answer; computer or calculator based explorations; and student presentations. Students will be encouraged to assess and monitor their own problem-solving process to determine when an error has been made or a new strategy should be used.

Evaluation Methods: Formal assessments will be in the form of written tests and/or short quizzes and summative assessment will be in the form of a final examination. There will be **three** regular exams and a cumulative final exam. HWs are assigned on WeBWork, the **students are expected to do all homework assignments. Recitation Quizzes will assigned almost every week, on WeBWork.** Problems on quizzes and tests will be similar to those of homework assignments.

HWs: 100 (20%)

10 Quizzes: 50 (10%)

4 in class Tests: $4 * 50 = 200$ (40%)

Final exam: 150 (30%)

A 10% scale will be used: A: 450 – 500 | B: 400 – 449| C: 350 – 399
D: 300 – 349 | F: below 300

Any student who is not satisfied with his/her grades during this course should discuss this with the instructor.

Make-up Information: There will be **no makeup tests**. If you anticipate missing a test, please let me know and we will arrange a time to take the test early. You may NOT start a test or take a test and then ask me not to count it.

There will be **no makeup Tests**. Tests may be taken early. If you miss a Test or do not take it early, you will receive a zero for that Test score. Your lowest Test grade will be replaced by a better Final grade.

Attendance Policy: Attendance is mandatory and will be taken daily. **If you do miss a class, you are responsible for any material covered in class during your absence.** If you miss a day, please get the notes from another student in the class. **All unexcused absences from tests are counted as 0 points towards the final grade and will not be replaced or dropped.** The instructor reserves the sole administrative right to assign a student “W” grade at any point of the semester for more than four consecutive and (or) more than 6 total absences and (or) missing subsequent portion of the online work. **Students are expected to refer to the Supplemental Syllabus for the following information:** (<http://ung.edu/academic-affairs/policies-and-guidelines/supplemental-syllabus.php>)

Final Report

Affordable Learning Georgia Textbook Transformation Grants

Final Report

Date: 12/23/2016

Grant Number: 178

Institution Name(s): University of North Georgia

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

1. Minsu Kim, Assistant Professor of Mathematics; minus.kim@ung.edu

2. Hashim Saber, Professor of Mathematics; hashim.saber@ung.edu

3. Bikash Das, Assistant Professor of Mathematics; bikash.das@ung.edu

4. Thomas Hartfield, Associate Professor of Mathematics; Thomas.Hartfield@ung.edu

Project Lead: Minsu Kim

Course Name(s) and Course Numbers:

1. College Algebra; Math 1111
2. Pre-Calculus; Math 1113
3. Elementary Statistics; Math 2400
4. Calculus II; Math 2460

Semester Project Began: Spring 2016

Semester(s) of Implementation: Spring 2016, Summer 2016, Fall 2016

Average Number of Students Per Course Section: 30

Number of Course Sections Affected by Implementation: 23

Total Number of Students Affected by Implementation: 581

1. Narrative

This project had a direct impact on 581 students and saved them a significant amount of money [\$48,717 to \$81,965] in four mathematics courses (College Algebra, Precalculus, Elementary Statistics, and Calculus II). We felt that we accomplished our main goal of this project in replacing high-cost required textbooks by high-quality and affordable instructional materials in the following two categories:

1. At zero cost to 465 students: We have incorporated chosen open textbooks, a free computerized homework and quiz delivery and grading system (WeBWork). Depending whether students buy an e-version, or purchase a hardcover copy, the savings were \$41,328 to \$70,567. The use of WeBWork to develop the homework and quizzes was thoughtful and allowed for ease of grading, supplementing the textbook homework and quizzes, and continued support and implementation for future courses.
2. At a reduced cost (20%-50%) for 116 students: These students were in four sections where an open textbook is chosen together with a commercial homework and quiz delivery system (WebAssign) which cost \$35 per student. Depending whether students buy an e-version, or purchase a hardcover copy, the savings were \$7,389 to \$11,409.

Thus, the total savings for the 581 students involved in this project was \$48,717 to \$81,965. Students expressed a more positive and satisfactory opinion about the course having a free textbook and a free or reduced cost homework program available to them from day one of the semester. Overall, they were also generally pleased with the content and examples of the selected textbooks.

Transformative impacts on students involved in this project include relevance, free and/or reduced cost of the material and presentation of the resources. The chosen open resources and constructed materials (short video lectures, notes, open textbooks materials and videos) were mapped to the objectives and topics of each of the four courses involved in this project. This was carefully done to maintain syllabus consistency and provide better capacity to meet learning goals of each course. In some of the courses materials were accessed through D2L and in others, local shared class files were used to post course materials.

Students on four sections of college algebra had the opportunity to access auditory and visual approaches which supplemented the lectures as well as provided additional review. In general, all courses have access to for videos and other resources stated in the syllabus.

One of the main outcomes of this project is that all instructional materials were made available to all students in the four courses from day one of the semester. As presented in the qualitative analysis section, having free resources available increased student's retention and their progression in the course. It also raised their awareness regarding resources that available to them at no or minimal cost.

Having ALG, OpenStax, and other vendors to locate resources was very beneficial to each professor and in response, to students. For our team, the transformation was an opportunity to

locate and evaluate new resources for courses involved in this project and for other future courses where open resource implementation is possible.

A challenge in implementing the project is to get students adopted to the limitations in using WeBWorK for students who are familiar with other commercial system that was used in previous course. Commercial systems usually have many rich features that are not yet available in WeBWorK. For example: math palette entry for symbolic questions; graphing tools students can use; links to sections of the e-text right on questions; links to animated mini-lectures (with sound); etc. We feel that some of the commercial features are too much for the students and WeBWorK have the necessary features that can support students' learning process. WeBWorK provides students with immediate feedback on the correctness of their answers, WeBWorK encourages students to make multiple attempts until they succeed. WeBWorK can present and grade any mathematics calculation problem from different mathematical courses. As with a commercial system, students usually take some time to learn the syntax and format of the software.

Our team felt that this project has given them the freedom from the restriction of using one assigned textbook and gave them the opportunity to improve education quality and student's learning by providing easy access to not just one, but several valuable textbooks and supplement materials with zero or minimal cost to students.

Our future-plans in using open resources will be mixing and combining materials from different textbooks to come up with a new textbook tailored to our students' needs.

By looking more closely at some of the homework problems developed in WeBWorK, we found some errors and things that needed to be improved. We also realized that we needed to put more time and effort to create problems that are compatible with the selected textbook. Faculty involved in this task felt they gained experience and felt the sense of ownership when developing WeBWorK problems, quizzes and tests that can be used in future courses. Faculty who use our product in future OER based courses will have better selection of WeBWorK problems. Moreover, with the experience gained by our team in open resources and learning about available resources, some of us will consider using different textbook for future classes with additional instructor designed content that better suits our needs. In fact, one of our team members changed the proposed Statistics textbook to a different one when he taught the course in Spring2016.

We also noticed that students tend to have a hardcopy of the textbook especially if it is not expensive. As a faculty, we felt that in-class activities and homework discussion can be done more efficiently when students have a tangible hardcopy in their hand. Hardcopy version of the textbook usually average \$35. In the future, we will encourage students to purchase a hardcopy of the book. Students in the sections of college algebra using WebAssign displayed satisfactory progress on homework strictly by using the online program resulting in a complementary net output per student when using this approach.

2. Quotes

- “The use of webwork and free textbook was fantastic! I am a nontraditional student and I pay for schooling myself. So, when Dr. Das told us of the free textbook and web based program we would use during his calculus 2 course, I was ecstatic. The average cost of a textbook is roughly \$150.00 and it is a cost added to already rising tuition costs. As one can imagine it is difficult enough to put yourself through school whilst raising a family. Professors, such as, Dr. Das are the few on the side of the students that REALLY want to help people of any age achieve their goals and I hope that these types of trends continue well into the future, and that other additional savings might be allocated as well.”
- “This semester I enjoyed having a free class. At the beginning of the semester, I thought I was going to struggle without having a hard copy text book. I didn't understand how to use WebWork, but then began to really appreciate the way it helped me learn. Being a freshman in college and paying for tuition, it was a treat to not have to pay for another textbook. On WebWork, I liked being able to see if I got the answer correct as soon as I submitted it. Overall, this has been a great class and learning opportunity.”
- “I enjoy and appreciate the easy accessibility of the online textbook and the fact that it is free of any charges.”
- “This paragraph is written in support of the use of Webwork in the Mathematics Department here at the University of North Georgia. I have had the opportunity the last two semesters to assist students and actually solve several of the problems in Calculus I and Calculus II. Webwork provides problems that are challenging for student to do. Webwork also provide students with additional practice and practice makes perfect for students who are trying to learn challenging material. Webwork give student immediate feedback if problems are done correctly. As a math tutor, I would encourage other colleges to use Webwork.”
- “The textbook I used in this course was a free to download book from APEX Calculus provided by my professor. I found the book to be very useful and informative, usually with both a comprehensive variety of clearly demonstrated examples for each lesson and a thorough explanation of the topic at hand as well as many practice problems and solutions. However, there were a couple problems over the course of the semester which the book did not cover in sufficient detail to solve.”

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: **581**

- Positive: **62.78 %** of **581** number of respondents
- Neutral: **20.41 %** of **581** number of respondents
- Negative: **16.81 %** of **581** 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?

The overall outcomes and grades in the semester(s) of implementation over previous semesters positive.

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?

The overall comparative impact on Drop/Fail/Withdraw (DFW) rates in the semester(s) of implementation over previous semesters positive?

Drop/Fail/Withdraw Rate:

26.85 % of students, out of a total **581** 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

To evaluate this project, we have collected data from three different data sources: Drop, Fail, Withdraw (DFW) rate from Banner Web. This data will then be cross tabulated along with the preliminary assessment and Cumulative Final exam results.

<i>Course</i>	<i>Total no. of stud. Registered</i>	<i>Withdraw %</i>	<i>A/B/C/D</i>	<i>Pass %</i>	<i>Fail % Individual Scores are less than 60%</i>
<i>College Algebra (Math 1111)</i>	<i>175</i>	<i>19.43 %</i>	<i>23/21/40/23</i>	<i>61.14 %</i>	<i>18.88 %</i>
<i>Pre-Calculus (Math 1113)</i>	<i>90</i>	<i>24.44%</i>	<i>14/21/16/7</i>	<i>64.44 %</i>	<i>11.11 %</i>
<i>Calculus II (Math 2460)</i>	<i>104</i>	<i>34.61 %</i>	<i>37/5/13/3</i>	<i>55.76 %</i>	<i>9.61 %</i>
<i>Elementary Statistics (Math 2400)</i>	<i>212</i>	<i>27.83 %</i>	<i>30/38/44/11</i>	<i>58.02 %</i>	<i>13.21 %</i>

All percentages in the chart above are based on the total number of students registered for each course since the first week of the semester, found in column two. The number of students who passed with each letter grade, A, B, C, or D, are displayed in column four. No comparison was made between passing/failing and the number of students who completed the course with a letter grade (not a W / WF). The percentage of students who completed each semester can be determined by subtracting the Withdraw % from 100%.

In total, 581 students registered for all four classes. A total of 156 students withdrew, producing combined average withdrawal rate of 26.85%.

- i) **Technological Competency:** The students' Internet skills, retrieving and managing information via technology was evaluated twice during the semester via assessments through D2L. Data like how often and how long a student is logged in to the online learning system WeBWorK or accessing OpenStax text books and how that corresponds to their successful completion of the course. We found the expected grade of a College Algebra student under the ALG Project was high C or a low B. Whereas the expected grade of a Pre-Calculus student under the ALG Project was a low B. We also found that the expected grade of a Calculus II student under the ALG Project was a high B. And the expected grade of an Elementary Statistics student under the ALG Project was a high B to low A.
- ii) **Students' feedback through survey:** Students were asked to participate in anonymous surveys about the overall effectiveness of the "no cost" courses twice during each semester. For each of the questions the student responded saying whether they **never (1), rarely (2), occasionally (3), regularly (4) or always (5)** participated or practiced the objectives of the survey on a weekly basis. The following tables describes the weighted means of the responses to some of the survey that directly correlates with the ALG project.

A. How often do you use material posted on D2L or shared class files?

		Mean beginning of the semester	Mean end of the semester
College Algebra		4.42	4.28
Pre-calculus		4.38	4.03
Calculus II		3.83	3.83
Elementary Statistics		4.44	4.23

B. How often do you use the online homework system?

		Mean beginning of the semester	Mean end of the semester
College Algebra		4.56	4.61
Pre-calculus		3.51	3.59
Calculus II		4.57	4.51
Elementary Statistics		3.92	4.28

C. How helpful is your online homework for learning?

		Mean beginning of the semester	Mean end of the semester
College Algebra		4.21	4.20
Pre-calculus		3.51	3.41
Calculus II		4.45	4.37
Elementary Statistics		3.05	3.34

D. How helpful is your textbook for learning?

		Mean beginning of the semester	Mean end of the semester
College Algebra		2.93	2.44
Pre-calculus		3.13	3.17
Calculus II		2.51	2.84
Elementary Statistics		3.51	2.78

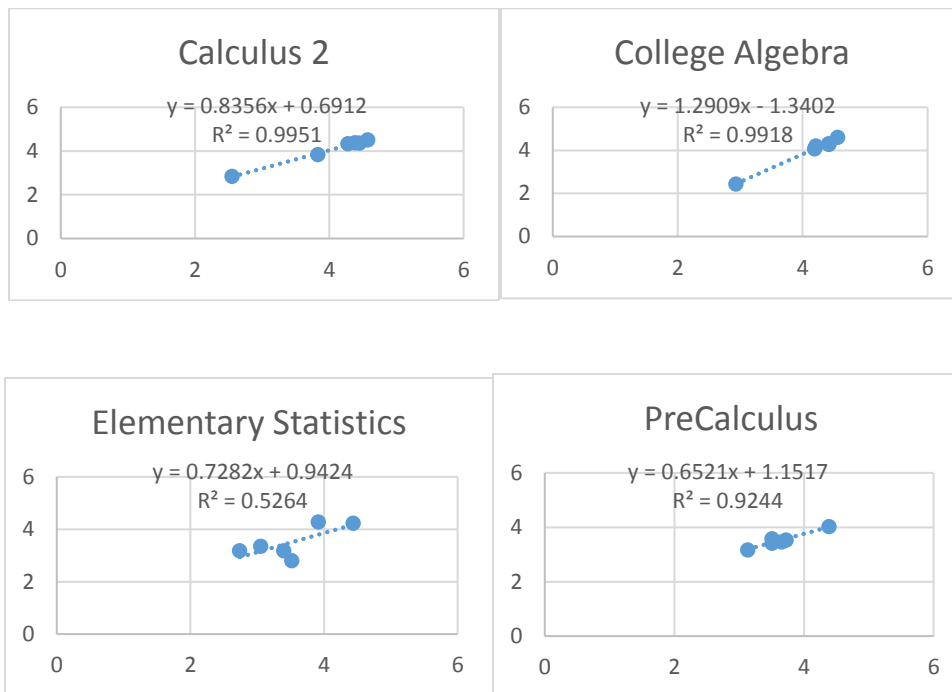
E. Overall, are you satisfied with the educational materials, for example, a text book, WebWork or worksheets?

		Mean beginning of the semester	Mean end of the semester
College Algebra		4.19	4.07
Pre-calculus		3.72	3.53
Calculus II		4.28	4.33
Elementary Statistics		3.4	3.18

F. Overall, are you satisfied with your learning experience in this class?

		Mean beginning of the semester	Mean end of the semester
College Algebra		4.42	4.31
Pre-calculus		3.66	3.47
Calculus II		4.38	4.38
Elementary Statistics		2.74	3.18

We also have performed regression analysis with these data to see whether the ALG project has any positive impact on the outcomes over the aforesaid qualitative traits of the subjected students. Between the two surveys, the first done early in the semester and the second done in the weeks preceding final exams, we have seen steep increase in the quality of the responses. We are providing four linear regression graphs demonstrating the correlation between student usage of the different facets of the ALG project and the likelihood of getting desired responses about the qualitative traits.



As shown in the above graphs, all four courses brought under the ALG banner have seen positive slope in the line of best fit. The impact on learning outcomes for these classes, as based on student experiences in zero/partial cost settings, was confirmed and investigators found a strong betterment of student responses. The range of betterments varied between 33% and 52% between the two surveys done at the beginning of the semester and at the end of the semester. A t-test has revealed that there is enough evidence at the significance level of 0.0001 (99.99%) that the ALG project implementation has improved the quality of student learning outcomes, student retentions during the academic year of 2016.

4. Sustainability Plan

We will share materials (open textbooks, class notes, WebWork, or OpenStax in WebAssign) for the four courses, College Algebra, Pre-Calculus, Elementary Statistics, Calculus II, with math instructors who are interested in OER. The project team members will keep the original copy of the learning material and will maintain and update materials as needed.

5. Future Plans

We expect that we will continue to improve and adopt the materials for the four courses. According to the positive results of this project, we have a plan to adopt open textbooks for the other courses and encourage faculty to adopt OERs. We anticipate to present our results at a conference.

6. Description of Photograph



- *(left to right) Mr. Thomas Hartfield instructor; Dr. Hashim Saber, instructor; Dr. Bikash Das, instructor; Dr. Minsu Kim, instructor and proposal investigator.*